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Airborne transmission of SARS-CoV-2: The world should face the reality

Lidia Morawska\textsuperscript{a,⁎}, Junji Cao\textsuperscript{b}

\textsuperscript{a} International Laboratory for Air Quality and Health (ILAQH), School of Earth and Atmospheric Sciences, Queensland University of Technology, Brisbane, Queensland 4001, Australia

\textsuperscript{b} Key Lab of Aerosol Chemistry & Physics (KLACP), Chinese Academy of Sciences, Beijing, China

\textbf{A B S T R A C T}

Hand washing and maintaining social distance are the main measures recommended by the World Health Organization (WHO) to avoid contracting COVID-19. Unfortunately, these measures do not prevent infection by inhalation of small droplets exhaled by an infected person that can travel distance of meters or tens of meters in the air and carry their viral content. Science explains the mechanisms of such transport and there is evidence that this is a significant route of infection in indoor environments. Despite this, no countries or authorities consider airborne spread of COVID-19 in their regulations to prevent infections transmission indoors. It is therefore extremely important, that the national authorities acknowledge the reality that the virus spreads through air, and recommend that adequate control measures be implemented to prevent further spread of the SARS-CoV-2 virus, in particularly removal of the virus-laden droplets from indoor air by ventilation.

The entire world is anxiously watching as COVID-19, a disease caused by the SARS-CoV-2 virus, spreads from country to country, following modern travel routes. It was first reported to the WHO Country Office in China on 31 December 2019 (https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen). After that, it inevitably crossed the country’s boundaries, and has become a global pandemic (WHO 2020b).

It could be said that compared with previous global epidemics or pandemics, humanity is much better equipped to control the new epidemic. The virus’s gene sequence was identified and made public and a testing method was developed within two weeks after its existence was announced (Zhu \textit{et al.} 2020), launching the race to develop a protective vaccine (Yan \textit{et al.} 2020). In addition, testing methods measuring the infection (using RT-PCR) and measuring the antibodies formed after infection (using immunoassays) (Elfaitouri \textit{et al.} 2005; Souf 2016). Real-time statistics on all aspects of the virus’s transmission are available online (Worldometers 2020). Countries have enacted emergency response procedures, and travel bans have been put in place (Tian \textit{et al.} 2020), and lockdown procedures which limit the movement of people inside the administrative zones.

Unfortunately, the truth is that we have only a rudimentary knowledge of several aspects of infection spread, including on one critical aspect of the SARS-CoV-2 virus: how THS virus transmits (Bourouiba 2020; Brosseau 2020). In general it is considered that viral respiratory infections spread by direct contact, such as touching an infected person or the surfaces and fomites that the person has either touched, or on which large virus-containing droplets expired by the person have landed (Morawska 2006), and there the virus can remain stable for days (van Doremalen \textit{et al.} 2020). The droplets can also be deposited directly on a person in close proximity to the infected person. Therefore, frequent hand-washing and maintaining a distance of at least one meter (arm’s length) are considered the main precautions against contracting the infection (WHO 2020a). One transmission route that is mentioned only in passing, or not at all, is the transport of virus-laden particles in the air. Immediately after droplets are expired, the liquid content starts to evaporate, and some droplets become so small that transport by air current affects them more than gravitation. Such small droplets are free to travel in the air and carry their viral content meters and tens of meters from where they originated (e.g. Morawska \textit{et al.} 2009), as graphically presented in Fig. 1.

Is it likely that the SARS-CoV-2 virus spreads by air? Its predecessor, SARS-CoV-1, did spread in the air. This was reported in several studies and retrospectively explained the pathway of transmission in Hong Kong’s Prince of Wales Hospital (Li \textit{et al.} 2005; Xiao \textit{et al.} 2017; Yu \textit{et al.} 2005), as well as in health care facilities in Toronto, Canada (Booth \textit{et al.} 2005), and in aircraft (Olsen \textit{et al.} 2003). These studies concluded that airborne transmission was the main transmission route in the indoor cases studied. Other examples of airborne transmission of viral infections include the spread of Norwalk-like virus between school children (Marks \textit{et al.} 2003), and the transmission of influenza A/H5N1
virus between ferrets (Herfst et al. 2012). A World Health Organization (WHO 2009) review of the evidence stated that viral infectious diseases can be transmitted across distances relevant to indoor environments by aerosols (e.g. airborne infections), and can result in large clusters of infection in a short period. Considering the many similarities between the two SARS viruses and the evidence on virus transport in general, it is highly likely that the SARS-CoV-2 virus also spreads by air (Fineberg 2020). Experts in droplet dynamics and airflow in buildings agree on this (Lewis 2020). Therefore, all possible precautions against airborne transmission in indoor scenarios should be taken. Precautions include increased ventilation rate, using natural ventilation, avoiding air recirculation, avoiding staying in another person’s direct air flow, and minimizing the number of people sharing the same environment (Qian et al. 2018). Of significance is maximizing natural ventilation in buildings that are, or can be naturally ventilation and ensuring that the ventilation rate is sufficiently high. These precautions focus on indoor environment of public places, where the risk of infection is greatest, due to the possible buildup of the airborne virus-carrying droplets, the virus likely higher stability in indoor air, and a larger density of people. Public places include in the first instance heath care facilities: while in many hospitals care to provide adequate ventilation is a routine measure, this is not the case in all hospital; often not where new patients are admitted; nursing homes, etc. Shops, offices, schools, restaurants, cruise ships, and of course public transport, is where ventilation practices should reviewed, and ventilation maximized. Also, personal protective equipment (PPE), in particular masks and respirators should be recommended, to be used in public places where density of people is high and ventilation potentially inadequate, as they can protect against in-
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viral infection spread. It is disconcerting that with all the experience and evidence currently available, when faced with a new viral outbreak of COVID-19, the authorities still fail to acknowledge the airborne pathway of transmission, although many experts in China and other countries have had experience in dealing with SARS.

We predict that this failure to immediately recognize and acknowledge the importance of airborne transmission and to take adequate actions against it will result in additional cases of infection in the coming weeks and months, which would not occur if these actions were taken. The air transmission issue should be taken seriously now, during the course of the epidemic. When the epidemic is over and retrospective data demonstrates the importance of airborne transmission it will be too late. Further, the lessons learnt now will prepare us better for when the next epidemic strikes.

To summarize, based on the trend in the increase of infections, and understanding the basic science of viral infection spread, we strongly believe that the virus is likely to be spreading through the air. If this is the case, it will take at least several months for this to be confirmed by science. This is valuable time lost that could be used to properly control the epidemic by the measures outlined above and prevent more infections and loss of life. Therefore, we plead that the international and national authorities acknowledge the reality that the virus spreads through air, and recommend that adequate control measures, as discussed above be implemented to prevent further spread of the SARS-CoV-2 virus.

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