WG2, 4 (doc version 07042020)

RESEARCH QUESTIONS

Transmission of SARS-CoV-2 via aerosols: Is it a **plausible** mechanism? If so, what is the **probability** of occurrence, and what the driving processes/mechanisms/forces, sources and spatio-temporal scales relevant for the interactions between viruses and aerosol particles? What are the factors discriminating indoors from outdoors (e.g., solar radiation, viral load)?

RATIONALE

Transmission of viruses between humans can occur via direct or indirect personto-person contact and through the air via respiratory droplets or aerosols. A generally accepted cut-off size to discriminate between respiratory droplets and aerosols is 5 µm diameter. However, the relative contribution of each route to efficiently transmit viruses remains unknown and under debate.

Yet it is widely accepted that aerosol or respiratory droplet transmission is the key factor for the rapid spread and continued circulation in humans.

Respiratory droplet transmission is mediated by expelled particles that have a propensity to settle quickly because of their size and therefore reliant on close proximity between infected (donor) and susceptible (recipient) individuals, usually within 1 m of the site of expulsion.

Aerosol transmission is mediated by expelled particles that are smaller in size than respiratory droplets and can remain suspended in the air for prolonged periods of time, allowing infection of susceptible individuals at a greater distance from the site of expulsion.

These small particles are potentially more infectious than larger sneeze- or cough-generated droplets for several reasons. First, smaller particles persist in the air for longer time periods before setting by gravity, thus increasing the probability of inhalation by susceptible individuals. Second, smaller particles have a larger probability of penetrating further into the respiratory tract of a susceptible individual to initiate a lower respiratory tract infection. Third, these are poorly characterised in the community of bioaerosol researchers. Fourth, some studies suggest that viral copies may be more numerous in fine than in coarse aerosol particles. On the other hand, aerosols emitted in exhales can rapidly dry up in ambient air, therefore their infection potential depends on the inactivation degree of the specific virus in a dried particle. Some viruses like SARS-CoV2 seem to survive better than others in an aerosol medium.

Therefore, there is the possibility that a significant fraction of cases may shed infectious virus, not merely detectable RNA, into aerosol particles small enough to remain suspended in air and presenting a risk for airborne transmission. Data suggests that large numbers of variants could be transmitted via aerosols, especially via the short-range mode. However, longer-range aerosol transmission, as might be observed in less-crowded environments, would be expected to usually result in lower exposures and transmission of fewer variants. In general, in outdoor environments, aerosols carrying viruses are expected to be rapidly dispersed and diluted to a high extent, while confined and indoor environments can favor infection via aerosol transmission.

Current guidelines (e.g., influenza virus transmission in health care settings) are only based on preventing respiratory droplet transmission. However, the recent body of work suggests also transmission by aerosol. This discordance between guidelines and experimental data highlights the urgent need to improve our fundamental understanding of virus transmission.

Once viruses are expelled from the donor, they must remain stable in aerosols/respiratory droplets to be able to initiate a new infection in the recipient. **Estimating the actual probability of transmission due to this cloud** requires information from traditionally distinct disciplines. Clearly, there are many urgent questions about the virus (and particularly, the SARS-CoV-2) transmission and aerosols to address before a conclusion is reached. It is necessary to calculate how these particles move through the air to a susceptible individual. This is where transport analysis and aerosol science are paramount. It is also crucial to understand chemo-physical properties of both the air and the particles, including particle size and chemistry, electrical and magnetic particle properties, as well as particle physical state (solid against liquid particles). Clearly, environmental factors like temperature, ultraviolet radiation, humidity and air movement, all influencing the virus stability and infectivity, should be analysed. In addition, the rate of evaporation of aerosols is higher than that of droplets, which might impact virus survival. In regard to virology, information is required about the average viral titer in the respiratory fluid and the emitted aerosol particles, as well a s the minimum infectious dose for COVID-19 in susceptible individuals. Importantly, understanding how the viral titers in these aerosols change with time post-infection and post-emission. Finally, technological shortcomings should be considered, as current measurement techniques are hampered by the difficulty to capture spatiotemporal scales relevant for the considered processes without inducing any artifacts. Only a strong collaboration between traditionally different aspects of science, and in particular virologists, epidemiologists, toxicologists, aerosol scientists and technologists, and meteorologists, can properly answer the question.

REFERENCES

https://doi.org/10.1038/s41467-020-14626-0 6 NATURE COMMUNICATIONS | (2020)
Scientific Reports | (2019) 9:2348 | https://doi.org/10.1038/s41598-019-38808-z
www.pnas.org/cgi/doi/10.1073/pnas.1716561115
https://www.ncbi.nlm.nih.gov/pubmed/23505369
Asadi, et al. (2020): The coronavirus pandemic and aerosols: Does COVID-19 transmit via expiratory particles?, Aer. S. Techn, DOI: 10.1080/02786826.2020.1749229