This document was also approved by CCOC.

Goal: Standardize best practices for treatment hypoxic respiratory failure and ARDS due to COVID-19.

Definition: Aerosol-generating procedures (AGP): pose a higher risk of viral transmission to staff and include (but not limited to): endotracheal intubation, bronchoscopy, open suctioning, administration of nebulized treatment, manual ventilation before intubation, physical proning of the mechanically ventilated patient, disconnecting the patient from the ventilator circuit, non-invasive positive pressure ventilation, obtaining induced sputum or nasal-oropharyngeal swab, tracheostomy, and cardiopulmonary resuscitation.

1. **Basic Respiratory Support for Persons Under Investigation (PUI) or with confirmed COVID-19**
2. **Nasal Cannula:**
    1. Use humidified nasal cannula (NC) 1 to 6 LPM for target SpO2 92-96%
        - Avoid humidification for rates above 6-8L/min NC flow as able. Consider transition to simple face mask, venturi, NRB
    2. O2 needs >6-8 L or rapid increase, consider pulmonary consult and possible transfer to higher level care area. Consider early call to anesthesia for assessment and preparation for possible need for intubation
3. **Venturi Mask/Simple Mask/ NRB:**
    1. If a patient requires >6 8 LPM NC, initiate dry Venturi mask, simple mask or NRB (non-humidified to reduce aerosolization risk)
        - Up-titrate FiO2 to goal SpO2 of 92-96%
        - Monitor patient's response closely- if goals of oxygenation not being met will need to progress rapidly to higher levels of support
4. **High Flow Nasal Cannula:**
    1. If HFNC is used, it should be under airborne precautions when possible and with all staff entering the room using recommended PPE for aerosol generating procedure
    2. HFNC should be utilized early and monitor response closely. Current data suggests the risk of transmission of virus via aerosolization with HFNC may be low when used with overlying facemask; HFNC may potentially decrease risk of transmission if it prevents the need for intubation in a certain percentage of patients
        - HFNC should be titrated with flow rate no higher than 40 L/min, with FiO2 at or below 70%. If needs exceed this, clinicians should consider this a likely failure and proceed to endotracheal intubation based upon code status and resources
        - In DNI patients who are not CMO, higher flow rates may be utilized with caution, and appropriate precautions/PPE should be reinforced as above given the uncertainty of aerosolization at higher flow rates.
    3. Patients on HFNC will be transferred utilizing a 100%NRB and an oxymizer in place, with a procedure mask overlying. A brief trial on this mode is required prior to moving, to ensure safe transfer.
    4. HFNC and NIPPV should not be utilized in CMO patients.
5. **Helmet Non-invasive Ventilation:**
    1. Provides CPAP therapy without significant risk of aerosolization. Should be utilized in critical care or emergency department space only with close supervision. Ideal patient will be failing 6L NC or higher-level therapies. Exclusion criteria include (and not limited to): encephalopathy, claustrophobia, inability to cooperate, DNR/DNI status, known thoracic barotrauma, impending cardiac/respiratory arrest,

intractable vomiting or hemoptysis, significant component of hypercapnic respiratory failure where bilevel NIV is needed-e.g. COPD exacerbation
2. Requires careful monitoring of respiratory status and monitoring for CO2 retention. If failing trial, proceed to endotracheal intubation.
3. See procedure for further details: UMMMC Procedure for Helmet Noninvasive CPAP Ventilation
4. Currently only offered at University Campus. Please contact Drs Becky Bauer, Paulo Oliveira, or Christine Bielick Kotkowski, and Rachel Carragher for patient evaluation.

6. **Traditional Noninvasive Ventilation**
    1. The role of traditional NIPPV in COVID-19 treatment is limited. The risk of aerosolization is likely higher compared to HFNC, and should be utilized in a negative pressure room when available with appropriate PPE by staff. Full face mask with a tight -fitting seal should be used, with at a minimum a viral particle filter placed on expiratory port/limb.
    2. CPAP-may be beneficial by raising mean airway pressure and recruiting lung. Would reserve traditional CPAP to those who do not meet criteria for or cannot tolerate helmet non-invasive ventilation.
    3. Bipap: may have a very narrow role in the following settings:
        - Rapidly reversible etiologies (e.g. flash pulmonary edema, volume overload- awaiting response to diuretics or HD)
        - Dual diagnosis- COPD exacerbation, NM disease not yet meeting criteria for intubation- with acute or acute on chronic respiratory acidosis/ hypercapnia where augmented ventilation is needed.
        - Known OSA/OHS/TBM without a good alternative
        - Select DNI patients

Awake Prone Ventilation

This involves a non-intubated patient on nasal cannula who prone themselves by lying on their belly. This may improve secretion clearance and recruitment of atelectatic lung. Recommended from initial experience in Wuhan, China, as method to avoid intubation, but no large studies have been performed.

1. Can be combined with simultaneous use of any other noninvasive support device (e.g. low-flow nasal cannula, high-flow nasal cannula, venti mask, or CPAP).
2. Requires cooperative patient with intact mentation.
3. Could be useful when applied early and especially in situations where access to invasive ventilation is limited or intubation not readily available.

Potential candidates for awake proning

1. Isolated hypoxemic respiratory failure without substantial dyspnea (the “paradoxically well appearing” hypoxemic patient- “silent hypoxemia” described in some COVID-19 pts). A reasonable candidate might meet the following criteria:
    1. Not in multi-organ failure
    2. Expectation that patient has a fairly *reversible* lung injury and may avoid intubation
    3. No hypercapnia or substantial dyspnea
    4. Normal mental status, able to communicate distress
    5. No spinal instability, facial or pelvic fractures, or open or unstable chest.
    6. No anticipation of difficult airway

2. Patients who do not wish to be intubated (DNI). The main risk of awake proning is that it could cause excessive delays in intubation. In the DNI patient who is failing other modes of ventilation, there is little to be lost by trialing awake proning.
3. This could be attempted as a bridge for a hypoxemic patient when intubation isn't immediately available (e.g. desaturation during transportation).

How to prone awake patient:

1. Help patient lie on their belly in a prone position.
2. Make sure support devices are well secured to the patient (e.g. it could be helpful to use tegaderm to anchor a nasal cannula).
3. Encourage proning as much as is tolerated (ideally ~12-18 hours/day if tolerated).
4. Follow oxygenation and FiO2 requirement. Ideally an improvement in oxygenation should be seen within a few hours. If no change in oxygenation is observed, ongoing pronation may have less merit.

Intubation

Given anecdotal rapid progression in COVID associated respiratory failure, the goal is to perform intubation in the most controlled setting as possible with preparation of patient and the staff to maximize success and minimize risks.

1. Maximize oxygenation with venturi, oxymizer, NRB, NRB plus NC at high L flow 10-15 L/min with goal of Spo2 > 92%
2. If had been on HFNC or NIV- remove just prior to intubation and turn off flow on these apparatuses to minimize risk of aerosolization
3. See Anesthesia/ED Intubation Protocol and guiding principles previously mentioned
4. Strict Airborne precautions and PAPR + N95 for those at head of patient involved ins securing airway and assisting.

Initial Mechanical Ventilation

1. Initiate ARDS ventilation per Management of Acute Respiratory Distress Syndrome (ARDS) CPG
2. Determine PEEP-anecdotally patients often require PEEP 10+
3. Assure adequate sedation as described below
4. See **ARDS Management CPG** for further details and other options for management and escalation of care and interventions.

RT ventilator safety considerations: See RT PowerPoint document for pics describing locations for filters on various vents. Use PPE whenever working with such patients in negative pressure room. Use in-line suctioning only. Attempt to use heated, humidified closed circuit for vent to minimize breaks in circuit associated with HME changes. Minimize the number of circuit disconnects; If required, clamp ETT closest to patient to avoid aerosolization and minimize decruitment. Before removing ventilator limb either stop all flow or place on stand-by.

Refractory hypoxemia- see ARDS Management CPG for details

1. If patient is hypoxic (Pa02 <55) on Vt = 6 ml/kg, optimal high PEEP and Fi02 >75%, consider the following as indicated and relevant to your patient:
    1. Optimize volume status
    2. Deep sedation, advancing to RASS-4 to -5 if needed

3. Initiate paralysis with neuromuscular blockade agent per pharmacy protocol especially if clear patient-ventilator asynchrony noted. Neuromuscular Blocker Continuous Infusions in Mechanically Ventilated Patients (ICU) CPG
4. Initiate prone ventilation; high consideration for use early in severe ARDS (<36 hours from ARDS onset, start discussion of proning when P:F < 150, prone within 12 hours of FiO2 > 75%). Please see Management of Acute Respiratory Distress Syndrome (ARDS) for details. Please also reference Manual prone positioning for patients with severe Acute Respiratory Distress Syndrome (ARDS) procedure, found on the Hub.
5. Continuous inhaled epoprostenol trial– If fails inhaled epopostenol, could consider switch to iNO if available and staff trained in use available with appropriate monitoring and scavenging (see Inhaled Vasodilator Therapy in ICU Patients)
6. Consider ECMO – the value of ECMO in COVID-19 patients is controversial. For very select younger patients with only single organ failure early in course (first 72 hrs and less than 7 days) consider ECMO. For more information on procedure to determine if ECMO can be initiated please see document: Utilization of ECMO during COVID-19

Other RT modalities:

Metered-Dose Inhalers (MDIs) vs. Nebulizers

1. Nebulization may aerosolize viral particles. Isolated COVID-19 does not typically result in significant bronchospasm thus role of bronchodilators may be limited. It should be avoided unless clear indication (bronchospasm, concomitant asthma/ COPD exacerbation).
2. Nebulization can be utilized more safely when intubated as circuit is closed.
3. When needed, MDI with spacer per RT protocol is preferred but shortages may preclude use.
4. In non-intubated, possible or known COVID patients meeting indications for short-acting beta agonist or short-acting anticholinergic inhaled meds and either not tolerating MDI or when MDI shortages exist, recommend nebulization as described and pictured in RT PPT slides using mask over nebulizer or PARI-neb with filter-in-line and this should be performed in a negative pressure room when available with all those entering room wearing appropriate PPE.
5. Breath actuated nebulized administration may limit aerosolization and is reserved for patients who are COVID19 positive or under investigation, and with appropriate inspiratory force (~15L). It should only be used in the breath activated mode.
6. If a negative pressure room is not available and the patient meets SABA/SACA indication and could benefit from this intervention, he/she should be placed in a single room with a mask over the unit and the door closed. All personnel entering room will wear PPE as per infection control.

Management of a Cystic Fibrosis Patient who is under investigation for COVID-19+

1. When PUI, nebulizer and airway clearance should be held pending results. MDI with spacer can be used when available.
2. If confirmed COVID-19 negative, all respiratory therapies including airway clearance and nebulized medications should be resumed.
3. If confirmed COVID-19 positive, manual chest PT should be avoided. Patient may use the vest with a surgical mask in place, ideally with the RT out of the room for the duration. Nebulized medications may be given as above, however it should also be considered an aerosol generating procedure and performed in a negative pressure room when available. All staff entering the room should wear appropriate PPE.

Nocturnal Bipap/CPAP Devices

Because rates of asymptomatic carriage in the community are unknown, wherever possible:

1. Use airborne precautions (Strict isolation, N95, negative pressure room) whenever possible, especially if PUI or known COVID + pt.
2. Use a UMMHC CPAP or BiPAP machine and use a tight fitting UMMHC full-face mask with viral filter on exhalation port as per protocol.
3. Ensure masks/devices fit well and there is minimal air leak
4. Patients should not use their home CPAP or BiPAP devices or masks as these can aerosolize particles. Transition to a UMMHC device as above
5. Consider using nocturnal nasal cannula in lieu of CPAP based upon clinician judgment.

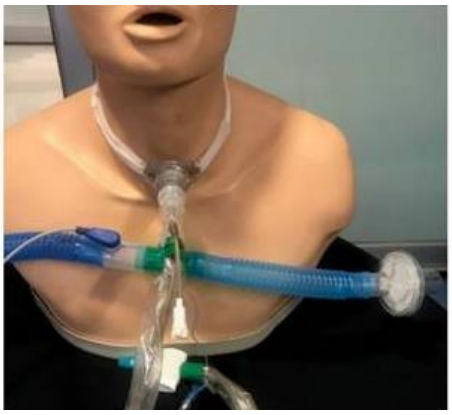
Management of an existing surgical airway

COVID-19 positive patients and PUIs who have a tracheostomy tube in place but do not require mechanical ventilation may aerosolize viral particles when not on a closed system (including mechanical ventilator. When a stoma is present, an overlying trach mask should be utilized. Uncuffed tracheostomy tubes should be exchanged to a cuffed tube.

1. If patient does not require mechanical ventilation but will be monitored closely in the intensive care unit, they should have one of the following:

    a. If not secretional, utilize O2/air blender system with closed suction, t-piece connector and extension tubing and filter as pictured (picture 1)

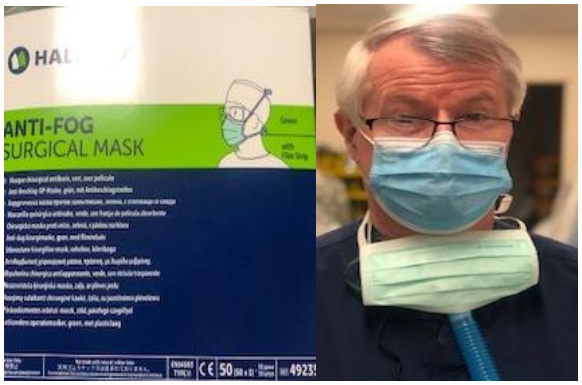
    b. If secretional, use trach mask with cool aerosol and mask tie over trach collar as able.



Picture 1: Ensure suction catheter is pulled back after each use and changed daily.
Photo credit: Nebraska Medicine

2. If patient is not in the intensive care unit, recommend trach collar with overlying surgical mask with appropriate PPE for staff members (Picture 2)

Picture 2: Trach mask with cool aerosol and mask tie as tolerated/able



3. If traveling and do not require mechanical ventilator, recommend switch to HME with oxy-vent adaptor and close monitoring as pictured (picture 3)

Picture 3: HME with oxy-vent adaptor for transport
Photo credit: Nebraska Medicine

Bronchoscopy

1. Risks of bronchoscopy:
    1. May cause some deterioration in clinical condition (due to instillation of saline and sedation) and de-recruitment.
    2. Enormous risk of transmission to providers.
    3. Considerable resource allocation
2. Bottom line on bronchoscopy
    1. Bronchoscopy should *not* be done for ruling COVID-19 in or out (as this entails risk with no definite benefits), as recommended by multiple society consensus statements
    2. Bronchoscopy might be considered in situations where it would otherwise be performed (e.g. patient with immunosuppression with concerns for Pneumocystis pneumonia or fungal pneumonia) or renal pulmonary syndrome and concern for DAH.
    3. Goal minimal number of people in room- 3 -4 with strict airborne precautions

Picture 2: HME with oxy-vent adaptor for transport
Photo credit: Nebraska Medicine

Extubation

Ideally patients would be noninfectious prior to extubation. Given this may not be feasible, standard extubation procedures apply and the following recommendations should be observed:

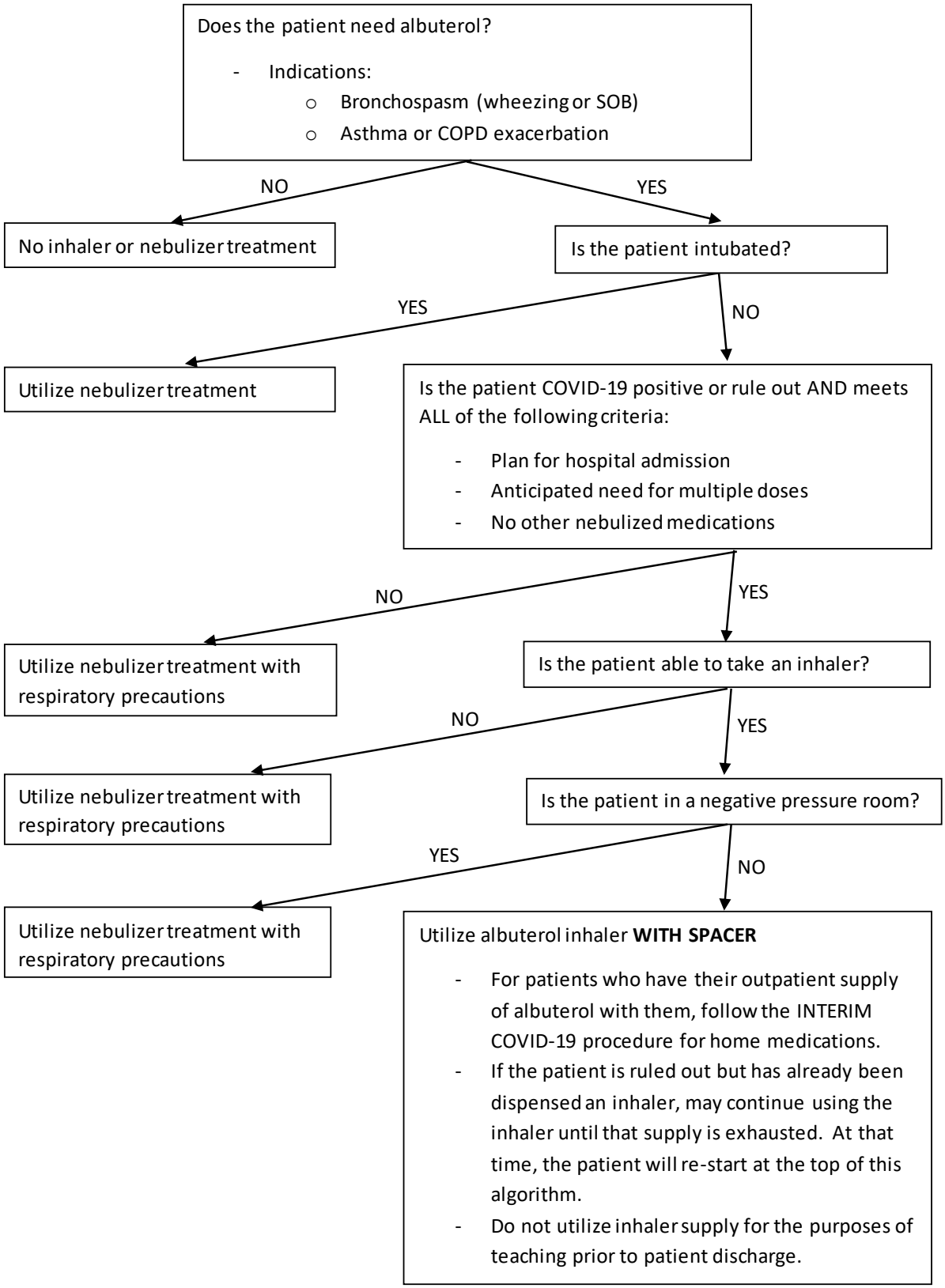
1. Patients should ideally be ready for extubation onto facemask.
2. HFNC could be considered at flows of 30L or less to provide additional PEEP for those at higher risk for extubation failure. Would avoid NIPPV unless clear comorbid condition that supports its use (ie. copd exacerbation in co2 retainer/chronic resp acidosis). PPE and negative pressure should be utilized as above.
3. Two staff members should perform extubation w/appropriate PPE for aerosol generating procedure.
4. The patient should not be encouraged to cough.
5. Perform gentle suctioning of mouth and posterior pharynx with Yankeur. Confirm ETT cuff not deflated.
6. Can perform gentle in-line suctioning prior. After can consider 3ml of 1-2% lidocaine instilled into ETT but wait until cough abates prior to removing tube.
7. Wrap a chuck, clear plastic sheet or plastic bag around the ETT tube while explaining to the patient what we will be doing and providing reassurance.
8. Ensure the vent is on standby or in no flow state then remove the ETT and ventilator circuit enbloc with wrapping lying over the patients mouth and face firmly gripped around the ETT to protect against expectoration after the cuff is quickly deflated
9. A simple oxygen mask/face mask or nasal prongs/NC (could be applied prior to ETT removal) should be placed on the patient immediately post-extubation to minimize aerosolization from coughing. If using nasal cannula would place simple face mask over if patient can tolerate.
10. Oral suctioning may be performed, with care taken not to precipitate coughing.

Terminal Wean (ETT remains in place): <u>Preferred method for staff safety</u>

1. Ensure adequate sedation and analgesia medications.
2. Gradually reduce FiO2 to .21 and Peep to 0. Place on SIMV and reduce rate to lowest possible rate or place on CPAP with extended apnea interval
3. Gently suction with inline suction catheter to remove secretions/maintain comfort as necessary
4. Continue monitoring patient for adequate sedation and analgesia medications.
5. When patient becomes apneic and asystolic, turn off vent.
6. Remove and cap circuit immediately. Place HEPA filter on ETT.
7. Prepare vent for decontamination.

Terminal Extubation (Requires 2 staff with appropriate PPE for aerosol generating procedure)

1. Ensure adequate sedation and analgesia medications.
2. Perform gentle inline suctioning of ETT. Gently suction mouth and posterior pharynx with oral suction. Confirm ETT cuff is inflated.
3. Consider 3ml of 1-2% Lidocaine instilled into ETT and wait until cough subsides.
4. Remove securement device from face, wrap chux around ETT, and hold ETT securely in place.
5. Cover patient's face with a 2nd chux and turn patient face in opposite direction and then turn off vent.
6. Immediately remove and cap circuit while clamping ETT.
7. Place HEPA filter on ETT.
8. Quickly deflate cuff and remove ETT (wrapped in chux) slowly to minimize risk of coughing.
9. Remove clamps while ETT remains inside 1st chux. Roll wrapped ETT inside 2nd chux, and discard.
10. Gently suction oropharynx and monitor patient for adequate sedation and analgesia medication.
11. Prepare vent and clamps for decontamination.



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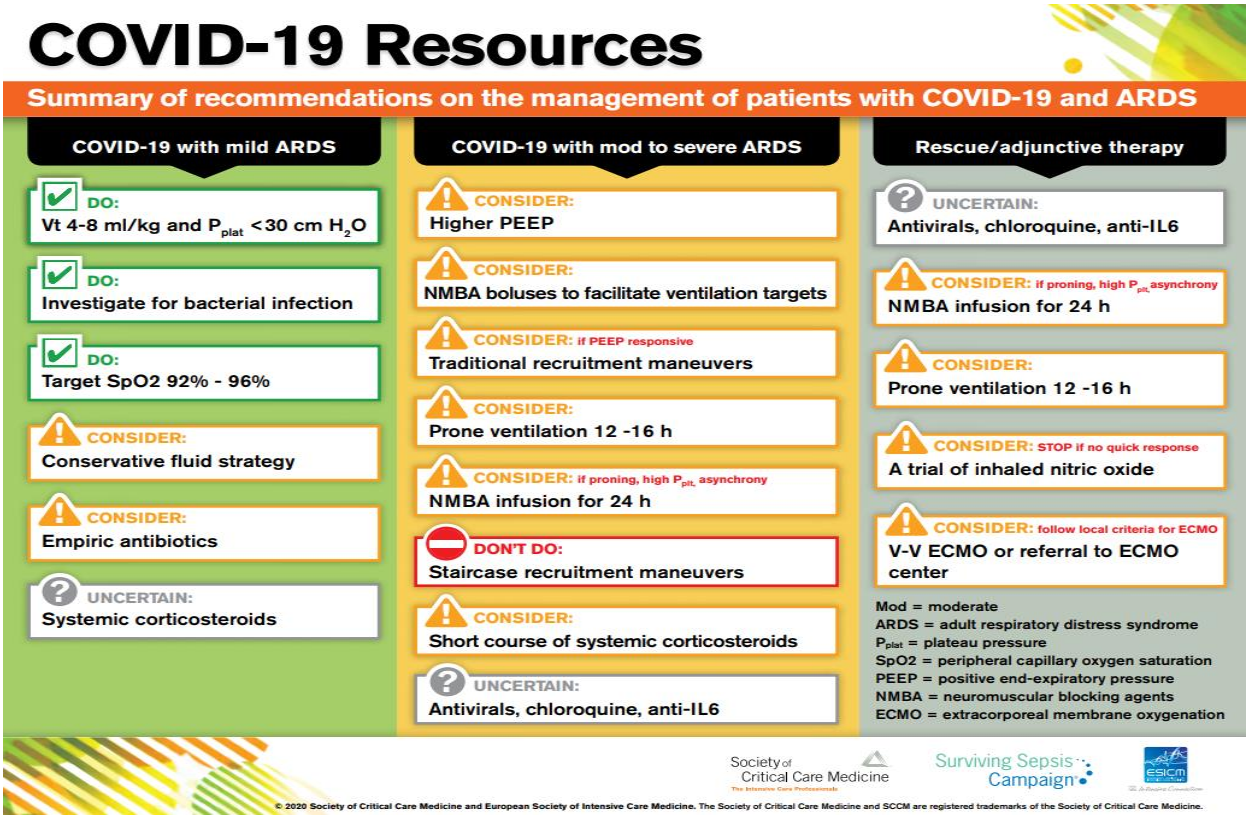
COVID-19 Resources
Summary of recommendations on the management of patients with COVID-19 and ARDS
COVID-19 with mild ARDS
DO: Vt 4-8 ml/kg and Pplat <30 cm H2O
DO: Investigate for bacterial infection
DO: Target SpO2 92% - 96%
CONSIDER: Conservative fluid strategy
CONSIDER: Empiric antibiotics
UNCERTAIN: Systemic corticosteroids
COVID-19 with mod to severe ARDS
CONSIDER: Higher PEEP
CONSIDER: NMBA boluses to facilitate ventilation targets
CONSIDER: if PEEP responsive Traditional recruitment maneuvers
CONSIDER: Prone ventilation 12 -16 h
CONSIDER: if proning, high Ppltasynchrony NMBA infusion for 24 h
DON'T DO: Staircase recruitment maneuvers
CONSIDER: Short course of systemic corticosteroids
UNCERTAIN: Antivirals, chloroquine, anti-IL6
Rescue/adjunctive therapy
UNCERTAIN: Antivirals, chloroquine, anti-IL6
CONSIDER: if proning, high Ppltasynchrony NMBA infusion for 24 h
CONSIDER: Prone ventilation 12 -16 h
CONSIDER: STOP if no quick response A trial of inhaled nitric oxide
CONSIDER: follow local criteria for ECMO V-V ECMO or referral to ECMO center
Mod = moderate
ARDS = adult respiratory distress syndrome
Pplat = plateau pressure
SpO2 = peripheral capillary oxygen saturation
PEEP = positive end-expiratory pressure
NMBA = neuromuscular blocking agents
ECMO = extracorporeal membrane oxygenation
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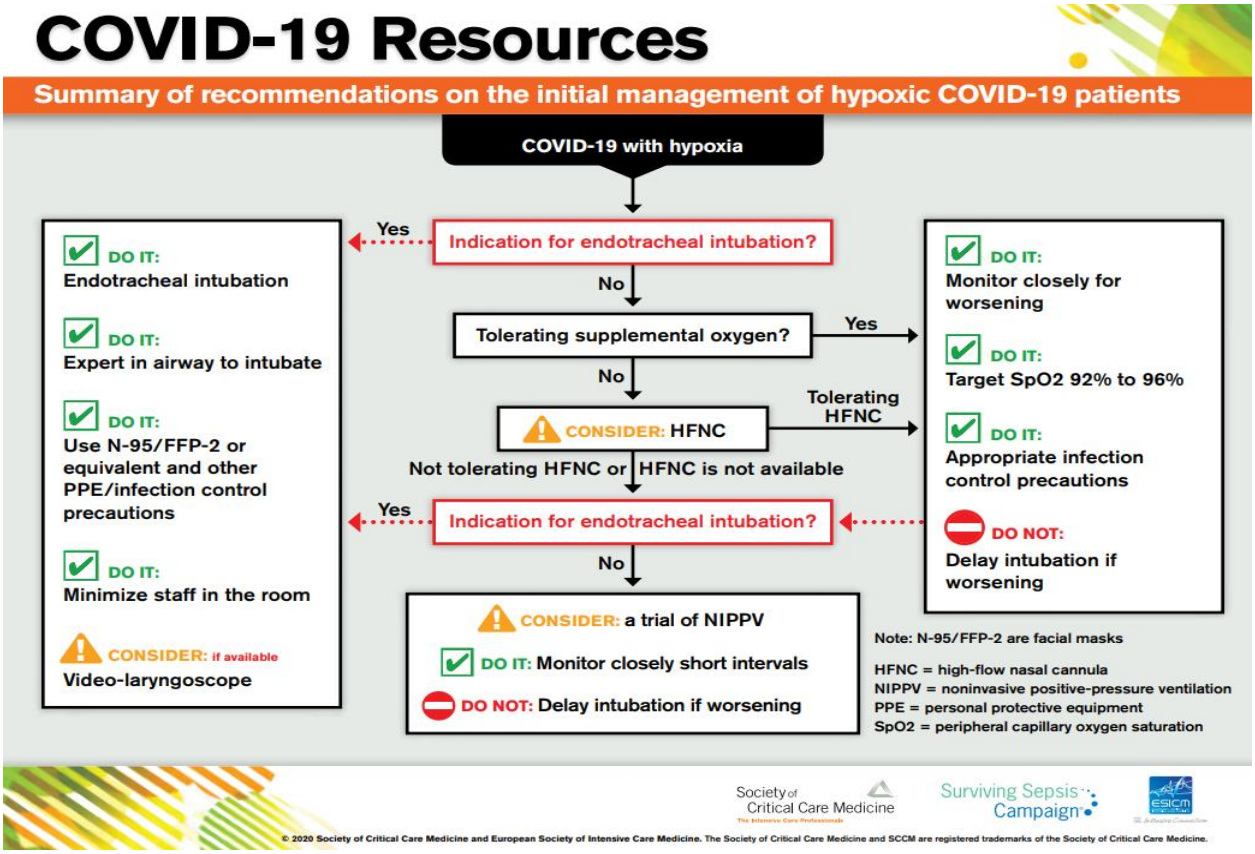
COVID-19 Resources
Summary of recommendations on the initial management of hypoxic COVID-19 patients
COVID-19 with hypoxia
Indication for endotracheal intubation?
Yes
No
Tolerating supplemental oxygen?
Yes
No
CONSIDER: HFNC
Tolerating HFNC
Not tolerating HFNC or HFNC is not available
Indication for endotracheal intubation?
Yes
No
DO IT: Endotracheal intubation
DO IT: Expert in airway to intubate
DO IT: Use N-95/FFP-2 or equivalent and other PPE/infection control precautions
DO IT: Minimize staff in the room
CONSIDER: if available Video-laryngoscope
DO IT: Monitor closely for worsening
DO IT: Target SpO2 92% to 96%
DO IT: Appropriate infection control precautions
DO NOT: Delay intubation if worsening
CONSIDER: a trial of NIPPV
DO IT: Monitor closely short intervals
DO NOT: Delay intubation if worsening
Note: N-95/FFP-2 are facial masks
HFNC = high-flow nasal cannula
NIPPV = noninvasive positive-pressure ventilation
PPE = personal protective equipment
SpO2 = peripheral capillary oxygen saturation
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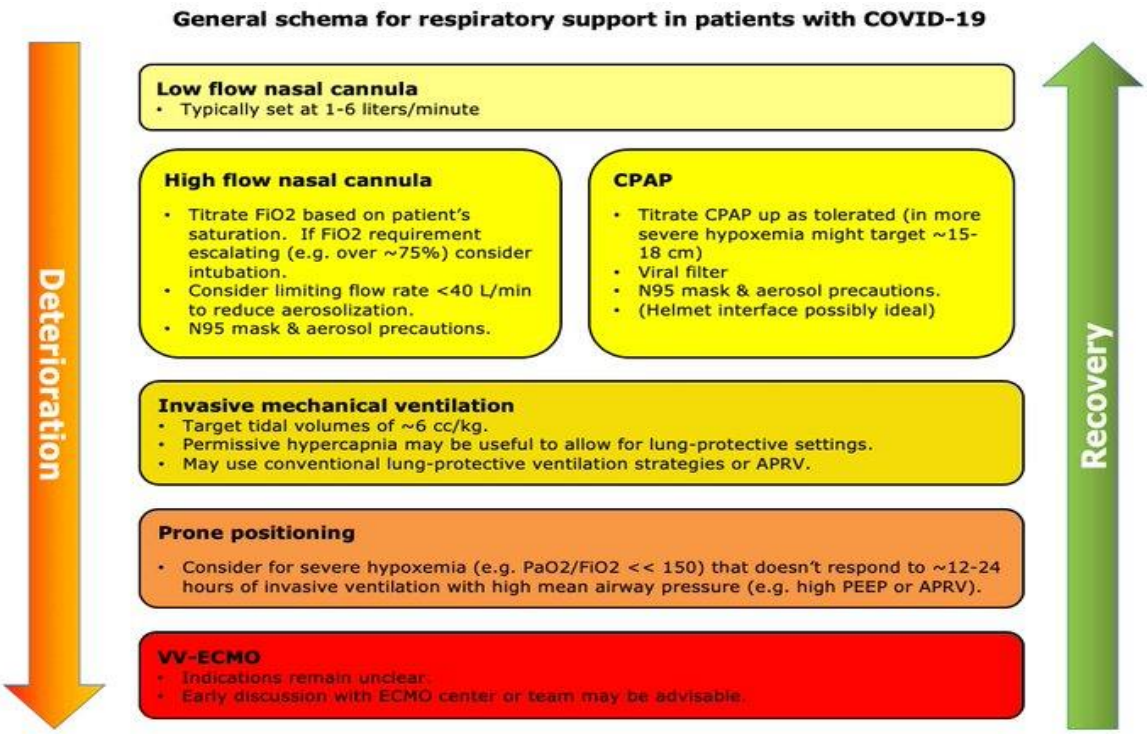
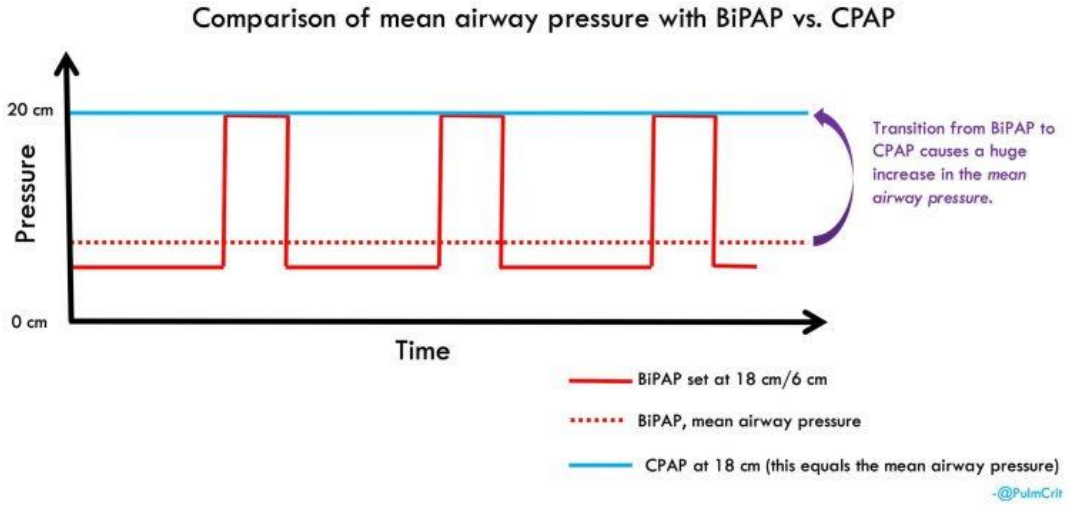


The optimal strategy for respiratory support in COVID-19 remains unknown. Patients with more complex respiratory disease (e.g. COPD plus COVID-19) might benefit from BiPAP. Choice of CPAP vs. HFNC may vary depending to resources and patient preference. ANZICS guidelines recommend HFNC rather than noninvasive ventilation.
-The Internet Book of Critical Care, by @PulmCrit



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