



## Patient self-proning with high-flow nasal cannula improves oxygenation in COVID-19 pneumonia

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### To the Editor,

A high-flow nasal cannula (HFNC) is commonly used in the management of hypoxic respiratory failure, and is associated with more ventilator-free days and lower mortality compared with standard oxygen therapy or non-invasive ventilation.<sup>1</sup> Nevertheless, its use in coronavirus disease 2019 (COVID-19) patients is complicated by the increased risk of particle dispersion (especially with coughing),<sup>2</sup> potential depletion of oxygen supplies,<sup>3</sup> and concerns that it is unlikely to change the natural course of viral pneumonia. These factors have resulted in calls to forgo its use in favour of earlier intubation.<sup>4</sup> While these concerns are valid, they may have unintended consequences during the current pandemic. Hospital policies directing earlier intubation of COVID-19 patients will accelerate consumption of intensive care unit (ICU) resources including ventilators, sedative medications, and human resources. Lastly, creating a lower barrier to intubation and ICU admission obscures the true severity of the disease and distorts pandemic modeling.

Emerging evidence suggests that COVID-19 patients develop atypical acute respiratory distress syndrome (ARDS) with relatively preserved lung mechanics despite severe hypoxemia due to shunt fraction.<sup>5</sup> It is additionally known that prone positioning can improve oxygenation and reduce shunt fraction.<sup>6</sup>

For patients without increased work of breathing, we propose that HFNC can meet the oxygen demands while allowing patients to manage their body position

independently through self-proning. Concerns related to additional HFNC-mediated aerosol generation can be mitigated through any or all of the following: a surgical mask placed on the patient to limit particle dispersal, enhanced personal protective equipment for staff, patient cohorting, and negative pressure environments.

We recently used this strategy to treat a 68-yr-old COVID-19 patient (who provided written consent for this report). The patient presented with bilateral opacities suggestive of pneumonia that rapidly worsened after two days of admission (Figure A). He was placed in a negative pressure room, HFNC was applied (initially at 60 Lpm and 90% oxygen), and the patient was instructed to self-prone via telephone by lying with his chest down for as long as possible (Figure B). He was also provided with pillows to arrange for his self-comfort and it was explained that this was done to improve his oxygen levels. Total proning time was approximately 16–18 hr each day (including 8–10 hr while asleep at night), and was interrupted for meals and short breaks for physiotherapy. While the patient never complained of severe dyspnea, he did say that he felt better while prone. Proning resulted in cyclical improvements in his oxygenation (Figure C). During his treatment, the patient developed nasal congestion and blood clots in posterior nasal passages that resulted in worsening oxygenation. Despite a shorter proning duration than is typical in ventilated patients, the observed physiologic effects of proning on oxygenation were clearly apparent and reproducible. During his stay, our patient maintained oral nutrition, communicated with his family via cellphone, and participated in self-directed physiotherapy. As the nurse conveyed instructions to the patient by phone and the patient self-proned, the direct nursing and respiratory therapist care were actually less than would be expected for an intubated patient requiring proning. The patient was

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**FIGURE** A) Anterior-posterior chest radiograph two days after intensive care unit (ICU) admission showing bilateral lung opacities. B) Patient self-proning while wearing high-flow nasal cannula. C) Changes in oxygenation expressed as arterial partial pressure of oxygen to fractional concentration of inspired oxygen (P:F) ratio versus time from ICU admission. Initiation of self-proning sessions is indicated by red arrows. Following the last self-prone session, the P:F

ratio failed to improve. The patient was subsequently un-proned, which did not improve oxygenation. The care team then realized that the patient had developed nasal congestion (due to blood clots) in his posterior nasal passages. Once these were cleared, his oxygenation once again improved, and he was discharged from the ICU to a dedicated COVID-19 ward.

discharged to a dedicated COVID-19 ward after four days without requiring intubation.

A recent report from Italy describes two time-related phenotypes of COVID-19 pneumonia.<sup>7</sup> Initially, many patients present with severe hypoxemia in the absence of dyspnea and preserved lung compliance, low lung weight, low ventilation to perfusion (V/Q) ratio, and low lung recruitability (defined as the L-phenotype). With time, some of these patients progress to a more classic ARDS phenotype characterized by low lung compliance, high lung weight, high right-to-left shunt, and high lung recruitability (defined as the H-phenotype). While we did not have computed tomography imaging to estimate lung weight in our patient, he would likely have fit the L-phenotype given severe hypoxemia and relative absence of dyspnea, although progression of his pulmonary infiltrates on chest radiography after two days of admission (Figure A) may point to the early stages of the H-phenotype.

The proposed reason for hypoxemia in the L-phenotype is the dysregulation of pulmonary perfusion and loss of hypoxic vasoconstriction.<sup>7</sup> Dorsal lung regions have more lung tissue, denser vasculature resulting in lower regional pulmonary resistance, and weaker hypoxic pulmonary vasoconstriction owing to higher endothelial expression of nitric oxide.<sup>8</sup> The prone position results in more even distribution of lung tissue between dorsal and ventral planes leading to more uniform alveolar architecture. Furthermore, it also leads to more uniform distribution of pulmonary perfusion.<sup>8</sup> Both of these changes likely reduced regional V/Q heterogeneity and improve oxygenation in the prone position. The improvement in oxygenation may also restore hypoxic pulmonary vasoconstriction, which is impaired at lower oxygen levels,<sup>9</sup> further improving V/Q mismatch. Finally, it is

possible that improved oxygenation prevents worsening of dyspnea, while redistribution of lung tissue with self-proning alters the lung stress-strain relationship and intrathoracic forces, slowing the formation of lung edema and progression of disease from L- to H-phenotype.

Future studies should determine whether routine use of HFNC combined with patient self-proning can be broadly applied in COVID-19 patients with hypoxemia and normal work of breathing. In addition to preserving ventilator capacity in resource replete settings, this care approach would have important applications to resource-limited countries where sophisticated ICU techniques may not be available.

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