

Supplementary Material

Serial Biomarker Measurements May Be Helpful to Predict the Successful Application of High Flow Nasal Cannula in COVID-19 Pneumonia Patients: A Retrospective Analysis

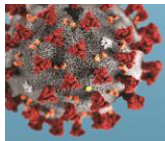
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GUIDELINES FOR USE OF HIGH FLOW NASAL CANNULA (HFNC) FOR PERSONS UNDER INVESTIGATION (PUI) FOR COVID-19 OR COVID-19 PATIENTS (Refer to Respiratory Care Policy #2508-18-560-B for additional information)

Purpose

To guide safe and effective use of HFNC in PUI for COVID-19 or COVID-19 patients who have severe hypoxemic respiratory failure that is disproportionate to affected lung compliance.

Appendices

1. Appendix #1 – Provider HFNC “Cheat Sheet”
2. Appendix #2 – RN HFNC “Cheat Sheet”

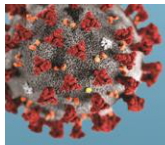
Indications for Use

- ï Patients with Acute Hypoxemic Respiratory Failure and inadequate response to a non-rebreather mask (which should not be used with oxygen flow rates >15L/min, or for >24 hours without improvement in the patient's condition):
 - o SpO₂<88% or
 - o Increased work of breathing or
 - o Asymptomatic hypoxemia and evidence of end organ or tissue hypoxia
- ï Patients must be awake and have intact airway protective reflexes.
- ï Patients should generally have a pH that is within normal limits and a pCO₂ that is near their baseline levels.
- ï Patients who are designated as “Do Not Intubate” status are eligible, but HFNC should not be used for air hunger in COVID-19 patients on comfort care.
- ï As there is a limited number of HFNC units available, orders for starting HFNC in PUI for COVID-19 or COVID-19 patients should be placed by intensivists assigned to provide care for COVID-19 patients.

Infection Control Safety

HFNC is aerosol generating and it has a higher risk of pathogen spread to health care workers than mechanical ventilation in patients who are intubated. Providers should weigh the expected benefits from HFNC use against the theoretical risk of infection transmission.

- ï Patients should ideally be placed in a negative pressure room, with an aerosol generating procedure sign on the closed door. If a negative pressure room is not available, the patient should be placed in a private room with the door closed, and an aerosol generating procedure sign should be placed on the door.
- ï Health care workers should wear full PPE including N95 masks, eye protection, and a gown while HFNC is in use.
- ï Patients should wear a surgical mask over their face and cannula when a health care provider is within 6 feet:



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- ï Health care workers should turn off HFNC whenever removing the device from the patient's face.
- ï A properly-sized cannula with a good fit of the interface should be used.
- ï As aerosolized particles are dispersed further with higher flow rates, the lowest effective flow rate should be used titrating upward in 10L/min increments, and flow rates should be kept ≤ 40 L/min if possible, and should not exceed 60 L/min.
- ï Patients should not be transported while on the HFNC device. If transport becomes necessary, patients should be intubated or placed on a non-rebreather mask during transport.

Patient Safety and Monitoring HFNC Effectiveness

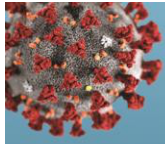
At QMC-Punchbowl, patients should be treated with HFNC on the QET 9 Diamond Head Advanced Respiratory Unit or in an ICU. At QMC-West, patients should be treated with HFNC in the Advanced Medical Surgical Unit (AMSU) or in the ICU. If beds are not available in these areas, patients on HFNC should be in a unit with central pulse oximetry monitoring capability and appropriately trained staff. Patients can be designated as medical- surgical ward status, but they require a higher level of attention and the acuity of each patient and the intensity of their care should be assessed and taken into consideration by the Charge Nurse or Nurse Manager when assigning patients to nurses.

Patients who are not improving with HFNC should be identified early to avoid intubation delays. Bag-mask ventilation is discouraged prior to intubation of COVID patients, and intubation should be done electively before it becomes emergent. To objectively determine whether patients are responding to HFNC support, use of the ROX Index (ROXI) to evaluate effectiveness is mandatory (see below).

Evaluation of HFNC Effectiveness Summary:

- ï Re-assess 2 hours after initiation:
 - If SpO₂ $\geq 88\%$ + RR < 40 + ROXI > 3.85 , continue HFNC
 - If SpO₂ $\geq 88\%$ + RR < 40 + ROXI 2.85-3.85, continue HFNC 6 hours and re-assess
 - If SpO₂ $< 88\%$ or RR ≥ 40 or ROXI < 2.85 , consider intubation

- Use ROXI (see below) or work of breathing (RR > 40 as surrogate) or resting SpO₂ to predict failure. Patients with a ROXI > 4.88 after 12 hours of HFNC support are less likely to require intubation, but continued monitoring and reassessments should be performed while on HFNC.
- If a patient on the QET 9 Diamond Head Advanced Respiratory Unit has a ROXI < 3.85 on HFNC, the consulting intensivist for the unit should be notified to reassess the patient.



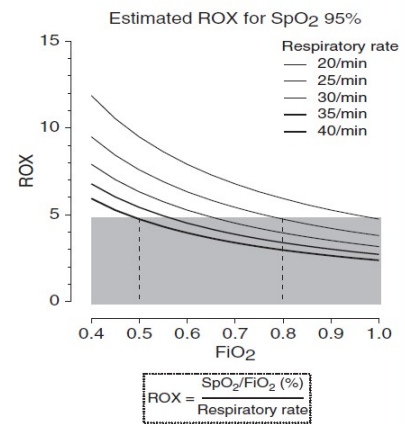
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ROX Index (ROXI) = (SpO₂ / FIO₂) / RR

Hours After HFNC Initiation	Lower Risk Intubation	Predictor of HFNC Failure
2 hours	ROXI > 4.88 (at all time points)	ROXI < 2.85
6 hours		ROXI < 3.47
12 hours		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



Eating on HFNC

- Healthy subjects have been noted to have decreased swallowing function with oxygen flow rates >40 LPM (11). Patients should be kept NPO if the HFNC flow rate is > 40LPM or if the ROXI is <3.85.

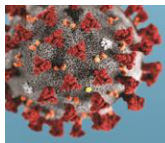
Weaning from HFNC

- Wean FIO₂ and flow as appropriate to a general SpO₂ goal of 90-92%, unless patient factors suggest a different SpO₂ goal.
- Generally, the FIO₂ is titrated down first to 40% and then the flow rate is decreased incrementally by 10 L/min/hour with a target SpO₂ of 90-92%. Upon reaching a flow rate of 20L/min, the patient can be trialed off the HFNC and on to other regular oxygen devices, such as a non-rebreather mask or an oxy-mask.
- If the patient decompensates, place them back on HFNC at the previous flows and FIO₂, and monitor for improvement.

References:

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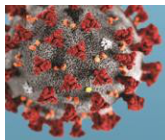
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COVID HFNC CHEAT SHEET – PROVIDER

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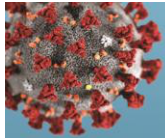
D2 intensivist (x5746) phone consultation for new HFNC initiation.

Call or TigerText D2 if you're concerned patient may need to be intubated within 24 hours (i.e., ROX index

<4, unable to wean from max HFNC settings). D2 will not be rounding on each HFNC patient daily.

1. Candidates for HFNC:
 - Requires flush NRB to maintain O2 sats >90%.
 - Significant work of breathing on 15L NRB
 - Due to supply limits: if rapid escalation of oxygen requirement, or desaturations with exertion, that led to flush NRB -> consider medical optimization and weaning first prior to starting HFNC. Order (written or verbal) for HFNC should be placed by D2 intensivist.
2. When on HFNC:
 - Start at 40L 100%, then wean FiO2 as tolerated.
 - Maximum flow is 60L. Minimum flow is ~30L
 - Goal is to wean FiO2 <60% (nontoxic levels) if able. Can increase flow to facilitate weaning FiO2.
 - Calculate ROX index (Use MD Calc) = SpO2/FiO2 (%) / RR (bpm)
 - o ROX index >4.88 is associated with lower risk of intubation
 - o ROX index <3.85 is associated with higher risk of HFNC failure
 - o ROX index between 3.85-4.88 -> reassess patient within 1-2 hours
 - Wean flow <40L when eating, may increase FiO2 temporarily if needed.
 - Emphasize self-proning whenever able. Refer to QMC Self Proning Guide and order set.
 - Place PICC line for reliable access and anticipation of ICU transfer.

- Strict I&Os. Maintain negative fluid balance unless hypotensive or renal failure.
 - Consider foley placement to minimize movement .
 - Consider standing antitussives (i.e., benzonatate or codeine). Guaifenesin is an expectorant and may worsen cough.
 - No transport while on HFNC. This includes between facilities, between floors, to imaging, etc. Transport can be done on NRB if able, or will require intubation.
 - Follow QMC COVID Therapies Guide for treatment considerations.
 - Consider early GOC+/-Palliative Consult in older patients and those with baseline organ/multiorgan dysfunction.
 - Consider atypical antipsychotics (i.e., seroquel or olanzapine) for sleep/anxiety. Try to avoid benzos as it can increase delirium.
3. If worsening respiratory status/oxygenation:
- Order CXR.
 - Look for superimposed infections (i.e., film array pneumonia panel, sputum gram/stain and culture) and consider empiric abx.
 - Trend d-dimer: if >3 and rapidly escalating, consider UE/LE dopplers. Consider therapeutic AC until dopplers can be done (usually too unstable for CTA chest).
 - If unable to wean from 100% FiO2 and 40L, consider NPO status.
 - Increase diuresis unless hypotensive or renal failure.

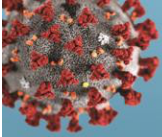


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- If patient is deteriorating, it is acceptable to temporarily add NRB to HFNC, but this should not be continued for prolonged period of time. Intubation should be considered. If patient is DNR/DNI status, should then discuss transitioning to CMO.
4. How to wean HFNC:
- Wean FiO2; goal O2 sat 90-92%.
 - Once FiO2 40%, can begin weaning flow by 10L/min/hour, and switch to a non-rebreather mask or an oxy-mask once the flow has been decreased to 20L/min.

*For specific details pertaining to QMC HFNC policy, please refer to Respiratory Care Policy #2508-18-506-B.



COVID HFNC CHEAT SHEET – RN

Consult D2 intensivist (x5746) for new HFNC initiation, and if you're concerned patient may need to be intubated within 24 hours (i.e., ROX index <4, unable to wean from max HFNC settings). D2 will not be rounding on each HFNC patient daily.

- ï If VOCSN alarms → check tubing for kinks; check nasal prongs for occlusion.
- ï If patient is decompensating, call RT STAT. Increase FiO₂ (NOT flow rate):
 - Consider repositioning patient if decompensation was after a turn.
 - For VOCSN, increase FiO₂ under therapy tab, or initiate 100%FiO₂ on side tab.
 - For Optiflow, dial up FiO₂.
- ï If your patient is ready to eat:
 - Patients should be kept NPO if the HFNC flow rate is > 40LPM or if the ROXI is <3.85.
 - Assess respiratory pattern. If tenuous, consider NPO status. Ensure current dietary orders are appropriate.
 - If patient is safe to eat, turn FLOW down to 30L (or less) for duration of meal.
 - FiO₂ may need to be increased if flow is decreased
 - When adjusting HFNC setting for meals, stay with patient for at least 5 minutes to ensure that they are stable on the new settings.
 - After meals, return patient to previous setting.
- ï For turns or other activity (bed bath, ROM, etc.):
 - Pre-oxygenate your patient
 - For VOCSN, increase FiO₂ under therapy tab, or initiate 100%FiO₂ on side tab.
 - For Optiflow, dial up FiO₂.
 - Return settings back to baseline after turn/activity.
- ï **Emphasize self-proning whenever able.** Refer to QMC Self Proning Guide and Prone order set.
- ï Be aware of the ROX Index for your patient (see HFNC guidelines for more details).
 - RT will calculate ROX index (Use MD Calc) = SpO₂/FiO₂ (%) / RR (bpm)
 - ROX index >4.88 is associated with lower risk of intubation
 - ROX index <3.85 is associated with higher risk of HFNC failure
 - ROX index between 3.85-4.88 -> reassess patient within 1-2 hours
- ï **DO NOT TRANSPORT** patients on HFNC.
- ï Patients should wear a surgical mask over the HFNC when staff is within 6 feet.
- ï AGP sign should be posted on the door of HFNC rooms.
- ï Consider use of CAPR for increased staff protection.

- Aerosolized particles are dispersed further with higher flow rates.
 - Particles may linger in the air longer in non-negative pressure rooms.
 - If there is no CAPR superuser on your unit, contact clinical education for CAPR education and validation.
- ï When in doubt, call RT.
 - Charge nurses from 9DH and 4M are also good resources if workflow permits.