Johns Hopkins Hospital: Division of Pulmonary and Critical Care Medicine and Division of Adult Critical Care, Anesthesiology and Critical Care Medicine

Clinical Guidance for Critical Care Management of Patients with COVID-19 Infection

Contributors: Scott Stephens, Dale Needham, Ann Parker, Sarina Sahetya, David Hager, Aliaksei Pustavoitau, Adam Sapirstein, Roy Brower

I. Respiratory Support

a. Non-Invasive ventilation should not be used under normal circumstances

i. Infection risk due to aerosolization
ii. Potential for lung injury with large tidal volumes
iii. Minimal (if any) data supporting NIV for hypoxemic respiratory failure
iv. In a true crisis situation, NIV may be considered if no invasive mechanical ventilators are available.

b. **High flow nasal cannula** is acceptable in a negative pressure room

i. Patient should wear a surgical mask or other covering over their face to prevent droplet formation and spray
ii. In general, flow rates $\leq$ 40 L/min should be used
    1. This limit on flow rate is intended to (1) prevent aerosolization (in theory, data limited) and (2) to encourage early (non-emergent) intubation intubation
    2. Higher rates could be considered in extenuating circumstances
iii. In general, high-flow FiO_2 support should be limited to < 40-50% O_2
    1. This is to encourage early (non-emergent) intubation in a patient with poor trajectory
iv. Patients should be closely monitored; if no improvement with high flow nasal cannula, proceed to endotracheal intubation

c. Endotracheal intubation

i. Intubation should be performed early and in a controlled fashion
ii. Intubate before the patient is in extremis
    1. Considerations include oxygen requirement, work of breathing, and time to marshal appropriate resources
    2. Intubation should be considered if FiO_2 on HFNC exceeds 40-50%
iii. Early lung protective ventilation may protect patients
iv. Controlled intubation will allow adequate donning of PPE for staff protection
v. Specific guidance for endotracheal intubation procedures appears in a separate document

d. Mechanical ventilation in COVID-19 ARDS

i. ARDS protocol low tidal volume ventilation should be used
ii. Tidal volumes goal = 6 ml/kg predicted body weight (PBW)
    1. Plateau pressure should be < 30 cm H_20, preferably lower
    2. Use lower tidal volumes (5 or 4 ml/kg PBW) if necessary to achieve Pplat goal

3. In the case of high respiratory drive and frequent breath stacking, tidal volume may be increased to 7 or 8 ml/kg PBW to eliminate double breaths, so long as plateau pressure remains < 30 cm H_2O

iii. PEEP: Most patients with COVID-19 ARDS appear to be PEEP responsive

1. The Higher PEEP/FiO2 table should be used in most cases

Higher-PEEP group (before protocol changed to use higher levels of PEEP)

FiO_2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5–0.8	0.8	0.9	1.0
PEEP	5	8	10	12	14	14	16	16	18	20	22	22	22–24

iv. Driving pressure (Pplat – PEEP) < 14 cm H_20 has been associated with improved outcomes in ARDS

1. PEEP may be titrated to minimize driving pressure at attending discretion

v. Respiratory rate may be increased as needed to keep pH > 7.20

1. Note that hypercarbic acidosis, even below a pH of 7.20, is generally well tolerated.
2. If dysynchronous (usually with fever), increase set rate to match or exceed patient's intrinsic rate. Overdrive to prevent double breaths, dysynchrony
3.

vi. **Patients appear to rapidly de-recruit** when PEEP is removed/decreased

1. Decrease PEEP slowly.
2. Consider decreasing FiO_2 first, maintaining PEEP
3. Consider clamping the ETT during any disconnection from ventilator (e.g. changing to transport ventilator, etc)
    a. Using a Kelly clamp (or similar) with padding (eg gauze or tape wrapped around each prongs of the clamp), clamp the ETT prior to disconnecting from the ventilator
    b. This may help reduce recruitment for patients on high PEEP
    c. This might reduce aerosolization of secretions

e. Prone positioning

i. Early proning is beneficial in ARDS

ii. Many COVID 19 patients are prone responsive

iii. Prone positioning should be employed if P:F <u>≤</u> 150 mm Hg if no contraindications

iv. Consider earlier proning if P:F < 200 or FiO_2 > 0.6.

v. Proning is <u>not</u> a salvage maneuver

1. Prone positioning is a lung protective maneuver

2. Consider time to assemble needed personnel and equipment

vi. Patients should remain prone for prolonged periods (at least 18-24 hours)

vii. If oxygenation deteriorates upon supination, return to prone position

viii. There is no limit to the time that patients may remain proned

ix. Note: there is anecdotal support for placing *spontaneously breathing non-intubated* patients in the prone position. This could be considered in some circumstances

x. A video demonstrating proning technique can be found here: https://www.youtube.com/watch?v=WUGM3GDG4SA

f. Neuromuscular blockade can be considered in the setting of significant ventilator dyssynchrony or refractory hypoxemia
   i. Adequate sedation should be achieved first
   ii. Bolus dosing should be trialed first, and if frequent boluses required, move to short-duration infusion of NMB
   iii. Cisatracurium or vecuronium are acceptable

g. **Inhaled nitric oxide** can be used in cases of refractory hypoxemia
   i. Initial dose of iNO is typically 5-10 ppm,
   ii. Daily assessment of dose-response should be performed
      1. Patients often become **more** sensitive to iNO with time
      2. Maximum efficacy is often at surprisingly low doses (eg 1 ppm)
   iii. Veletri will not be used due to aerosolization risk.

h. Bronchoscopy should be avoided
   i. Bronchoscopy is an aerosol-generating procedure which may increase staff risk
   ii. Diagnostic yield is low
   iii. Bronchoscopy is unlikely to change management
   iv. If a lower respiratory specimen is desired, consider endotracheal aspirate

i. Chest CT imaging should also be avoided if possible
   i. Resource intensive
   ii. Removes staffing from ICU
   iii. Limited utility as far as changing management
   iv. Consider lung/pleural ultrasound, but weigh the risks/benefits of change in management versus the time required to don/doff PPE and clean the POCUS machine

j. **Chest x-rays should be minimized** to prevent staff exposure/equipment contamination
   i. Consider central line/ETT confirmation with POCUS

k. **ECMO** may be considered on a case-by-case basis in patients with single organ failure and high airway pressures or refractory hypoxemia
   i. Evaluation for ECMO support at JHH will proceed according to our standard institutional ECMO guidelines
      1. ECMO is a limited and intensive resource with unproven benefit
      2. We do not routinely offer ECMO to patients > 55-60 years old
   ii. Dr. Errol Bush or Dr. Jinny Ha should be the surgeon initially consulted for all potential ECMO patients. Drs. Dan Choi, Glenn Whitman, Bo Kim, and Scott Stephens can also be resources for ECMO evaluation
   iii. Potential ECMO patients at outside hospitals will transferred to the MICU or BCU for evaluation for ECMO, not the CVSICU.
   iv. Cannulation will occur at the bedside or in the operating room, at the discretion of the cannulating surgeon

1. Cannulation should occur in a negative pressure environment
2. Specific configuration (Fem-IJ, Fem-Fem, DLIJ) is at discretion of cannulating surgeon

v. Regardless of location, the cardiac OR team should be mobilized for all cannulations

vi. Post-cannulation, patients will be cared for in negative pressure rooms in the CVSICU or CCU.

1. This guidance may change based on patient/ECMO volumes

II. Cardiovascular Support

a. Excessive fluid resuscitation should be avoided

b. Early use of vasopressors may limit fluid administration

i. Low-dose vasopressors (e.g. < ~0.1-0.2 mcg/kg/min norepinephrine) may be safely administered via peripheral IVs in many cases

ii. With normal LV function, oral midodrine (up to 20 mg TID) may be considered as a pressor-sparing agent

c. Myocarditis and/or severe arrhythmias have been reported.

i. This seems to occur as the lungs begin to recover, and patients may transiently improve before abrupt deterioration

ii. Providers should be alert for signs of myocardial dysfunction, including new arrhythmias

iii. Rapid LV assessment with POCUS could be considered if there is concern regarding myocarditis

d. In patients with myocardial failure, early cardiology consultation should be obtained

e. Mechanical circulatory support (IABP, ECMO, temporary LVAD) may be considered on a case-by-case basis

III. Hematology

a. There are increasing anecdotes and data suggesting COVID-19 patients may be hypercoagulable and prone to DIC

b. Use CBC, PT, aPTT, fibrinogen, and D-dimer to monitor coagulopathy

i. Consider thromboelastography (TEG) in critical patients

c. Use enoxaparin or q8 hr SQ heparin for prophylaxis if no contraindication

i. Consider therapeutic lovenox vs heparin infusion in high risk patients

IV. Renal Support and Renal Replacement Therapy

a. Continuous renal replacement therapy should be offered if indicated and available

b. If CRRT unavailable, consider other modalities (IHD with vasopressor support, etc.)

V. Anti-Inflammatories

a. Steroids: Not recommended

i. Steroids appeared to worsen outcome in SARS and are associated with worse outcomes with other respiratory viral infections (RSV, HMPV, etc)

ii. Stress-dose steroids (e.g. hydrocortisone 50 mg q 6-8 hrs) may be considered with refractory hemodynamic instability

VI. Antivirals

a. There are as yet no randomized data on anti-viral efficacy

b. Consultation with Infectious Diseases is advised

c. Enrollment in clinical trials is encouraged – additional guidance will be provided as clinical trials come online.

VII. Standard Critical Care Best Practices are Indicated

a. Sedation
b. Nutrition
c. Deep Venous Thrombosis Prophylaxis
d. Stress ulcer prophylaxis

VIII. Cardiopulmonary resuscitation

a. Guidance is being developed by the CPR Committee.

IX. Other Resources

a. University of Washington Protocols and Experience

i. https://covid-19.uwmedicine.org/Pages/default.aspx

b. ICU Primer for Non-Intensivists