

COVID-19: CLINICAL GUIDANCE FOR CRITICAL CARE MANAGEMENT OF PATIENTS

RESPIRATORY SUPPORT

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

1. Infection risk due to aerosolization.
2. Potential for lung injury with large tidal volumes.
3. Minimal (if any) data supporting NIV for hypoxemic respiratory failure.
4. 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

1. Patient should wear a surgical mask or other covering over their face to prevent droplet formation and spray.
2. In general, flow rates ≤ 40 L/min should be used.
 - This limit on flow rate is intended to (1) prevent aerosolization (in theory, data limited) and (2) to encourage early (non-emergent) intubation.
 - Higher rates could be considered in extenuating circumstances.
3. In general, high-flow FiO₂ support should be limited to < 40 -50% O₂.
 - This is to encourage early (non-emergent) intubation in a patient with poor trajectory.
4. Patients should be closely monitored; if no improvement with high flow nasal cannula, proceed to endotracheal intubation.

C. Endotracheal intubation

1. Intubation should be performed early and in a controlled fashion.
2. Intubate before the patient is in extremis.
 - Considerations include oxygen requirement, work of breathing, and time to marshal appropriate resources.
3. Early lung protective ventilation may protect patients.
4. Controlled intubation will allow adequate donning of PPE for staff protection.
5. Specific guidance for endotracheal intubation procedures appears in a separate document.

D. Mechanical ventilation

1. ARDS protocol low tidal volume ventilation should be used.
2. Tidal volumes should generally not exceed 6 ml/kg predicted body weight.
 - 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 H₂O.
3. Our standard PEEP:FiO₂ Table should be used in most cases.
 - Most patients with COVID19 appear to be PEEP-responsive.
4. Plateau pressure should be < 30 cm H₂O, preferably lower.
5. Driving pressure (P_{plat} – PEEP) < 14 cm H₂O has been associated with improved outcomes in ARDS.

- PEEP may be titrated to minimize driving pressure at attending discretion.
6. Respiratory rate may be increased as needed to keep pH > 7.20
 - Note that hypercarbic acidosis, even below a pH of 7.20, is generally well tolerated.
 7. Patients have been reported to rapidly de-recruit when PEEP is removed
 - 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.
 - This may help reduce recruitment for patients on high PEEP.
 - This might reduce aerosolization of secretions.

E. Prone positioning

1. Early proning is beneficial.
2. Prone positioning should be strongly considered if P:F \leq 150 mm Hg if no contraindications
3. Consider earlier proning (e.g. with P:F > 150).
 - It should not be viewed as a salvage maneuver
 - Prone positioning is a lung protective maneuver
 - Consider time to assemble needed personnel and equipment
4. Patients should remain prone for prolonged periods (at least 18-24 hours).
5. If oxygenation deteriorates upon supination, return to prone position.
6. There is no limit to the time that patients may remain prone.
7. Note: there is anecdotal support for placing *spontaneously breathing non-intubated* patients in the prone position. This could be considered in some circumstances.

F. Neuromuscular blockade can be considered in the setting of significant ventilator dyssynchrony or refractory hypoxemia

1. Adequate sedation should be achieved first.
2. Bolus dosing should be trialed first, and if frequent boluses required, move to short-duration infusion of NMB.
3. Cisatracurium or vecuronium are acceptable.

G. Inhaled nitric oxide may be used in cases of refractory hypoxemia.

1. Initial dose of iNO is typically 5-10 ppm.
2. Daily assessment of dose-response should be performed.
 - Patients often become **more** sensitive to iNO with time.
 - Maximum efficacy is often at surprisingly low doses (e.g. 1 ppm).
3. Veletri will not be used due to aerosolization risk.

H. Bronchoscopy should be avoided

1. Bronchoscopy is an aerosol-generating procedure which may increase staff risk .
2. Diagnostic yield is low.
3. Bronchoscopy is unlikely to change management.
4. If a lower respiratory specimen is desired, consider endotracheal aspirate.

I. Chest CT imaging should be avoided when possible

1. Resource intensive.
2. Removes staffing from ICU.
3. Limited utility as far as changing management.

4. 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.**
1. 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.**
1. Evaluation for ECMO support will proceed according to our standard institutional ECMO guidelines.
 - ECMO is a limited and intensive resource with unproven benefit.
 - We do not routinely offer ECMO to patients > 55-60 years old.
 2. 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.
 3. Potential ECMO patients at outside hospitals will transferred to the MICU or BCU for evaluation for ECMO, not the CVSICU.
 4. Cannulation will occur at the bedside or in the operating room, at the discretion of the cannulating surgeon.
 - Cannulation should occur in a negative pressure environment.
 5. Regardless of location, the cardiac OR team should be mobilized for all cannulations.
 6. Post-cannulation, patients will be cared for in negative pressure rooms in the CVSICU or CCU.
 - This guidance may change based on patient/ECMO volumes.

CARDIOVASCULAR SUPPORT

- L. **Excessive fluid resuscitation should be avoided**
- M. **Early use of vasopressors may limit fluid administration**
1. Low-dose vasopressors (e.g. < ~0.1-0.2 mcg/kg/min norepinephrine) may be safely administered via peripheral IVs in many cases
 2. With normal LV function, oral midodrine (up to 20 mg TID) may be considered as a pressor-sparing agent
- N. **Myocarditis and/or severe arrhythmias have been reported.**
1. This seems to occur as the lungs begin to recover, and patients may transiently improve before abrupt deterioration
 2. Providers should be alert for signs of myocardial dysfunction, including new arrhythmias
 3. Rapid LV assessment with POCUS could be considered if there is concern regarding myocarditis.
- O. **In patients with myocardial failure, early cardiology consultation should be obtained.**
- P. **Mechanical circulatory support (IABP, ECMO, and temporary LVAD) may be considered on a case-by-case basis.**

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.).

STEROIDS

- A. Steroids should probably not be used.
- B. Steroids worsened outcome in SARS and are associated with worse outcomes with other respiratory viral infections (RSV, HMPV, etc.).
- C. Stress-dose steroids (e.g. hydrocortisone 50 mg q 6-8 hrs.) may be considered with refractory hemodynamic instability.

ANTIVIRALS

- A. There is no randomized data on anti-viral efficacy.
- B. Close consultation with ID is advised.
- C. Enrollment in clinical trials is encouraged – additional guidance will be provided as clinical trials come online.

CARDIOPULMONARY RESUSCITATION

- A. Guidance is being developed by the CPR Committee.

The recommendations in this document are derived from review of current literature and expert opinion based on experience derived from Italy and the State of Washington.

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