The Rationale for use of HFNC in patients with COVID-19 pneumonia

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Key Articles

- Li J, Fink JB, Ehrmann S. High-flow nasal cannula for COVID-19 patients: low risk of bio-aerosol dispersion. Eur Respir J 2020; in press (https://doi.org/10.1183/13993003.00892-2020).
- Ferioli M, Cisternino C, Leo V, et al. Protecting healthcare workers from SARS-CoV-2 infection: practical indications. Eur Respir Rev 2020; 29: 200068 (https://doi.org/10.1183/16000617.0068-2020).

Background

- COVID-19 produces a hallmark pneumonia characterized by severe hypoxic respiratory failure
- High flow nasal cannula (HFNC) has demonstrated certain advantages – it provides more reliable and titratable oxygen delivery, improved comfort and dyspnea, improves end-expiratory lung volume, reduces dead space ventilation, and improves the work of breathing and dynamic lung compliance.
- In randomized controlled trials, the efficacy of HFNC has been mixed. One trial observed a reduced 90-day mortality with no difference in intubation rate (Florali 2015) but a subsequent study in immunocompromised patients found no decrease in either intubation rate or mortality (HIGH 2018).
- Many guidelines recommend the use of HFNC over the use of non-invasive ventilation
- Healthcare workers are worried about the exposure risk in patients who are placed on HFNC

Objective

- Determine whether providing High Flow Nasal Cannula confers any risk to healthcare workers or patients

Review of risks to HCW

- Smoke simulation studies done by Hui et al.
    - Performed in a negative pressure room
    - Using a manikin simulator, variable lung compliance, measured with a laser
    - Smoke used – which has a size of <1 micron
        - Nasal cannula @ 5lpm – dispersion distance of 100cm
        - Non-rebreather mask @12lpm – dispersion distance of <10cm
        - HFNC @60lpm – dispersion distance of 17cm (60cm sideways)

        - CPAP @ 20cmH20 – negligible dispersion distance
        - BPAP @13/5, full face mask – dispersion distance of 92cm
        - BPAP @10/10, helmet – negligible dispersion distance
    - **All respiratory devices can produce air dispersion. A perfect fit of NIV interface may result in the least dispersion. According to this study, HFNC has less dispersion than a NC**
- Retrospective evaluation during other coronavirus pandemics
    - SARS-1 in Toronto – risk of transmission to healthcare workers was evaluated
        - 26/624 HCW contracted SARS
        - Highest risk encounters were:
            - Encounters that exposed providers to patient's mucus membranes or eyes
            - Manipulation of oxygen mask
            - Sputum collection
            - Intubation
        - HFNC was not associated with greater risk
        - NIV was associated with greater risk
        - None of the 26 providers were wearing an N95 at time of patient exposure
    - **Proper PPE, training, and caution while handing respiratory secretions seem most important to prevent virus spread to healthcare workers**
- Wearing a mask may decrease droplet spread
    - A mask can capture 83% of the particles dispersed when using HFNC at 40lpm
    - Particles that escaped the mask traveled the same distance as particles from patients without oxygen devices who were not wearing a mask

Review of risks to patients:

- Delays in intubation may have the potential to cause patient harm
    - In a propensity matched trial of patients who fail HFNC, those two fail early had improved outcomes compared with those who fail late (>48hours)
    - Patient self-induced lung injury (P-SILI) is a conceptual and theoretical construct on how patients may worsen lung injury through spontaneous breathing; it's the analogy to high TV ventilation in mechanically ventilated patients
    - Currently it is an unproven theory
- **Without clear guidance or endpoints, a decision to initiate or continue HFNO therapy to prevent lung injury rests on clinical judgment and gestalt. The incorporation of clinical scores predicting failure of HFNO may also be useful to discriminate in this setting**

Recommendations:

- HFNC can be used in select patients with COVID-19
    - Ideally place patient in a negative pressure room
    - Cover face and nasal cannula interface with face mask

- HCW treating these patients should wear a respirator and other appropriate PPE at all times
    - Consider the following criteria in selection
        - Awake, protecting airway, clearing secretions
        - No evidence of multi-organ failure or shock
        - Requiring more than 6lpm to maintain adequate oxygen sats
        - Respiratory rate < 30 breaths per minutes
        - Initial P:F ratio >150
    - Monitor patients closely and use ROX index to guide continued therapy
        - ROX index is the ratio of SpO2/FiO2 to RR rate
        - ROX index > 4.88 at any time is predictive of success of HFNC
        - At 2 hours ROX < 2.85 predicts HFNC failure
        - At 6 hours ROX < 3.47 predicts HFNC failure
        - At 12 hours ROX < 3.85 predicts HFNC failure
    - Consider the following exclusion criteria
        - SpO2 < 88% despite NRB mask
        - Respiratory rate > 35 breaths per minute
        - Hypercapnic respiratory failure (pH <7.30)
        - Uncontrolled metabolic acidosis
        - Alterations in mental status
        - Hemodynamic instability with use of vasopressors
- Guideline recommendations by relevant Societies and Organizations

Organization	Recommendation	Statement
World Health Organization (WHO) [46]	Caution	• HFNO should only be used in selected patients with hypoxemic respiratory failure.
Society of Critical Care Medicine (SCCM) [47]	Use	• For adults with COVID-19 and acute hypoxemic respiratory failure despite conventional oxygen therapy, we suggest using HFNO over conventional oxygen therapy (weak recommendation, low quality evidence). • In adults with COVID-19 and acute hypoxemic respiratory failure, we suggest using HFNO over NIPPV (weak recommendation, low quality evidence).
Italian Thoracic Society (AIPO-ITS) [48]	Use	• When available, use a high-flow oxygen blender of at least 70 L/min • Increase FiO2 up to 0.9-1 to guarantee just enough oxygenation
Australia and New Zealand Intensive Care Society (ANZICS) [49]	Use	• We therefore recommend that airborne PPE precautions should be used to care for all COVID-19 patients in intensive care. This includes the use

		of high flow nasal oxygen in non-ICU environments. • HFNO is a recommended therapy for hypoxia associated with COVID-19 disease, as long as staff are wearing optimal airborne PPE. Negative pressure rooms are preferable for patients receiving HFNO therapy.
American Association for Respiratory Care (AARC) [50]	Use	• In patients with early hypoxemia, consider high flow nasal oxygen. This is controversial, with some concerns regarding environmental contamination. If used, there should be a low threshold for failure and urgent intubation. Some clinicians will elect to avoid high flow nasal cannula.
National Institutes of Health (NIH) [51]	Use	• For adults with COVID-19 and acute hypoxemic respiratory failure despite conventional oxygen therapy, the Panel recommends high-flow nasal cannula oxygen over noninvasive positive pressure ventilation

Take Home Points

- **HFNC may benefit patients with acute hypoxic respiratory failure, though there is some variation in the literature**
- **HFNC, when used properly, exposes HCW to no greater risk than a traditional nasal cannula. This assessment is based on available literature and extrapolation from prior epidemics and from simulation models**
- **Patients on HFNC should be monitored closely for clinical worsening and should receive intubation and mechanical ventilation if they are not responding appropriately to therapy. A combination of subjective clinical assessment and the ROX score can help with this decision.**