Proposed Management of COVID-19 with High-Flow Nasal Cannula

This document collates society & institutional guidelines and offers guidance for use of HFNC for treatment of COVID 19 disease while minimizing risk to staff. This is an evolving area without definitive evidence or uniform policy that underwent multi-disciplinary discussion. Considerations include:

- Safety of staff (particularly respiratory therapy and nursing)
- Paucity of data on the increased aerosol risk
- Difficulty in assessing how many patients failing NRB would survive on HFNC alone
- HFNC has been utilized in lieu of ventilation of both full code and DNI patients in the setting of limited resources

**Recommendation**

HFNC may have a role in the subset of COVID-19 patients who have essentially normal compliance but severe symptomatic hypoxemia.

**Indications for Use**

- Use in patients:
  - P/F 200-300
  - Patients with incomplete response to 15L NRB mask O₂ challenge, but RR adequate
  - Patients with asymptomatic hypoxemia & evidence of end organ or tissue hypoxia
- Support of hypoxemic patients who are DNI and in whom there is a treatment in place that the patient needs support to see if it will work. (On anti-viral and need to survive 2d to see if drug will work.)
- Do not use for air hunger in patients on comfort care.

**Infection Control Safety**

- Airborne + contact precautions
- Negative pressure room
- PAPR (preferred) or N-95 (+ face protection) required
- Should not be routinely deployed in ED or acute care units unless limited ICU capacity
- Turn off HFNC for patient movement through the hospital

**Safety**

- Keep HFNC off until patient has simple surgical facemask in place over HFNC & RT is away from face. (Ideally > 2m / 6 ft.).
- Turn off HFNC for any removal or adjustment.
- Correct size with snug fit of interface
- Limit flow to 30L max.

**Evaluation of Effectiveness**

- Use ROXI (see below) to predict failure. Re-assess 2 hours after initiation:
  - If SpO₂≥93% + RR<25 + ROXI>3.85, then continue HFNC
  - If SpO₂≥93% + RR 25-30 + ROXI 2.85-3.85, then continue HFNC for 6 hours & re-assess
  - If SpO₂<93% or RR≥30 + ROXI<2.85, then stop HFNC & consider intubation
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### Summary of Guidelines & Recommendations of HFNC in COVID-19

<table>
<thead>
<tr>
<th>Society or Institution</th>
<th>Use?</th>
<th>Recommendation</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHO</td>
<td>Yes</td>
<td>HFNC … systems with good interface fitting [i.e., good seal, no air leak] do not create widespread dispersion of exhaled air and therefore should be associated with low risk of airborne transmission.</td>
<td></td>
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<tr>
<td>Surviving Sepsis Campaign</td>
<td>Yes</td>
<td>For adults with … acute hypoxemic respiratory failure despite conventional oxygen tx, we suggest using HFNC over conventional oxygen therapy (weak recommendation, low quality evidence).</td>
<td>Raboud 2010. HF O2 not associated w/ HCW transmission</td>
</tr>
<tr>
<td>Society Critical Care Medicine</td>
<td>Maybe</td>
<td>Practices such as … high-flow nasal cannula (HFNC) … may veer away from everyday standards.</td>
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<tr>
<td>Australia New Zealand Intensive Care Society</td>
<td>Yes</td>
<td>High Flow Nasal Oxygen (HFNO) is a recommended therapy for hypoxia associated with COVID-19 disease, as long as staff are wearing optimal airborne PPE. We suggest avoidance of HFNO use to preoxygenate patients prior to intubation.</td>
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<tr>
<td>University College London Hospitals</td>
<td>Maybe</td>
<td>Consider HFNO in pts. who SpO2 ≥95% (&gt;90% COPD) w/ 15L NRB “O2 Challenge”</td>
<td></td>
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<tr>
<td>Wuhan University</td>
<td>Yes</td>
<td>Use in pts. with P/F 200-300 @ FiO2 1.0 for 2h. Use ROX index to evaluate continued use: (SpO2≥93% + RR&lt;25 + ROXI&gt;3.85) continue HFNO (SpO2≥93% + RR 25-30 + ROXI 2.85-3.85) HFNO x6h (SpO2&lt;93% or RR≥30 + ROXI&lt;2.85) stop HFNO</td>
<td></td>
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<tr>
<td>Shanghai Medical Association</td>
<td>Yes</td>
<td>If 1-2h nasal or mask oxygen treatment does not meet the treatment requirements, no improvement in respiratory distress, or during treatment hypoxemia and/or respiratory distress, or oxygenation index of 150 to 200 mmHg, use HFNO.</td>
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<tr>
<td>Italian Society Infectious Disease</td>
<td>Yes</td>
<td>Suggest use if &gt;2 of: - Staccato speech (can’t count to 20 quickly after deep breath) - RR &gt; 22 - PaO2&lt;65mmHg or SpO2&lt;90% - Significant worsening of CXR</td>
<td></td>
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<tr>
<td>Brigham &amp; Women’s Hospital</td>
<td>No</td>
<td>Avoid high-flow nasal cannula (HFNC) … for ARDS.</td>
<td></td>
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<tr>
<td>Intermountain Health System</td>
<td>No</td>
<td>Proceed with intubation — no NIPPV/HFNC — if requiring therapy &gt;6L via nasal canula given (1) NIPPV/HFNC likely does not prevent intubation; (2) initial NIPPV/HFNC may yield worse outcomes; and (3) increased droplet production increasing risk to HCW.</td>
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**Effectiveness**

**Zhou 2020**: Observational study 191 pts. from Jinyintan Hospital & Wuhan Pulmonary Hospital. 54 (28%) died in hospital. 41 pts. (21%) received High-flow nasal cannula oxygen therapy. HFNC was used more often in non-survivors (61%) vs. survivors (6%).

**Matthay 2020**: Before endotracheal intubation, it is important to consider a trial of high-flow nasal oxygen for patients with moderately severe hypoxemia. This procedure might avoid the need for intubation and mechanical ventilation because it provides high concentrations of humidified oxygen, low levels of positive end-expiratory pressure, and can facilitate the elimination of carbon dioxide. WHO guidelines support the use of high-flow nasal oxygen in some patients, but they urge close monitoring for clinical deterioration that could result in the need for emergent intubations because such procedures might increase the risk of infection to health-care workers.

**Roca 2019**: 2-year multicenter prospective observational cohort study including patients with pneumonia treated with HFNC. 36% of the patients went on to intubation & mechanical ventilation. Cox proportional hazards modeling of ROX association with HFNC outcome. Among the 191 patients treated with HFNC in the validation cohort, 68 (35.6%) required intubation. The prediction accuracy of the ROX index increased over time (area under the receiver operating characteristic curve: 2 h, 0.679; 6 h, 0.703; 12 h, 0.759). ROX greater than or equal to 4.88 measured at 2 (hazard ratio, 0.434; 95% confidence interval, 0.264–0.715; P = 0.001), 6 (hazard ratio, 0.304; 95% confidence interval, 0.182–0.509; P = 0.001), or 12 hours (hazard ratio, 0.291; 95% confidence interval, 0.161–0.524; P = 0.001) after HFNC initiation was consistently associated with a lower risk for intubation. A ROX less than 2.85, less than 3.47, and less than 3.85 at 2, 6, and 12 hours of HFNC initiation, respectively, were predictors of HFNC failure. Patients who failed presented a lower increase in the values of the ROX index over the 12 hours. Among components of the index, oxygen saturation as measured by pulse oximetry/FIO2 had a greater weight than respiratory rate.

| ROX Index (ROXI) = (SpO2 / FIO2) / RR |
|---------------------|---------------------|---------------------|
| Hours After HFNC Initiation | Lower Risk Intubation | Predictor of HFNC Failure |
| 2 hours | ROXI > 4.88 | ROXI < 2.85 |
| 6 hours | (at all time points) | ROXI < 3.47 |
| 12 hours | (at all time points) | ROXI < 3.85 |

**Example 1**: SpO2 90% on FIO2 0.5, RR 32, 12h after initiation
ROXI = (90/0.5)/32 = 5.63
lower risk intubation

**Example 2**: SpO2 90% on FIO2 0.8, RR 32, 12h after initiation
ROXI = (90/0.8)/32 = 3.52
predicts HFNC failure & need for intubation
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Safety
High-Flow Nasal Cannula (HFNC) is an aerosol-generating procedure. Increased droplets may be limited to close proximity to the patient.

Zou 2020: High viral loads detected soon after symptom onset, higher viral loads in nose than throat. Analyzed the viral load in nasal and throat swabs obtained from the 17 symptomatic patients in relation onset of any symptoms. Higher viral loads were detected soon after symptom onset, with higher viral loads detected in the nose than in the throat. Our analysis suggests that the viral nucleic acid shedding pattern of patients infected with SARS-CoV-2 resembles that of patients with influenza and appears different from that seen in patients infected with SARS-CoV.

Cheung 2004: NIV prevented IMV in 70% of patients with SARS; no infection in 155 HCWs. Examined the efficacy of NIV in early ARDS and also evaluated the infection risk among healthcare workers who had direct contact with patients on NIV. A total of 22 patients needed NIV and a total of 155 healthcare workers, including doctors, nurses and healthcare assistants, were exposed to these patients on NIV therapy. Coronavirus serology was obtained in 97% of healthcare workers. NIV equipped with expiratory bacterial and viral filters was provided in isolated cubicles in the ward or ICU, which were centrally air-conditioned, and fitted with exhaust ventilation fans to achieve negative pressure flow. This study concluded that NIV was not only effective in preventing IMV in 70% of patients with acute respiratory failure due to SARS but effectively reduced the ICU length of stay or avoided ICU admission. Moreover, no infection was noted in any of the 155 healthcare workers. Their serology tests for coronavirus were negative. The potential risk of particle dispersion and spread of infection due to NIV must not be overlooked, even though, at present, the data remains inconclusive.

Hui 2019: HFNC airflow leakage distance 13cm @ 30L flow. Human patient simulator (HPS) in an isolation room with 16 air changes/hour. CPAP was delivered at 5–20 cmH2O via nasal pillows (Respironics Nuance Pro Gel or ResMed Swift FX) or an oronasal mask (ResMed Quattro Air). HFNC, humidified to 37°C, was delivered at 10–60 L/min. Exhaled airflow was marked with intrapulmonary smoke for visualization and revealed by laser light-sheet. Normalized exhaled air concentration was estimated from the light scattered by the smoke particles. Significant exposure was defined when there was ≥20% normalized smoke concentration. In the normal lung condition, mean±SD exhaled air dispersion, along the sagittal plane, increased from 186±34 to 264±27 mm and from 207±11 to 332±34 mm when CPAP was increased from 5 to 20 cmH2O via Respironics and ResMed nasal pillows, respectively. Leakage from the oronasal mask was negligible. Mean±SD exhaled air distances increased from 65±15, 130±11, 172±33mm when HFNC was increased from 10, 30, 60 L/min. Air leakage to 620 mm occurred laterally when HFNC and the interface tube became loose.

Kotoda 2019: Manual repositioning of the cannula significantly increased the water dispersal. This study aimed to investigate the risk of pathogen dispersal during high-flow nasal therapy. Liquid and bacterial dispersal were assessed via in-vitro experimental set-ups using a manikin. Thickened water or fresh yeast solution mimicked saliva and nasal mucus secretions. In the liquid dispersal experiment, water was detected only on the sheet placed in front of the manikin’s face. Manual repositioning of the cannula significantly increased the water dispersal. Water dispersal was not
detected on the sheets placed 5 m away from the manikin. Similar to the liquid dispersal experiment, yeast colony formation was observed only on the dish that was closest to the manikin’s face. Manual repositioning of the cannula significantly increased the colony formation. Dispersal was observed in two dishes placed in front of and lateral to the manikin’s face. Colony formation was not observed on the dishes placed 5 m away from the manikin.

**Leung 2019**: At six air changes/hr, total bacterial count on plates placed at 1.5 m while the patients were using HFNC was statistically significantly higher than when using an oxygen mask. This randomized controlled crossover non-inferiority trial evaluated the degree of environmental contamination by viable bacteria associated with the use of high-flow nasal cannula compared with conventional oxygen mask for critically ill patients with Gram-negative pneumonia. The results from 19 patients (of 196 screened) with full data sets are presented. Mean (SD) oxygen flow rate while using O2 mask was 8.6 (2.2) L/min and the FiO2 while using HFNC was 0.5 (0.1). No difference in GN bacteria count between the HFNC and O2 mask use for air samples, settle plates at 0.4 or 1.5 m, and at six or at 12 air changes per hour. At six air changes per hour, the total bacterial count on plates placed at 1.5 m while the patients were using HFNC was statistically significantly higher than when using an oxygen mask, after one and two days of incubation. Otherwise, no difference in total bacteria count was detected between HFNC and mask use.

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