



How long are small speech droplets airborne?

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Summary

- There is evidence that normal speech produces thousands of oral fluid droplets with a broad size distribution (1 μ m to 500 μ m)
- High viral loads of SARS-CoV-2 were detected in the oral fluids of COVID-19 patients including asymptomatic ones. However, the role of oral fluid droplets generated during loud speech in a confined space has not been studied for probability of infection risk.
- Authors studied the airborne life time of small speech droplets <30 μ m that could possibly play a role in SARS-CoV-2 transmission
- The experiments were done in a rectangular enclosure of 226 L capacity with an iPhone Pro camera mounted on the front side and the speaker port on the back side where the volunteer placed his mouth and spoke when instructed
- Using spherical and cylindrical optics, output from a green (532 nm) Coherent Verdi laser was transformed into a light sheet 150 mm tall and 1 mm thick. The laser sheet entered and exited the enclosure through rectangular slits placed at the centres of two sides opposite to each other and located perpendicular to the axis in which the speaker port and camera were aligned
- A 40 mm 12 V fan placed at the centre of the enclosure when activated spatially homogenized the particles in the enclosure
- At the beginning of the experiment, the enclosure was purged with HEPA filtered air for several minutes with the internal circulation fan kept on
- The purge shutter was subsequently closed and the speaker port was opened through which the subject repeatedly spoke the phrase “stay healthy” for 25 seconds in a loud voice (maximum 85 dB_B at a distance of 30 cm; average 59 dB_B)
- Movie clips of speech droplet nuclei visualised within the laser light sheet were recorded using the camera at a frame rate of 24 Hz with high definition resolution (1,920 × 1,080 pixels)
- The camera lens provided a horizontal field of view of ~20 cm. Therefore, the volume intercepted by the light sheet and viewed by the camera was ~30 cm³, [20 cm (length of field of view) × 15 × 0.1 (dimensions of laser light sheet)]
- The internal fan was turned off 10 seconds after speech was terminated, and the camera continued recording for 80 minutes
- The movie clip was analysed frame by frame to determine the number of spots/streaks whose maximum single-pixel intensity exceeded a threshold value of 30
- The estimated number of speech droplet nuclei released into the enclosure was ~66,000 at the rate of 2600 per second of speaking. A bright and a dim fraction of droplet nuclei were detected which showed exponential decay with time constants respectively at 8 and 14 minutes. The weighted average of time constants of decay for both fractions translated into a half-life of 8 minutes within the enclosure
- Based on the estimated initial diameter and volume of droplets derived from their terminal settling velocities and using the data from prior reports on the average viral load of SARS-CoV-2 in oral fluid of COVID-19 patients, the authors estimated that: **1 minute of loud speaking generates at least 1,000 virion-containing droplet nuclei that remain airborne for more than 8 minutes.**

Conclusion:

- Loud speaking in a confined space can generate thousands of oral fluid droplets that remain suspended in air for tens of minutes and can potentially play a role in the airborne transmission of SARS-CoV-2

Appraisal

Strengths: Fills the gap in the knowledge on airborne course and half-lives of droplet nuclei released by speech. Unlike experiments using aerodynamic particle sizer, the experimental set up allows natural transformation of droplets into droplet nuclei in the prevailing ambient conditions and therefore gives better estimate of airborne lifetime of the droplet nuclei.

Limitations: Size of droplets was not measured directly and was estimated based on their terminal velocities. The setup did not detect every small particle in each frame of the movie, and the reported values are therefore conservative lower limit estimates. Experiments were conducted in healthy human volunteers and not in COVID-19 patients.

Opinion

The study provides evidence, under laboratory conditions, of the number of droplets produced by loud speech and their airborne duration suggesting a plausible role of speech droplets in the transmission of SARS-CoV-2 in confined spaces.

Appraisers

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