High-flow nasal cannula for COVID-19 patients: risk of bio-aerosol dispersion

From the authors:

We appreciate the comments of J. Elshof and co-workers on our article "High-flow nasal cannula for COVID-19 patients: low risk of bio-aerosol dispersion" [1] and agree that further research is warranted to reduce the risk of virus transmission from infected patients. The presented *in vitro* data of J. Elshof and co-workers from a model using light detection of smoke dispersion distance and velocity, suggesting that high-flow nasal cannula (HFNC) generates a larger dispersion distance than non-rebreather masks and Venturi masks, is in contrast to reports from Hui *et al.* [2] using a similar model. Presumably, because the smoke used by J. Elshof and co-workers was larger (0.3–2.5 µm) than that used by Hui *et al.* [2] (⩽1 µm), the larger particles dispersed differently. It should be noted that smoke in both models represents only a small fraction of the range of bio-aerosols generated by patients during breathing, speaking, coughing or sneezing [3]. Using the same size airway model, J. Elshof and co-workers observed that the dispersion distance decreased from 71 cm to 25 cm by changing the nasal cannula size from small to large when HFNC flow was set at 30 L·min^{-1}; however, when HFNC flow was set at 60 L·min^{-1}, the medium-size nasal cannula generated a shorter distance than both small and large nasal cannulas. This raises the role of proper fit of prongs to nares and highlights the limitations of modelling. Regardless of the sizes of nasal cannula, the dispersion distance was farther with 60 L·min^{-1} than 30 L·min^{-1}, which is in line with the results of Hui *et al.* [2] and may be expected, as higher velocity of the gas will carry exhaled smoke to a further distance. However, this effect of total flow did not occur when testing the Venturi mask. Surprisingly, the Venturi mask with large open holes and a total gas flow of 40 L·min^{-1} generated a shorter dispersion distance than normal breathing. These inconsistencies are difficult to interpret without comprehensive peer review of extensive methods and results. Whether smoke imaging models truly reflect the natural features of the transportation and dispersion of bio-aerosols generated by patients has not been established and results from these studies should be interpreted cautiously.

In a recent clinical study of aerosol particle concentrations and severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus detection in the vicinity of patients with coronavirus disease 2019 (COVID-19), aerosol particle size and concentrations were measured before and after HFNC was applied to patients. No difference was observed between conventional nasal cannula applied prior to HFNC, and HFNC. More importantly, no SARS-CoV-2 virus was detected in the room air with the sampling cassette placed at 30 cm from the patients' airways for an hour (unpublished data).

It should also be noted that oxygen masks, including Venturi masks, non-rebreather masks, simple masks and aerosol masks, do not enable placement of a filter, except for some oxygen masks with special design [3, 4]. Bio-aerosols generated by patients might be exhaled *via* the holes or the one-way valve on the masks, and the high gas flow from the masks helps carry those bio-aerosols to a further distance. In contrast, patients using HFNC can wear a surgical mask over the HFNC, in order to reduce the dispersion of bio-aerosols that they generate [4, 5].

In all, compared to conventional oxygen devices, HFNC has been proven to improve oxygenation and reduce intubation rate in hypoxaemic patients [6]. Abandoning HFNC to use other oxygen devices for the uncertain risks of virus transmission is unnecessary and ill advised. Special caution taken to protect personnel during "aerosol-generating procedures" is more important than avoidance of "aerosol-dispersing procedures" [3]. Studying the production of aerosols by breathing support devices using laboratory models (*e.g.* smoke dispersion) is interesting but has important limitations, because they are just simulations. What is really important, and still lacking in the literature, is a real-life study assessing the actual virus

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cargo within the patient's generated aerosols and, more importantly, how infective such a viral cargo is, which would probably depend on the physical and chemical characteristics of the aerosol particles.

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