Airborne disease transmission: how it works, why it was misunderstood and how to fight it

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The modes of transmission of SARS-CoV-2 have been controversial. Overwhelming evidence now supports dominant airborne transmission for this and other respiratory viruses: some infected people (with high viral load) exhale virus-containing aerosols that float in air like invisible smoke and follow air currents. Aerosols infect by inhalation. This mechanism easily explains substantial transmission in close proximity, superspreading events, less frequent long-distance transmission, and why transmission indoors is far larger than outdoors (Greenhalgh *et al*, 2021; Wang *et al*, 2021).

COVID-19 superspreading events can be jointly explained with a Wells-Riley airborne transmission model. A novel single risk parameter can quantify the relative risk of transmission of a given disease, indoor location and activity (Peng *et al*, 2022 and Figure 1). This approach can be used to prioritize mitigation actions.

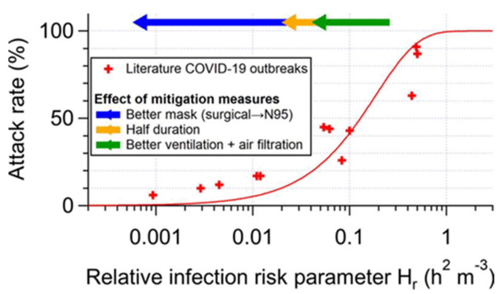

Figure 1. Attack rate of COVID-19 superspreading events vs. the infection risk parameter (Peng *et al*, 2022).

Surface transmission is difficult, and very few, if any, cases of surface transmission have been convincingly demonstrated. A small fraction of transmission may go through ballistic “WHO” droplets, mostly important when an infected person coughs or sneezes on someone else's face. The historically dominant “droplet transmission” is mostly a historical error.

The roots of the extreme resistance from WHO, CDC (and other Public Health authorities) to airborne transmission are rooted in a century of denial of (till 1962) and resistance to (afterwards) airborne transmission, since American public health luminary Charles Chapin in 1910 successfully changed the previous airborne-dominant paradigm (Jimenez *et al*, 2022).

I will present some ideas about how to protect ourselves better from COVID-19 and other respiratory diseases, focusing on: (1) publicly visible CO_2 monitors in all public spaces where we share air with others; (2) the critical importance of mask quality and fit, which have not been explained to the population. This failure underlines much of the confusion about the actual efficacy of masks in the civil society; and (3) the ways in which airborne pathogens can be removed from the air.

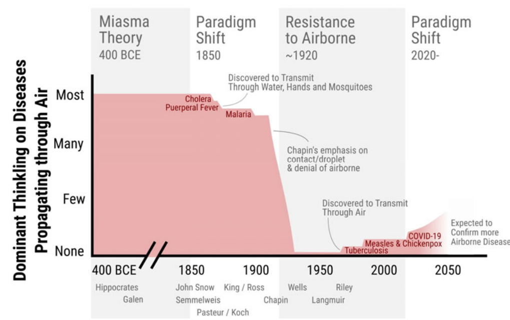

Figure 2. Schematic of dominant thinking on airborne disease transmission in history (Jimenez *et al*, 2022).

Scientists recommend ventilation or filtration as the primary air cleaning methods (Morawska *et al*, 2020). Methods that rely on chemical reactions with the virus (e.g. ions, plasmas, photocatalysis, or hydroxyls, or those based on spraying chemicals in the air) may be dangerous due to the indoor air pollution that they create. Increases of single-digit ppb of O_3 indoors may lead to significant health impacts via PM formation, and can in some cases result in more pollution deaths than saved from airborne disease. Those methods should be avoided until sufficient peer-reviewed study has been performed.

Germicidal UV (GUV; see http://bit.ly/guv-cheat) is highly effective for disinfection. However, it does create indoor air pollution that had not been studied until recently. In particular, GUV222 generates O_3, which in turns generates indoor PM which is 10-30 times more deadly than O_3 itself. GUV222 should not be installed in situations with low ventilation (Peng *et al*, 2023).

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