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SUPPLEMENT to Reducing the Risk of COVID-19 Using Engineering Controls

Guidance Document

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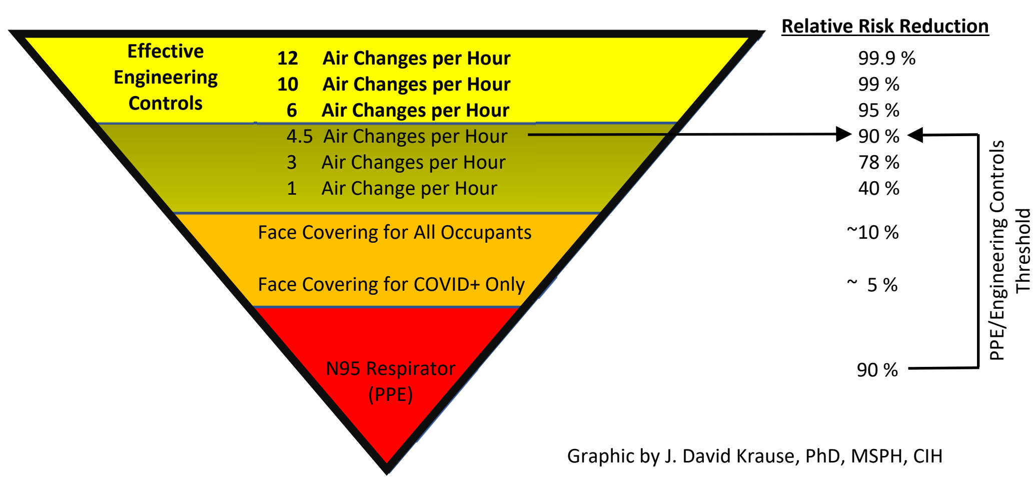

Derivation of estimated relative risk reduction offered by different control measures described in Figure 2

This supplement is provided to explain how estimates of relative risk reduction were derived for face coverings and engineering controls in Figure 2 of the AIHA guidance document *Reducing the Risk of COVID-19 using Engineering Controls*, Version 1, August 11, 2020. Citations of published studies and available CDC guidance are provided by reference and the considerations made by authors and contributors to the guideline are discussed.

Rengasamy et al reported that fabric materials commonly used to construct face coverings may only provide marginal protection against particles in the size range of virus-containing particles in exhaled breath. Average penetration levels for the three different cloth masks were between 74% and 90% (meaning they captured between 10% and 26% of aerosols), while N95 filter media controls showed penetration of only 0.12% at 5.5 cm/sec face velocity.(1)

The average penetration levels for three different models of towels and scarves ranged from 60–66% and 73–89% respectively. "The results obtained in the study showed that cloth masks and other fabric materials had 40–90% instantaneous penetration levels when challenged with polydisperse NaCl aerosols. Similarly, varying levels of penetration (9–98%) were obtained for different size monodisperse NaCl aerosol particles in the 20–1000 nm range." Two of the five surgical masks that were evaluated demonstrated 51–89% penetration levels against polydisperse aerosols.(1)

While not evaluated in this study, face seal leakage is known to further decrease the respiratory protection offered by fabric materials. Aerosol penetration for face masks made with loosely held fabric materials occurs in both directions (inhaled and exhaled). Due to their lose fitting nature and the leakage that occurs even when a face mask is properly worn, a modifying factor of 25% was applied.

Finally, compliance with the proper wearing of face coverings when people generate the most aerosols (i.e. speaking, exercising, etc.) significantly impacts the anticipated risk reduction they can offer. Due to observed lapses in proper wearing of cloth face coverings (i.e. covering only the mouth or wearing them below the chin) and when people pull the mask down when speaking to someone, a modifying factor of 50% was applied. A face covering only worn half the time or covering only the mouth offers less risk reduction.

MacIntyre et al reported that laboratory tests showed the penetration of particles through cloth masks to be very high (97%) when compared to medical masks (44%) that were tested, and when compared to N95 3M model 9320 (<0.01%), and the 3M Vflex 9105 N95 (0.1%). In other words, the cloth masks tested in this study only captured 3% of the exhaled aerosols.[2]

This study also evaluated compliance of healthcare workers wearing cloth masks and medical masks. They found that healthcare workers complied only 56.5% of the time for cloth masks and 56.8% of the time for medical masks.[2]

The high levels of initial penetration reported in the studies cited above, ranging from 40-97% equates to capture efficiencies of 3-60%. The impact of typical leakage and frequent non-compliance with proper use and wear, is the basis for a generous estimate of 5-10% relative risk reduction for face masks and cloth face coverings. Studies do suggest that surgical and medical masks, when worn properly and with full compliance could offer greater protection, for both the wearer and for those nearby. However, their availability and proper use is not currently required and was not the basis for the relative risk reduction estimated for reusable facial coverings and masks.

This supplement is not intended to suggest that face coverings and masks not be used, but rather to objectively examine and recognize their contribution to risk reduction. In light of the limited level of relative risk reduction offered by face coverings and masks the AIHA has recommended engineering controls be used to reduce the risk of exposure in indoor environments, which is anticipated to reduce the transmission of disease, even in nonhealthcare settings.

Estimates of relative risk reduction presented in the figure above that can be offered by outside air ventilation and/or enhanced filtration (i.e. HEPA or MERV 17) were derived using the model presented below. Initial and ending concentrations of respirable aerosols were modeled at various air change rates in a room over a 30-minute period. Similarly, the steady state concentration of aerosols given equal source strength (i.e. virus-containing aerosols exhaled by a person) can be estimated using this model. The formula and its applicability to infectious disease control are described in detail in the CDC [Guidelines for Environmental Infection Control in Health-Care Facilities (2003)].[3]

$$t2 - t1 = -[\ln(C2 / C1) / (Q / V)] \times 60, \text{ with } t1 = 0$$

where

t1 = initial timepoint in minutes

t2 = final timepoint in minutes

C1 = initial concentration of contaminant

C2 = final concentration of contaminant

C2 / C1 = 1 – (removal efficiency / 100)

Q = air flow rate in cubic feet/hour

V = room volume in cubic feet

Q / V = ACH

1. Rengasamy, S., Eimer, B., and Shaffer, R. E. Simple Respiratory Protection—Evaluation of the Filtration Performance of Cloth Masks and Common Fabric Materials Against 20–1000 nm Size Particles. Ann. Occup. Hyg., Vol. 54, No. 7, pp. 789–798, 2010

2. MacIntyre CR, Seale, H., Dung, , TC, et al. A cluster randomised trial of cloth masks compared with medical masks in healthcare workers. BMJ Open 2015;5:e006577. doi:10.1136/bmjopen-2014-006577

3. CDC Guidelines for Environmental Infection Control in Health-Care Facilities (2003) https://www.cdc.gov/infectioncontrol/guidelines/environmental/appendix/air.html#tableb1