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## **Transmission of COVID-19 (Droplet vs Aerosol)** Is SARS-CoV-2 transmittable via aerosolized form?

### **Key Findings**

- Droplet Laboratory Synthesized Studies
  - A droplet particle ( $>5 \mu\text{m}$ ) may become an aerosol ( $\leq 5 \mu\text{m}$ ) during its trajectory therefore a droplet cannot be thought in isolation from an aerosol.<sup>1</sup>
  - 7/10 studies that were based on modeling found that the horizontal spread of droplets less than  $60 \mu\text{m}$  can vary between 2 meters – 8 meters (about 6 feet – 26 feet).<sup>1</sup>
    - Humidity also factors into the trajectory of SARS-CoV-2 droplet transmission.<sup>1</sup>
      - With increased humidity, the horizontal distance that droplets can travel decreases, but the size of the droplet cloud (the width of it) increases.
- Aerosol Laboratory Synthesized Studies
  - A model was created to estimate the transmission risk in New York City public schools. Transmission risk was higher in the heating season, in high income neighborhoods, and newer buildings. This is likely attributed to schools that are older have poorer insulation, allowing more outdoor air to enter and thus increasing ventilation.<sup>21</sup>
  - SARS-CoV-2 was aerosolized in tissue culture media (TCM) and artificial saliva at medium relative humidity (40%-60%) and high relative humidity (68%-88%). After 90 minutes, in TCM, ~12% of SARS-CoV-2 remained at high humidity and ~45% remained at medium humidity. After 90 minutes, in artificial saliva, ~70% remained at high humidity and ~25% remained at medium humidity.<sup>10</sup>
- Air/Fomite Sampling Studies
  - In a hospital ward in Sweden when sampling patient rooms with patients who had COVID, SARS-CoV-2 was detected in 7/19 vent openings via rRT-PCR; viral RNA was also detected in exhaust filters that were over 50 m away from patient care areas. The infectivity of these samples was not determined.<sup>18</sup>
  - Air samples were taken from patient rooms with COVID patients at the University of Nebraska Medical Center. They were taken for 15 minutes and overall 63.2% of them were positive.<sup>2</sup>
    - The air sampler did not make direct contact with the patients.<sup>2</sup>
    - In 2/3 air samples (in which the air sampler was confirmed to be  $>6$  feet away from the patient) the air sample was positive for SARS-CoV-2.<sup>2</sup>
    - In the NQU (National Quarantine Unit), the percent of positive samples decreased by 20% (from 85% to 65%) from hospital stay days 5-7 to days 8-9. This may indicate a decrease in viral shedding.<sup>2</sup>
    - In the NBU (National Biocontainment Unit), the percent of positive samples slightly increased from at 84% on hospital stay day 10 to 89% on day 18. This was based on different patient rooms being sampled on day 10 and 18.<sup>2</sup>

- The clothing of the personnel who were in rooms with SARS-CoV-2 patients were tested positive for virus RNA including during the absence of cough by the patient when the personnel were present.<sup>2,3</sup>
- High aerosols have been found in public restrooms and in locations where there are high concentrations of people (around a department store entrance and area of a hospital where many outpatients pass by).<sup>3</sup>
- When air samples were taken, it indicated that the maximum distance of aerosolized transmission may be 4 meters (about 13 feet).<sup>4</sup>
- In a well-ventilated environment (mechanical ventilation with an entrance door and small window open), the number of small droplets from a cough was cut in half after 30 seconds. In a non-ventilated environment, the number of droplets was cut in half after 30 minutes.<sup>8</sup>
- Air-recirculation can increase the dissemination of virus particles in an indoor environment.<sup>9</sup>
- 20 COVID-19 patients in Duke University Hospital had fomite and aerosol samples collected from them and their hospital rooms. 6 close contacts were also sampled.<sup>13</sup>
  - Results
    - 12/20 saliva specimens, 11/19 NP swabs, and 3/12 rectal swabs were positive via RT-PCR.
    - 5/19 patient rooms had ≥1 positive fomite sample from an object (toilet bowl, bed railing, remote, bed tray, cell phone).
    - 3/20 patient rooms had positive aerosol samples (2/3 patients had a cough during time of the sample).
  - Comparison
    - Overall, there was lower positive aerosol and fomite samples compared to previous studies; the authors suggested that this may be due to 10 patients being ≥8 days into their illness while the median length for viral clearance is estimated to be 9 days.
- In 2 COVID-19 patient rooms, air samplers were placed 6.6 feet – 15.7 feet away from the patient and using RT-qPCR, COVID-19 was detected in the samples in concentrations of 6 to 74 TCID<sub>50</sub> units/L of air; this is in the absence of aerosolizing procedures. This supports that COVID-19 is viable in aerosols, and that there may be risk of transmission via inhalation of expirations (coughs, sneezes, and speaking).<sup>15</sup>
- Humans Transmission Patterns Supporting Aerosol Spread
  - In an apartment building in South Korea, 10 people in 7 different households tested positive for COVID-19. The households were in two vertical lines of apartments. Each vertical line of apartments shared the same natural ventilation shaft. The people who tested positive reported no contact with each other and wore masks while outside. The authors suggest that the virus may have become aerosolized and entered the ventilation system, spreading to the other households.<sup>20</sup>
  - There is evidence of potential fecal oral transmission. 3 families lived in 3 vertically aligned apartments that were connected by drainage pipes in China, and 9 people from these 3 apartments tested positive for COVID-19. One family had been exposed elsewhere, but the other 2 families had not and had a later onset of symptoms compared to the first family.<sup>14</sup>
  - At a choir rehearsal in Washington state, 1 person was symptomatic and is believed to have infected 52/61 people; 32/52 tested positive. This implies that forceful exhalation

may have aerosolized virus, facilitating transmission in closed room without social distancing.<sup>5,7</sup>

- In different New York City nail salons, at salon with the lowest outdoor airflow rate (3.72 m<sup>3</sup>/min), the airborne infection transmission rate was highest (99%) assuming no one was wearing face masks. In the salon with the highest outdoor airflow rate (94.19 m<sup>3</sup>/min), the transmission rate was (<18%) assuming the same conditions.<sup>17</sup>
- **Ventilation**
  - [This](#) is a summary of evidence that is related to indoor COVID transmission and how ventilation affects it.<sup>19</sup>
    - Aerosol spread is possible beyond 6 feet in poorly ventilated and crowded indoor spaces but additional studies are needed to quantify the role of aerosol transmission in COVID spread. Though SARS-CoV-2 RNA has been detected in ventilation systems, no viable virus has been isolated to date nor any evidence of transmission occurring through HVAC systems.<sup>19</sup>
  - In addition to adequate ventilation, ventilation must be done appropriately (location of the source of ventilation relative to where people in the room are), otherwise there may be increased deposition of particles on surfaces.<sup>16</sup>
  - Based on laboratory modeling of exposure to SARS-CoV-2 on single-aisle and twin-aisle aircraft, exposures in scenarios in which the middle seat was vacant were reduced by 23% to 57%, compared with full aircraft occupancy, depending upon the model.<sup>22</sup>
  - Room ventilation rate significantly affects short-range airborne route, in contrast to traditional belief<sup>23</sup>
    - Ventilation rate of 10L/s per person provides a similar concentration vs distance decay profile to that in outdoor settings, which provides additional justification for the widely adopted ventilation standard of 10 L/s per person
    - Newly obtained data of this study does not support basic assumption in the existing ventilation standard ASHRAE 62.1 (2019) that required people outdoor air rate is constant if the standard is used directly for respiratory infection control
    - Necessary to increase ventilation rate when physical distance between people is less than ~2m

### How Data Supports Aerosol Transmission

- Viruses that are transmitted via aerosols (e.g. measles) have a high reproduction value which is the number of people someone spreads a virus to (e.g. measles is 18). SARS-CoV-2 has a reproductive value of ~2.5 according to one study; therefore, this supports that SARS-CoV-2 is not being primarily spread by aerosols or the amount of virus required to cause infection is much higher than for measles.<sup>11</sup>
  - Transmission rates of COVID-19 in different scenarios<sup>11</sup>
    - Between same household members: 10% - 40%
    - Close but short-term contact (e.g. sharing a meal): 7%
    - Healthcare workers caring for COVID-19 patients when they were unaware the patient was positive and only wearing a mask: < 3%
    - Passing interactions (e.g. passing by someone while shopping): 0.7%
- Currently COVID-19 is ranked 8/9 on plausibility of aerosol transmission<sup>12</sup>
  - This is based on: aerosol generation (COVID-19 has been found in the air around patients), viability in the environment (has been found to survive in aerosols for 16 hours), and access to target tissue (can reach the respiratory tract).

## Recommendations

- Evidence continues to grow for a degree of airborne dissemination and transmission therefore precaution against airborne transmission may potentially be taken.<sup>18</sup> Some ways this may be done is by filtering indoor air or circulating air in from outside.<sup>19,21</sup>
- Droplet and aerosol transmission of SARS-CoV-2 may both be further than the current 6 feet guideline in place so caution should be taken even if you are 6 feet apart.<sup>1,2,4,6</sup>
  - When indoors and without a mask, it may be necessary to keep a 33 feet distance between others to minimize transmission, while when indoors and everyone is wearing a mask, the distance may decrease to about 6.5 feet.<sup>6</sup>
- Caution should be taken in the presence of SARS-CoV-2 patients when considering particles on clothing including in the absence of a cough.<sup>2,3</sup>
- Airborne transmission may be possible therefore airborne precautions are recommended (N95 masks for healthcare workers).<sup>3,5,7</sup>
- Areas that are poorly ventilated may increase the risk of transmission of COVID-19.<sup>8,9</sup>
  - Air-recirculation in buildings should also be minimized or avoided to reduce the airborne spread of COVID-19 by, for example, changing air conditioning settings or opening windows.<sup>9</sup>
- In areas with higher humidity, SARS-CoV-2 may survive longer in saliva particles (e.g. from coughing or sneezing), so extra caution should be taken.<sup>10</sup>
- Currently the chance of aerosol spread of SARS-CoV-2 being the primary method of transmission is low, based on the current data on the pattern of spread, so it may be sufficient to practice social distancing and good hand hygiene, wear masks, disinfect objects, and optimize indoor ventilation to reduce the spread in the public.<sup>11</sup> However, there is increasing evidence that aerosols may contribute to transmission therefore avoiding large crowds and poorly ventilated areas should be practiced when possible (CDC guidelines have been changed again to reflect possible aerosol transmission); more guidance on precautions for the safety of the general public in case of aerosol transmission is needed.<sup>12,15</sup>
- There may be evidence of fecal oral spread, though not much data is available at this time. In the case of fecal oral transmission, drainage system leaks should be monitored and adequate hygiene in sanitary drainage (known to prevent transmission of other fecal oral diseases) can be done to prevent transmission.<sup>14</sup>
- Ventilation
  - Ventilation can be improved by increasing the number of ventilation sources in a room as well as considering where the ventilation source is (especially in the settings like a classroom where the teacher is in one area and speaks the most).<sup>16</sup>
  - Increasing outdoor airflow may also greatly decrease the airborne transmission rate.<sup>17</sup>

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