

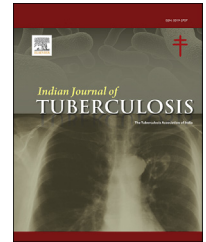


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Editorial

Air pollution, COVID-19, and tuberculosis interrelationship

Three entirely different threats to respiratory health, all global in extent, addressed and confronted differently by the public, health care professionals, and our political leadership. Yet, in all the differences, there is common ground and the interrelatedness cannot and should not be disregarded.

1. Deaths

Tuberculosis remains the largest killer among all infectious diseases caused by a single agent. For the year 2018, the World Health Organization (WHO) estimated that tuberculosis had caused 1.2 million deaths.¹ By mid-June 2020, 430,000 cumulative deaths from or with SARS-CoV-2, the virus causing COVID-19, have been reported (<https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>). WHO estimates that annually 4.2 million people die from outdoor air pollution (https://www.who.int/health-topics/air-pollution#tab=tab_2).

2. Transmission

M. tuberculosis and SARS-CoV-2 are both largely transmitted by the airborne route. For tuberculosis, it has been firmly established that droplets play virtually no role, while the principal vehicles are droplet nuclei (aerosols) that reach the alveoli, in importance dwarfing the frequency of all other routes of transmission.^{2–4}

Current data suggest that SARS-CoV-2 is transmitted primarily via respiratory droplets produced when the infected person speaks, coughs, or sneezes. Droplets can land in the mouths, noses, or eyes of people who are nearby or possibly be inhaled into the lungs of those within close proximity (literally taken from⁵). The principal recommended means for personal protection are hand-washing and physical distancing (termed “social distancing”) based on an understanding of the above routes of transmission. Pictures from some countries soaking the streets and walkways with disinfectants suggest that other, rather less plausible, routes of transmission have also been considered. Probably all too long the possibility of aerosol transmission has been disregarded as an important additional

route, although SARS-CoV-1 did spread this way in the air.⁶ Where the size of the epidemic is receding or where it was never large, outbreaks start to emerge into visibility. Some of these outbreaks and the notion of super-spreading^{7,8} just cannot be easily explained by transmission via droplets in close proximity alone. Examples are for instance those in churches in the United States⁸ and Germany (<https://www.wsj.com/articles/more-than-100-in-germany-found-to-be-infected-with-coronavirus-after-a-churchs-services-11590340102>), or in a large call center in South Korea.⁹ If aerosols do indeed play a larger role than previously assumed, the implications for personal protection – notably for health care workers – are also substantial: there are lessons to be learnt for COVID-19 from tuberculosis.

3. Personal protection

The saying goes that in Japan a person will wear a (face) mask if she or he falls ill with a respiratory ailment, with the intention to protect fellow citizens from oneself. In contrast, in most other countries people seem to wear face masks with the expectation that they are protecting themselves from others with a transmissible respiratory ailment. In tuberculosis, we have a clear understanding of transmission and thus the role of face masks versus that of “respirators”. As their name suggests, surgical masks (or face masks) were originally developed to prevent the wearer’s spoken or coughed secretions from contaminating an operative field and masks were not designed to protect the wearer.¹⁰ Masks will thus contribute to prevent the spread of infectious particles,¹¹ if those with transmissible disease comply with wearing them in the public. As it seems established that SARS-CoV-2 can be transmitted before symptom onset,¹² transmission would even only partially be curtailed in settings like Japan where culture norms would guarantee high adherence upon symptom onset. Thus, wearing masks would have to be imposed universally, a source-intensive requirement that is probably impossible to impose uniformly, and one notably requiring technically correct wearing of technically correctly specified masks. Furthermore, and perhaps paramount, masks will only contribute importantly outdoors in preventing

transmission via splashes of droplets during close encounters. As even correctly worn face masks are not suitable to provide sufficient protection for the wearer against aerosols,¹³ the risk may remain substantial indoors unless well fitted respirators are worn (and male wearers are also cleanly shaved), and respirators are for health care professionals only for good reasons. There has been a large proportion of COVID-19 cases among health care workers for instance in China and Russia with a substantial death toll.^{14,15} As the authors¹⁴ note “The infections in these patients may have resulted from inadequate precautions and insufficient protection in the early stages of the epidemic”. It might be added in the light of increasing evidence for the role of aerosols that face masks as still commonly seen among health care workers might provide a false sense of security.

4. Impact across all walks of life and health care

A correlation between deaths from or with COVID-19 and ambient air pollution from nitrogen dioxide and other pollutants has been shown in several studies, such as from England¹⁶ and Germany, Italy, and Spain.¹⁷ As ecological studies, such correlations all carry the possibility of inherent bias resulting from failing to address individual-level risk factors such as notably age, disease severity or comorbidity. What seems likely though is that the substantially reduced air pollution during lockdown must in itself have reduced the number of deaths substantially at the population level. The substantial impact the worldwide lockdown has had on the reduction in ambient air pollution is remarkable.¹⁸ But the price for this salutary effect is substantial, and it will be short lived.

One may speculate that the policy now in place in many countries to impose uniform wearing of face masks may temporarily also reduce the risk that patients with yet undiagnosed transmissible tuberculosis pose a reduced risk of transmitting *M. tuberculosis*. However, as *M. tuberculosis* is virtually uniformly transmitted by droplet nuclei in aerosols and indoor transmission trumps outdoor transmission, the effect is likely going to be limited. If there should be any effect, it will not least also be temporally as any strict policy of wearing masks is likely going to be relaxed or lifted once the SARS-CoV-2 epidemic recedes. Protection from ambient air pollution for the wearer of masks is going to be defined to a considerable extent by particle size of pollutants: expectedly, face masks are likely quite inefficient against small molecules like nitrogen dioxide.

At the public health level, the SARS-CoV-19 epidemic has forced public health professionals to shift priorities and adapt tuberculosis services to minimize risks for patients.¹⁹ Adapting to the new situation also risks increasing the barriers for tuberculosis to diagnosis and care.²⁰ One of the Sustainable Development Goals addresses health, and specifically calls to end AIDS, tuberculosis, and malaria (and others) by 2030.²¹ Progress has already been suboptimal and the COVID-19 pandemic has further slowed down the process.²² WHO has

warned that the COVID-19 pandemic could have led to as much as 25% reduction in expected tuberculosis case detection for 3 months, and thus associated excess deaths.²³ The challenges are formidable, and not just in resource-strapped health care systems.

Given the ambitious plan of India to end tuberculosis by 2025,²⁴ COVID-19 may substantially impede the route towards the agreed target. As Kuldeep Singh Sachdeva has reminded us earlier this year about ending tuberculosis in India: “the country will need continuous surveillance and constant vigil for any early sign of resurgence of disease and appropriate response thereof”.²⁵ Simultaneously, we are called to find a balance between stabilizing and studying the economy despite the COVID-19 epidemic, protect the public in general and the front-line health care workers specifically as much as possible from it. As all of this would not be enough, we now have got a taste of how marvelously less pollution, notably in large metropolitan areas, literally smells. May we also manage to move forward on that front for a better quality of life for our citizens. After all the biggest killer among all these three formidable challenges to health is the pollution of our ambient air. The true interrelatedness between the three health issues is that we must recognize that in all the apparent differences that characterize them, they are among the biggest challenges to mankind's respiratory health right now. We cannot afford to neglect any of them by forgetting or assigning temporarily lower priority to one or the other. It would seem to be an almost insurmountable task, but we do have no other option nor is there any escape route.

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