



## Early View

### Correspondence

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

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Human-to-human SARS-COV2 transmission has been established with more than 3,300 clinicians reported to be infected in China and more than 1,116 clinicians infected in Italy where 13,882 cases were confirmed by 13 March 2020. Room surfaces in the vicinity of COVID-19 symptomatic patients and clinician's protection equipment were found to be contaminated.<sup>1</sup> The primary strategy for COVID-19 patients is supportive care, including oxygen therapy for hypoxemic patients, in which high-flow nasal cannula (HFNC) was reported as effective in improving oxygenation. Among patients with acute hypoxemic respiratory failure, HFNC was proven to avoid intubation compared to conventional oxygen device.<sup>2,3</sup> However, there is an important concern that HFNC may increase bio-aerosol dispersion in the environment due to the high gas flow used. The increased dispersion might favor transmission of infectious agents (such as COVID-19) carried in aerosol droplets generated by the infected patient. This concern is reflected in the limited use of HFNC in the first clinical study reporting 21 patients with COVID-19 in Washington State, where only one patient used HFNC.<sup>4</sup> In contrast, a broad utilization was observed in the study by Yang and colleagues from Wuhan, China where 33 out of 52 ICU patients were treated with HFNC.<sup>5</sup>

There appears to be an uncertainty and a trend to avoid HFNC among COVID-19 patients in the western world, thus increasing early intubation rates and potentially associated harms such as sedation and prolonged intensive care unit stay but also intubation procedures *per se* which represent a high risk situation for viral exposure. Early intubation increases the demand for ventilators, contributing to the critical shortage reported worldwide. Avoiding or delaying invasive mechanical ventilation could substantially reduce immediate demand for ventilators. Thus, we aimed to discuss the scientific evidence supporting the risk of HFNC induced bio-aerosol dispersion in the COVID-19 context.

The utilization of smoke (an aerosol of solid particles < 1  $\mu\text{m}$ ) simulation via a manikin model by Hui et al<sup>6,7</sup> provides a direct visualization of exhaled smoke dispersion. It

appears that when using HFNC, dispersion is greater at 60 L/min than at 10 L/min.<sup>6</sup> We summarize the results from reported *in-vitro* with different oxygen devices by Hui and colleagues in Table 1.<sup>6,7</sup> Interestingly, using the same study method and similar breathing patterns, the exhaled smoke dispersion distance from the manikin with HFNC at 60 L/min<sup>6</sup> was similar to the one observed with a simple oxygen mask at 15 L/min<sup>7</sup> and even smaller than with other oxygenation devices, particularly non-rebreathing and Venturi masks.<sup>7</sup> While the dispersion of smoke in this model is instructive, especially between interfaces, particle size of smoke ( $< 1\mu\text{m}$ ), only represents a small fraction of the mass of bio-aerosol generated by patients naturally. As aerosol generated by patient's cough contains particles from 0.1-100  $\mu\text{m}$ , clinical studies are demanded to truly evaluate aerosol dispersion particularly the aerosol dynamics during physiological exhalation and cough.

Leung and colleagues reported a randomized controlled trial comparing the utilization of HFNC at 60 L/min with oxygen mask at  $8.6 \pm 2.2$  L/min in 19 ICU patients with bacterial pneumonia on the environmental contamination. The patient's room air was sampled and settle plates were placed at 0.4m and 1.5m from patients. No significant difference in bacterial counts was reported in the air sample and settling plates between the two oxygen devices at 1, 2 and 5 day incubation.<sup>8</sup> These clinical results confirm the *in-vitro* smoke experiments.

*In-vitro* and clinical studies demonstrated that placing a simple surgical protection mask on patients significantly reduces dispersion distance<sup>9</sup> and virus infected bio-aerosol 20 cm away from patients while coughing.<sup>10</sup> Such a surgical mask can be worn by patient oxygenated through a nasal cannula (standard nasal cannula or HFNC) but not when using simple, non-rebreathing or Venturi oxygen masks.

Taken together, compared to oxygen therapy with a mask, the utilization of HFNC does not increase either dispersion or microbiological contamination into the environment; the patient being able to wear a surgical mask above HFNC in order to reduce the aerosol transmission during coughing or sneezing represents an additional benefit.

However, given the high efficacy of HFNC to oxygenate the patients, closely monitoring the use of HFNC for COVID-19 patients is crucial to avoid any delay in intubation, respiratory rates, pulse oximetry and clinical examination is essential.

In conclusion, massive numbers of clinicians were infected during the COVID-19 outbreak, which raised the concerns of implementing aerosol generating procedures, consequently, there appears to be a trend to avoid HFNC. The scientific evidence of generation and dispersion of bio-aerosols via HFNC summarized above show a similar risk to standard oxygen masks. HFNC prongs with a surgical mask on patient's face above could thus be a reasonable practice which may benefit hypoxemic COVID-19 patients and avoid intubation.

Clinicians should consider moving away from the dogma refraining the use of HFNC among COVID-19 patients.

## **Declarations**

### **Authors' contributions**

SE, JBF and JL conceived of the idea. JL performed literature search and drafted the manuscript. All authors reviewed and revised the manuscript and approved the final draft.

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### **Ethics approval and consent to participate**

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### **Conflict of interests**

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Table 1. Summary of exhaled smoke dispersion distances with different oxygen devices

Oxygen device	Dispersion distance, cm	
HFNC <sup>3</sup>	60 L/min	17.2 ± 3.3
	30 L/min	13.0 ± 1.1
	10 L/min	6.5 ± 1.5
Simple mask <sup>4</sup>	15 L/min	11.2 ± 0.7
	10 L/min	9.5 ± 0.6
Nonrebreather mask <sup>4</sup>	10 L/min	24.6 ± 2.2
Venturi mask at F <sub>I</sub> O <sub>2</sub> 0.4 <sup>4</sup>	6 L/min	39.7 ± 1.6
Venturi mask at F <sub>I</sub> O <sub>2</sub> 0.35 <sup>4</sup>	6 L/min	27.2 ± 1.1

Summary of studies evaluating oxygen delivery devices using a high-fidelity human simulator with smoke particles of < 1 μm (an aerosol of solid particles). While the smoke was illuminated by a laser light-sheet and high definition video to measure dispersion distance away from the manikin. Indicated dispersion distances give an idea of proximity of contaminated bio-aerosols, in which healthcare workers may be directly exposed. HFNC, high-flow nasal cannula; F<sub>I</sub>O<sub>2</sub>, fraction of inspired oxygen.