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COVID-19: SARS-CoV-2 Transmission and Respiratory Protection for Health Care Workers

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The protection of Healthcare workers (HCWs) is a central element in the fight against infectious diseases transmission. Previous outbreaks (SARS-CoV-1, H1N1, MERS-CoV) have shown that HCWs are at high risk of infection in the course of their work. Chowell et al. studied the SARS outbreaks in 2003 and reported, for the HCWs, infection rates between 19% and 57% of the diagnosed cases (1). Regarding COVID-19, during the first wave in Quebec and Ontario, Dubois reported that respectively 12% and 17% of COVID-19 infections were detected among HCWs (2). In early June 2020, the Public Health Agency of Canada (PHAC) indicated that nearly 27% of COVID -19 positive cases were among HCW (3).

With the COVID-19 pandemic (2020-2021), important debates have arisen about droplet or aerosol transmission and therefore, respiratory protection for healthcare workers. Over the past two decades, similar debates have occurred in the scientific community in 2003 (SARS), 2009 (H1N1) and 2014 (MERS-COV). The World Health Organization (WHO) definition of droplet transmission refers to airborne particles larger than 5 µm that cannot travel more than 2 meters in the air. As soon as transmission occurs at short distances during close contact, the WHO concludes the risk is from droplet transmission. In contrast, aerosol (airborne) transmission involves smaller particles that have the ability to travel long distances while remaining infectious. These definitions are very different from those used in the fields of aerosol science and occupational hygiene. According to these disciplines, all particles smaller than 100 µm in size that contain the coronavirus are called bioaerosols. These bioaerosols can follow airflows, remain suspended, travel and most importantly enter into the human respiratory tract. The physical and aerodynamic characteristics of bioaerosols are influenced by many parameters such as emission velocity, air movement, air temperature and humidity.

At the beginning of the SARS-CoV-2 pandemic, many public health authorities considered the potential for aerosol (airborne) transmission exclusively during aerosol-generating medical procedures (AGMPs). Therefore, the precautions implemented in health care facilities were primarily physical distancing, hand hygiene, eye protection, and a procedural (medical) mask. Respiratory protection (respirator) was only recommended when performing AGMPs (4). In July 2020, an open letter signed by 239 scientists called on WHO to recognize the potential for airborne transmission of SARS-CoV-2, even in the absence of AGMPs (5). In response to this letter, more than 300 signatories from hospital and community epidemiology groups stated that clinical experience in managing the pandemic affirmed that the mode of transmission of SARS-CoV-2 is short-range, not airborne, and that they are concerned that the debate about airborne transmission will lead to confusion and fear among the general public.

To date, no studies have shown that only particles > 5 µm are involved in the transmission of COVID-19 or any other respiratory infections. The size of particles emitted from the human respiratory tract varies from large (> 100 µm) to very small (< 1µm). This fact is now a consensus and makes it one of the most important focal points of the pandemic. As a result, during close contact, workers are exposed to both small and large particles. Several case reports and observational studies also suggest transmission of the virus in the absence of close contact (7, 8). There is growing evidence that SARS-CoV-2 can travel more than two meters and experimental evidence indicates that the virus is viable in aerosols for several hours (9-10). Therefore, the transmission through inhalation of particles containing SARS-CoV-2 virus cannot be ruled out. This risk must consider and include inhalable particles at both short and long distances.

In January 2021, the Quebec government recognized the potential of COVID-19 transmission through inhalation even if AGMPs were not performed, and in March 2021, the Quebec occupational health and safety research institute (IRSST) recommended that HCWs in close contact with suspected or confirmed COVID-19 patients should use properly fitted filtering face piece respirators and ruled that medical masks are not respirators and do not protect workers from inhalable particles (11). Whether or not aerosol transmission of COVID-19 is accepted (particles < 5 µm as defined by infection control and prevention experts), how can it be justified that recommendations to wear respirators are governed solely by particle size and not by the intensity and probability of exposure? This is the very basis in the risk assessment of potential exposure for workers. A support tool for choosing respiratory protection against bioaerosols has been proposed (12). This tool is a six-step approach that uses a control banding method based on the hazard and the exposure level to select appropriate respiratory protection against bioaerosols (13). Using this tool for SARS-CoV-2, a minimum of an air-purifying respirator with half-mask (e.g. N/R/P-95/99/100) would be needed for low levels exposures and a powered air-purifying respirator with full facepiece would be needed for very high exposure levels. Between these two recommendations, several respirators could be used, such as a powered air-purifying respirators with loose-fitting facepieces, and an air-purifying respirators with full facepieces (reusable elastomeric full-facepiece). The graduated risk management tool highlights the need to provide higher-level respiratory protection in certain situations and introduces reusable elastomeric masks (full-face masks and half masks) to protect healthcare workers in the context of pandemic. These recommendations are still not retained in Canada. The health organizations' recommendations are limited to the duality between a procedure mask and a N95. Major modifications including a respiratory protection program are necessary as per CAN/CSA-Z94.4-18 Selection, use, and care of respirator (14) in order to change the practices of Infection Prevention and Control (IPAC).

Because the boundary between droplet and aerosol transmissions is not only complex to establish, but also not based on current scientific knowledge, a paradigm shift seems necessary to define the risks of respiratory virus transmission. Transmission should be determined by mechanism, not by particle size. Inhalation transmission (bioaerosols <100 µm), versus projection transmission, would better describe the transmission and particles dynamics. Skeptics will say that the boundary

between < and > 100 µm is also difficult to define, and this is true. However, this definition has no impact on the choice of respiratory protection for HCWs. Finally, it should be noted that in light of the SARS experience in 2003 in Canada, the Ontario Independent Commission recommended that the health and safety of HCWs be assured and that the precautionary principle be applied to protect them in the absence of scientific evidence in future outbreaks. The commission recommended that the highest standards for HCWs protection be applied (15). Institutional delays in recognizing the risk of inhalation transmission and the need to protect workers with respiratory protection devices are unacceptable. The precautionary principle or the prevention principle should apply since scientific data, even from the start of the pandemic, indicated the importance for respiratory protection. We must take into account past experience, invest in prevention, and ensure the protection of all workers against inhalation of respiratory pathogens.

* Adapted from Marchand et Debia (2020). COVID-19 : transmission du SARS-CoV-2 et protection respiratoire pour les travailleurs de la santé. *Travail et Santé*. 36(3) :S4-S5. Tirée de https://travailetsante.net/wp-content/uploads/2020/10/TS-HIVER-2021-Scientifique-COVID-19-Transmission-et-protection.pdf

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