COVID-19: High Flow Nasal Cannula (HFNC)/Non-Invasive Positive Pressure Ventilation (NIPPV) Indications

A Rapid Guidance Summary from the

Penn Medicine Center for Evidence-based Practice

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Key questions answered in this summary

1. What are the indications for HFNC and NIPPV in COVID-19 positive patients?
2. How should these devices be initiated?
3. What are the thresholds for intubation and mechanical ventilation for patients who are not responding or deteriorating when on HFNC or NIPPV?

Summary of major recommendations

Recommendation	**Rating**
If a patient with COVID-19 infection is not improving or is deteriorating under HFNC or NIPPV, then healthcare providers should have a low threshold for intubation and/or mechanical ventilation.	A
Use of HFNC may be indicated for COVID-19 patients with hypoxemic respiratory failure.	C
HFNC may be indicated over NIPPV as an initial course of treatment in COVID-19 hypoxemic respiratory failure when early intubation and ventilation is not indicated.	C
When HFNC is not available and intubation is not indicated, some recommendations suggest to consider a short NIPPV trial for COVID-19 hypoxemic respiratory failure.	C
BIPAP may be reserved for those with COVID-19 hypercapnic acute on chronic ventilatory failure.	C
CPAP may be indicated in COVID-19 patients with acute hypoxemic respiratory failure.	C

Key: A–consistently recommended in multiple guidelines, B–recommended in a single guideline, recommended only in hospital policy documents, or recommended weakly, C–guideline recommendations lacking or inconsistent.

Q1: Government guidelines on HFNC or NIPPV indications for COVID-19 patients

Source	**Recommendations**
NHS April 6	The use of HFNC is not indicated in COVID-19 patients based on lack of efficacy, oxygen use, and infection spread. BiPAP is usually not needed in those with otherwise normal lungs; compliance is usually maintained in COVID-19 patients. The use of NIPPV (BIPAP) should be reserved for those with hypercapnic acute on chronic ventilatory failure. CPAP is the preferred form of NIPPV in the management of the hypoxemic COVID-19 patient (should not be used in those with agitation and confusion). Its use does not replace mechanical ventilation, but early application may provide a bridge to mechanical ventilation. See Appendix for escalation and treatment plan for hospitalized patients.

CDC April 3	The CDC refers care providers to guidelines put forth by the WHO as well as the Surviving Sepsis Campaign. See Appendix for algorithm for HFNC, intubation, and NIPPV trials for COVID-19 patients with hypoxia.
DoD March 23	HFNC is indicated over NIPPV when early intubation and ventilation is not possible, as it has shown to be both safer and more efficacious. HFNC is indicated when oxygen therapy at 5-6 L/min is insufficient to maintain SpO2 92-96% and when invasive ventilation is unavailable. If HFNC is unsuccessful, early intubation is favored over BIPAP and other NIPPV.
WHO March 13	HFNC and NIPPV (including CPAP) are indicated only in select patients with hypoxemic respiratory failure. HFNC: Potential contraindications for HFNC in COVID 19 patients are hypercapnia, hemodynamic instability, multiorgan failiure, or abnormal mental status, although emerging data suggest that *HFNC may be safe in patients with mild-moderate and non-worsening hypercapnia.* Attempt a short trial (1 hour) and intubate in case the patient acutely deteriorates or does not improve. NIPPV: Limited data suggest that NIPPV (CPAP or BiPAP) has a high failure rate in patients with viral infections

Q1: Professional society statements on HFNC or NIPPV indications

Source	**Recommendations**
ACCP April 1	Use of HFNC in COVID-19 patients is controversial, and if necessary should only be utilized within an airborne infection isolation room. Because it is known to be aerosol-generating, NIPPV [type not specified] is recommended against. Clinicians should instead consider early intubation.
SCCM/ESICM March 28	HFNC: For adults with acute hypoxemic respiratory failure despite conventional oxygen therapy, SCCM suggests using HFNC over conventional oxygen therapy or NIPPV (Weak recommendation, low-quality evidence). NIPPV: If HFNC is not available and there is no urgent indication for endotracheal intubation, SCCM suggests a trial of NIPPV with close monitoring and short-interval assessment for worsening of respiratory failure (Weak recommendation, low-quality evidence). See Appendix for algorithm for HFNC, intubation, and NIPPV trials for COVID-19 patients with hypoxia.
ASA March 26	Due to limited efficacy, lack of airway protection, and risk of virus aerosolization, avoid NIPPV (CPAP or BiPAP) or HFNC in COVID-19 patients. A rare consideration is HFNC with ICU consult and high-level personal protective equipment (PPE).
SOCCA March 25	SOCCA is part of a collaboration with the ASA and the SSCM to address the COVID-19 pandemic, and endorses the positions of these societies.

ANZICS March 16	HFNC: recommended therapy for hypoxia associated with COVID-19 as long as staff are wearing optimal airborne PPE. NIPPV: [type not specified] is not recommended for treatment of hypoxic respiratory failure in COVID-19 patients due to high failure rate, delayed intubation, and possible increased risk of aerosolization. If NIPPV is appropriate for an alternate clinical presentation of COVID-19 (e.g. concomitant COPD, APO), this should be provided using similar precautions as for HFNC.

SCCM/ESCIM–Surviving Sepsis guidelines

Q1: Hospital guidance on HFNC or NIPPV indications

Source	**Recommendations**
MGH April 5	Where mechanical ventilation is available, it is the preferred means of respiratory support in COVID-19 patients. In the presence of bilateral infiltrates and hypoxemia, mechanical ventilation with low tidal volumes may be less injurious than continued vigorous spontaneous breathing with or without non-invasive support, but this benefit has to be weighed against the need for sedation often associated with mechanical ventilation. In patients with other etiologies of respiratory failure, HFNC and NIPPV should be offered in accordance with usual indications. NIPPV [BIPAP]: we should to continue to offer NIPPV in patients with hypercarbic respiratory failure and known COPD.
Washington March 31	NIPPV [type not specified] and HFNC should be avoided when there is high suspicion for COVID-19, as they may increase risk of virus transmission. Clinical scenarios where exceptions may be warranted: HFNC: can consider if a patient has “do not intubate” status. NIPPV: can consider for specific clinical indications (ex. COPD or CHF along with COVID-19)
Michigan March 25	HFNC should be considered in patients with persistent hypoxia despite supplemental oxygen or in areas where ventilator supply is limited. HFNC is recommended over NIPPV [type not specified]. However, if HFNC is unavailable and intubation is not indicated, NIPPV may be attempted for a short trial period and with close monitoring.
UCSF March 18	HFNC can be considered in hypoxemic patients. NIPPV (BiPAP and CPAP) may only be used in selected patients with respiratory failure
Zhejiang March 18	HFNC or NIPPV [type not specified] is used for sequential respiratory support after withdrawal of mechanical ventilation. HFNC indications: HFNC oxygen therapy is recommended for the patients with the following conditions: SpO2 < 93%; PaO2/FiO2 < 300 mmHg (1 mmHg = 0.133 kPa); respiratory rate > 25 times per min at bed; or remarkable progression on X-ray imaging. HFNC contraindications: Older patients (> 60 years old) with more complications or PaO2/FiO2 less than 200 mmHg should be treated in ICU. NIPPV indications: A short-term (less than 2 hours) use of NIV can be closely monitored if the patient has acute left heart failure, chronic obstructive pulmonary disease or is immunocompromised NIPPV [type not specified] is not strongly recommended in COVID-19 patients who fail HFNC treatment, as some patients who fail HFNC may progress rapidly to ARDS. Additionally, excessive inflation pressure may cause gastric distension and intolerance which contribute to aspiration and worsen lung injury.

Q2: Government guidelines regarding initiation of HFNC or NIPPV

Source	Recommendations
NHS April 6	BIPAP suggested initial settings: PS 8-10 cm H_20 + PEEP 5-10 cm H_2O + 60% oxygen, targeting SpO_2 88-92%. CPAP suggested initial settings: 10 cm H_2O + 60% oxygen. Consider increasing CPAP support: (i.e. 12-15 cm H_2O + 60-100% oxygen) if needed. Consider weaning CPAP/NIV to conventional oxygen therapy when oxygen concentration < 40%. High-flow face masks with non-rebreathe reservoir bags should be considered as a modality to give short breaks to patients from CPAP. See Appendix for escalation and treatment plan for hospitalized patients
CDC April 3	CDC refers care providers to guidelines put forth by the WHO as well as the Surviving Sepsis Campaign.

Q2: Professional society statements regarding initiation of HFNC or NIPPV

Our review did not find society guidance on initiation of HFNC or NIPPV

Q2: Hospital guidance regarding initiation of HFNC or NIPPV

Source	Recommendations
Washington March 31	When either NIPPV or HFNC is indicated, oxygen flows should be limited to <15 L/min if possible.
Zhejiang March 18	HFNC: The airflow of HFNC oxygen therapy should start at a low level and be gradually increased up to 40-60 L/min when PaO2/FiO2 is between 200-300 mmHg so that patients do not feel obvious chest tightness and shortness of breath. An initial flow of at least 60 L/min should be given immediately for patients with obvious respiratory distress. NIPPV: use of a double circuit is recommended. A virus filter should be installed between the mask and the exhalation valve when applying NIPPV with a single tube.
UCSF March 18	HFNC: Flow rates greater than 25 L/min are cautioned against in order to limit transmission.

Q3: Government guidelines regarding thresholds for intubation and mechanical ventilation

Source	Recommendations

NHS April 6	Recommendations strongly advocate early discussions seeking to ascertain ceilings of treatment at presentation in all patients, to avoid inappropriate escalation of ventilatory support. There should be a low threshold for intubation where there is clinical decline (which may include a rising oxygen requirement, consistently or rapidly declining SpO2, consistently or rapidly increasing respiratory rate and increased work of breathing). This should trigger immediate assessment for intubation and mechanical ventilation if deemed appropriate. BiPAP: for those on BiPAP, excessive work of breathing is a possible indicator for intubation. CPAP Assess the response to CPAP within 30 minutes. If the patient responds, close observation and monitoring must continue for a further 6 hours to ensure no decline occurs, with careful monitoring continuing thereafter. Where there is no adequate response, where clinical decline continues, or where patient tolerance limits use, early intubation and mechanical ventilation should be sought where appropriate. Generally, aim for SpO2 92-96% or 88-92% for patients with chronic or acute on chronic type II respiratory failure. An SpO2 target of 90-93% is acceptable in patients with visible continuous pulse oximetry in an appropriately monitored environment. See Appendix for escalation and treatment plan for hospitalized patients
CDC April 3	The CDC refers care providers to guidelines put forth by the WHO as well as the Surviving Sepsis Campaign.
DoD March 23	If HFNC is unsuccessful, early intubation is favored over BIPAP and other NIPPV.
WHO March 13	HFNC: intubate in case the patient acutely deteriorates or does not improve after a **short trial (about 1 hour)**.

Q3: Professional society statements regarding thresholds for intubation and mechanical ventilation

Source	Recommendations
SCCM/ESICM March 28	In adults with COVID-19 receiving NIPPV or HFNC, we recommend close monitoring for worsening of respiratory status, and early intubation in a controlled setting if worsening occurs (Best practice statement). See Appendix for algorithm for HFNC, intubation, and NIPPV trials for COVID-19 patients with hypoxia.
SOCCA March 25	SOCCA is part of a collaboration with the ASA and the SSCM to address the COVID-19 pandemic, and endorses the positions of these societies.
ANZICS March 16	For patients receiving HFNC: should consider early invasive mechanical ventilation if worsening hypercapnia, acidemia, respiratory fatigue, hemodynamic instability or those with altered mental status (if appropriate). Patients receiving NIPPV [type not specified]: Deteriorating patients should be considered for early endotracheal intubation and invasive mechanical ventilation.

SCCM/ESCIM–Surviving Sepsis guidelines

Q3: Hospital guidance on thresholds for intubation and mechanical ventilation

Source	Recommendations

Washington March 31	Early consideration for mechanical ventilation is encouraged, especially in the context of worsening respiratory failure despite the use of HFNC or NIPPV.
Michigan March 25	Mechanical ventilation should be considered when patients on either HFNC or NIPPV experience worsening of respiratory failure (SPO_2 < 92%).
Zhejiang March 18	Tracheal intubation for patients on HFNC is dependent on disease progression, systemic status and complication of patients for those with stable situation but with a low oxygenation index (<100 mmHg). MV indications for the patient on HFNC: Tracheal intubation should be performed as early as possible for patients with an oxygenation index less than 150 mmHg, worsening symptoms of respiratory distress or multiple organ dysfunction within 1-2 hours after high-flow (60 L/min) and high-concentration (> 60%) HFNC oxygen therapy. MV indications for the patient on NIPPV [type not specified]: Intubation should be performed as early as possible if improvement of respiratory distress symptoms or PaO2/FiO2 is not observed.
UCSF March 18	Patients who receive HFNC or NIPPV (CPAP or BiPAP) should be monitored **hourly** by staff capable of performing endotracheal tube intubation. Proceed directly to endotracheal intubation in patients with no evidence of improvement after short trials (e.g 1 hour).
MGH March 18	Indications for intubation include increased work of breathing (accessory muscle use, tachypnea) and persistent or rapidly worsening hypoxemia. Note that some patients will deteriorate quickly.

Key sources searched

Government/NGO guidelines: Centers for Disease Control and Prevention (CDC), US Military Health System (DoD), UK National Health Service (NHS), World Health Organization (WHO)

Professional society statements: American Society of Anesthesiologists (ASA), Australia and New Zealand Intensive Care Society (ANZICS), European Society of Intensive Care Medicine (ESICM), Society of Critical Care Anesthesiologists (SOCCA) , Society of Critical Care Medicine (SCCM)

Hospital guidance: Cleveland Clinic, Johns Hopkins, Massachusetts General Hospital, Mayo Clinic, Mount Sinai, NYU Langone, Oregon Health Services University, Penn Medicine, University of California San Francisco, University of Michigan, University of Washington, Weill-Cornell Medical Center, Zhejiang University Hospital (China)

Definition of terms

HFNC: High flow nasal cannula.

NIPPV: Non-invasive Positive Pressure Ventilation. This designation may include bilevel positive airway pressure (BiPAP), continuous positive airway pressure (CPAP).

About this report

A Rapid Guidance Summary is a focused synopsis of recommendations from selected guideline issuers and health care systems, intended to provide guidance to Penn Medicine providers and administrators during times when latest guidance is urgently needed. It is not based on a complete systematic review of the evidence. Please see the CEP web site for further details on the methods for developing these reports.

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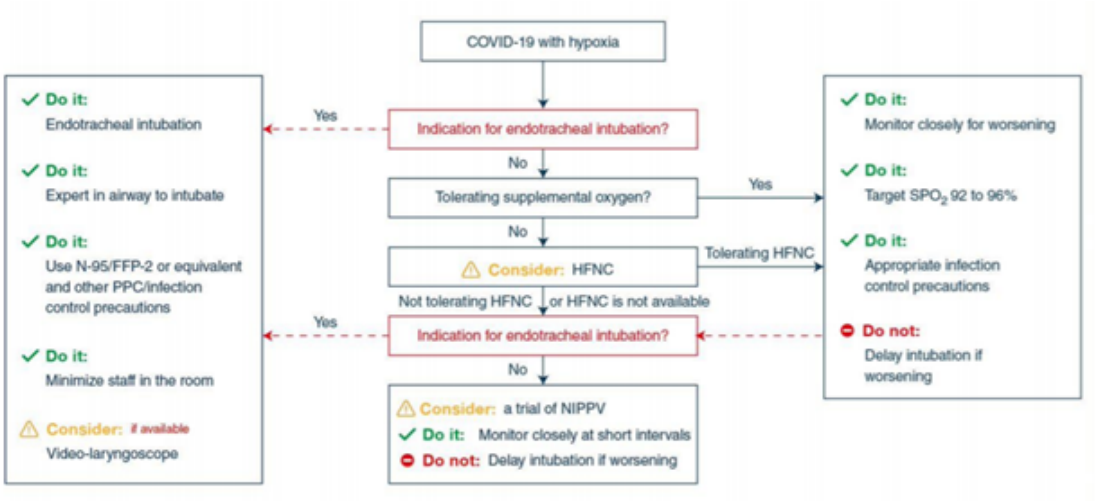
Appendix: Algorithm details

NHS: Escalation and treatment plan for hospitalized patients (April 6, 2020)

Category	Clinical Status	Suggested action
Green	RR ≥ 20bpm with SpO_2≤94%	Administer O_2 <40% by face mask. If SpO_2 rises to >94%, observe and monitor
Yellow	RR ≥ 20bpm with SpO_2≤94% on FiO_2 ≥40%	Start 15L/min O_2 via non-rebreathe mask *Senior clinical review to consider:* If orientated and able to tolerate well-fitted non-vented face mask, trial CPAP 10cmH_2O with FiO_2 0.6 If further escalation appropriate, consider increasing CPAP 12-15 cmH_2O + 60-100% oxygen if needed If not, IMV if in accordance with TEP
Red	RR ≥ 20bpm with SpO_2≤94% on 15L/min O_2 via non-rebreathe mask and/or patient unable to tolerate CPAP mask, obtunded/ disorientated, rising FiO_2 needs, significant clinical decline	Urgent critical care review and prepare for intubation if in accordance with TEP

Abbreviations: RR = respiratory rate; SpO_2 = oxygen saturation; CPAP = continuous positive airways pressure; FiO_2 = fraction of inspired oxygen, IMV = invasive mechanical ventilation, TEP = treatment escalation plan.

SCCM: HFNC, intubation, and NIPPV trials for COVID-19 patients with hypoxia (March 28)



This decision algorithm for was put forth in a joint report by the Society of Critical Care Medicine (SCCM) and the European Society of Intensive Care Medicine (ESICM). The following organizations make similar recommendations: CDC, DoD, University of Michigan.