Preventing virus aerosol nosocomial transmission

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Introduction

Healthcare workers (HCWs) are at risk from nosocomial transmission of SARS-CoV-2 from virus laden aerosols. The World Health Organization (WHO) and Centres for Disease Control and Prevention (CDC) updated their advice regarding the critical role of airborne transmission of SARS-CoV-2 in April and May of 2021, respectively. Their guidelines now recommend that HCWs caring for COVID-19 patients wear an N95 or equivalent respirator and that indoor air quality is optimised, which includes the deployment of portable high efficiency particulate absorbing (HEPA) filters when enhancement of permanent air-handling systems is not feasible. However, the rank importance of these measures is not clear and the magnitude of effect on infection risk reduction is not known.

Aims

This study aimed to: 1) quantify the degree of protection from virus aerosol provided by different types of mask (surgical, N95, fit-tested N95) and personal protective equipment (PPE); 2) determine if the use of a portable high efficiency particulate air (HEPA) filter can enhance the effectiveness of PPE.

Methodology

Virus aerosol exposure experiments were conducted using the model virus bacteriophage PhiX174 (10^8copies/mL). A HCW wearing PPE (mask, gloves, gown, faceshield) was exposed to nebulised viruses for 40mins in a sealed clinical room. After exiting, the HCW doffed PPE. Virus exposure was quantified via skin swabs applied to the face, nostrils, forearms, neck, and forehead. Experiments were performed with and without the presence of a portable HEPA filter (13.4 room volume air filtrations per hour).

Results

Swabs quantified significant virus exposure on the face and nostril while wearing either surgical or fit-tested N95 mask. Only the fit-tested N95 resulted in lower virus counts compared to no mask control (p=0.027). Nasal swabs demonstrated very high virus exposure, which was not mitigated by the surgical or N95 masks, although there was a trend for the fit-tested N95 mask to reduce virus counts (p=0.058). The addition of HEPA filtration substantially reduced virus counts from all swab sites, and to near zero levels when combined with a fit-tested N95 mask, gloves, gown and faces shield.

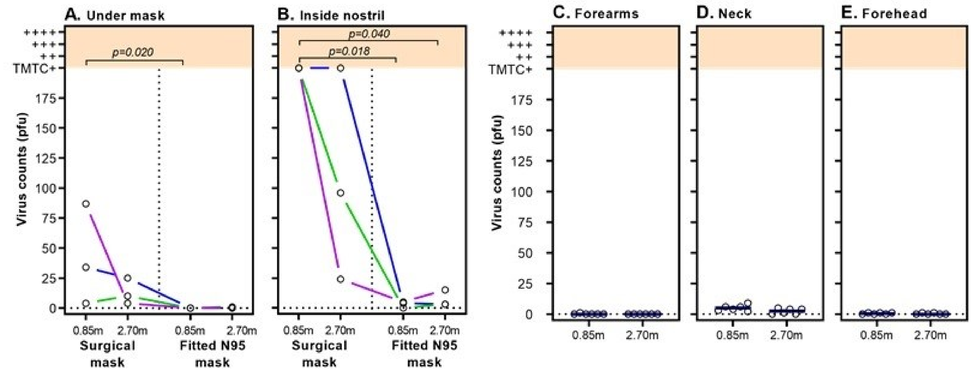

Figure 1 - HEPA filtration combined with PPE and distance on virus plaque counts. *Virus counts from skin swabs (open circles, y-axis) are shown at 0.85m (i.e. bedside) and 2.5m (distanced) locations (x-axis). Virus counts were quantified as plaque forming units (PFU). Coloured lines connect data points collected on the same day (same exact bacteriophage titre). Blue bars represent the median. A HEPA filter set to a clean air filtration rate of 470m^3/hr (equivalent to 13 exchanges/hr) is present in all conditions.* ***A)*** *Virus counts recovered from under the mask were significantly lower with a fitted N95 mask.* ***B)*** *Virus counts from inside nostril were substantially higher for the surgical mask compared to the fitted N95 mask. Combining HEPA filtration and PPE (gown, gloves and face shield) resulted in very low virus counts on* ***C)*** *Forearms,* **D)** *Neck, and* ***E)*** *Forehead, however the neck was the least protected body site, likely due to no coverage provided by the gown.*

Conclusions

These data demonstrate that quantitatively fit tested N95 masks combined with a HEPA filter can offer protection against high virus aerosol loads at close range and for prolonged periods of time and that this strategy should be utilised in the protection of healthcare workers. Skin contamination from virus aerosol can be effectively removed by showering.