

Hamilton Health Sciences ECMO Guidelines for COVI-19 Pandemic
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Definitions:

ECLS - Extra-corporeal Life Support

ECMO - Extra-corporeal Membrane Oxygenation

VV ECMO - Veno Venous Extracorporeal Membrane Oxygenation. This term defines the application of extracorporeal circulation primarily for respiratory support, in which the extracorporeal circuit drains blood from the venous system and reinfuses into the venous system with the primary goal of oxygenating and decarboxylating the blood.

VA ECMO - Veno Arterial Extracorporeal Membrane Oxygenation. This term defines the application of extracorporeal circulation for combined cardiac and respiratory support, in which the extracorporeal circuit drains blood from the venous system and reinfused into the arterial circulation with the goal of supporting gas exchange as well as restoring organ perfusion with hemodynamic support.

HGH - Hamilton General Hospital

CS - Cardiac Surgery

ARDS - Acute Respiratory Distress Syndrome.

COVID-19 - Novel coronavirus, culprit agent of current pandemic.

P/F ratio - arterial PaO₂ over FiO₂ ratio.

Background

- The World Health Organization declared COVID-19 a pandemic on March 11, 2020. Severe disruptions and health care resource depletion in medically sophisticated countries has been heavily reported. There is a potential for substantial impact on national and regional health care resources in Canada.
- There is no known proven therapy for COVID-19, and recommended therapy is entirely supportive at this time.
- For severe respiratory failure, VV-ECMO is a recognized therapy (Level of evidence IIB – weak recommendation, moderate quality of evidence). At present, VV-ECMO is not offered in Hamilton, Ontario. However, we have a functional VA-ECMO program within the Cardiac and Vascular Program at Hamilton Health Sciences, along with relevant medical expertise within the critical care multidisciplinary team.

****Note:** The purpose of these guidelines is not to introduce a formal VV-ECMO program but rather communicate to physicians, surgeons and critical care health care teams what can and cannot currently be offered within Hamilton specifically during the COVID-19 pandemic.

Current Resources and Limitations

ECMO resources at HHS are finite – we currently have two consoles with six total circuits. Provincial and national ECMO resources are also expected to be limited during the COVID-19 pandemic. We also anticipate supply shortages to impact ECMO circuits and equipment (e.g. membrane oxygenators, pump tubing, etc.). It is therefore conceivable that there will be patients who could potentially benefit from VV or VA ECMO whilst resources are not otherwise available. In such circumstances, lung protective ventilation strategies and prone ventilation are to continue until such time ECMO resources become available, or the patient can be safely transported to another ECMO centre.

ECMO can only be offered at HGH. The patient will be housed in a dedicated COVID-19 critical care unit based on the bed allocation at the time of decision to go on ECMO. Regardless of

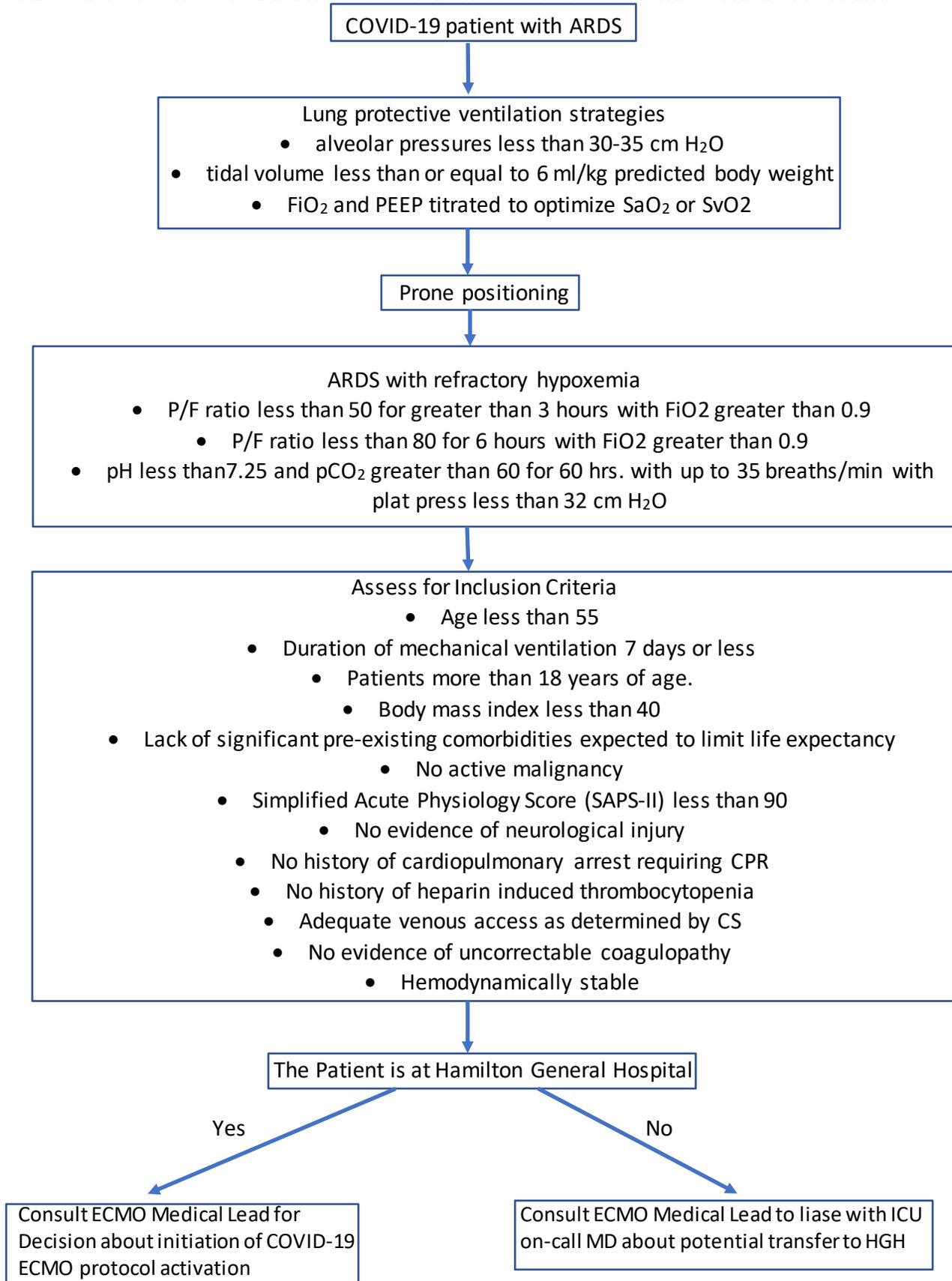
which critical care unit the patient is allocated to, there will be 24/7 bedside perfusion support and effort will be made to deploy ECMO-trained nurses for these patients.

Guiding Principles

These guidelines follow the same guiding principles as the HHS Policy “Adult Critical Care Triage and Resource Allocation Protocol for Pandemic”

Briefly, these are **Utility** (maximizes benefit); **Proportionality** (triage should have the smallest possible negative impact upon care); **Transparency and Trust** (criteria and rationale for decisions should be widely available and clearly documented, with accountability); **Efficiency and Sustainability** (the triage pro practical to use and provide timely decisions which protect staff); and **Fairness** (clinically-relevant criteria, as objective as possible, should guide decisions whenever possible, without discrimination).

ALGORITHM FOR CONSIDERATION OF VV-ECMO SUPPORT FOR THE COVID-19 PANDEMIC



*ECMO team for COVID-19 patients will include Drs. F. Amin (or delegate), A. Lamy (or delegate), P. Engels, MRP Intensivist +/- ICU South MD. See ECLS Algorithm attached

Initiating ECMO

Recognizing that more patients may potentially benefit from ECMO than can be provided the therapy, a fair, transparent, and clinically-relevant process of resource allocation will be used to determine which patients will receive a trial of ECMO Therapy. Where feasible, the process parallels that of the Critical Care Triage and Resource Allocation Policy to ensure a consistent organizational approach to allocation of scarce, life-saving resources during the Pandemic.

- ECMO will only be initiated within HGH. ECMO will not be started at other institutions within Hamilton during the COVID-19 pandemic; patients must be sufficiently stable for transfer to HGH to be considered for ECMO
- The risk / benefit of ECMO versus transport of a critically ill patient to HGH will need to be considered on a case by case basis, on the basis of patient stability, travel distance, and critical care transport resources available
- Referral to HGH for consideration of ECMO requires discussion between critical care attendings at the sending and receiving site; early involvement of the ECMO team is important.
- If current ECMO resources are consumed at HGH, COVID-19 patients will not be transferred to HGH to wait for resources to become available; this minimizes the risk of harm to the patient and staff from unnecessary transfers
- Droplet/contact precautions plus N95 will be worn by all health care team members during the establishment of ECMO support.
- The COVID-19 OR Protocol (attached) must be followed during the cannulation
- Femoral-jugular or femoral-femoral cannulation will be the standard cannulation performed by CS within HGH

To be considered for ECMO at HGH, patients must meet the following **Inclusion Criteria**. These are designed to identify patients who have already received optimal non-ECMO critical care treatment and may potentially benefit from ECMO. The **Exclusion Criteria** identify patients with a poor prognosis outside of their acute illness, **OR** patients whose current medical condition makes them unlikely to benefit from ECMO **OR** whose physical characteristics or comorbidities make ECMO treatment infeasible.

To ensure fairness of consideration, **all** patients who meet Inclusion Criteria for ECMO should be discussed with the ECMO team so as to avoid under-triage. The Inclusion Criteria are thus correspondingly strict.

Additionally, to ensure the concepts of transparency, trust, sustainability and fairness are maintained, all patients referred for ECMO will be tracked. Relevant demographic and clinical variables will be documented and tracked along with outcomes, regardless of whether they are ultimately treated with ECMO or not. This will also serve as a means to determine quality indicators for provision of ECMO therapy during a similar pandemic environment.

Inclusion Criteria

In order to be referred to HGH for consideration of ECMO, all patients must:

- fulfill the Berlin Consensus definition of ARDS
- be intubated and mechanically ventilated with refractory hypoxemia despite maximal lung protective strategies, defined as:
 - low tidal volume ventilation, 4-6 mL/kg IBW, PEEP optimization)
 - P/F ratio less than 50 for greater than 3 hours or a P/F ratio less than 80 for 6 hours or an arterial pH less than 7.25 with a pCO₂ greater than 60 for 6 hours with a RR up to 35 breaths per minute with Plateau pressure less than 32 cm H₂O.
- be ventilated for less than 7 days and preferably less than 5 days.
- have had a trial of paralysis **and** prone ventilation prior to being considered for ECMO for COVID-19
- Age less than 55, as increasing age predicts mortality while on ECMO
- as pregnancy is a recognized contraindication to proning, pregnant patients do not require a trial of prone ventilation prior to consideration for ECMO

Exclusion Criteria

- patients less than 18 years of age. However, physiologically mature minors (weight greater than 50 kg) will be considered on a case by case basis.
- body mass index greater than 40
- pre-existing comorbidities expected to limit life expectancy
- any active malignancy
- moribund or a Simplified Acute Physiology Score (SAPS-II) more than 90
- cardiopulmonary arrest
- prior history of heparin induced thrombocytopenia
- inadequate venous access as determined by CS
- uncontrollable coagulopathy
- concomitant severe distributive shock

Pre-ECMO Management Protocol

- The critical care team shall attempt best management with a conventional lung protective strategy
 - mechanical ventilation with alveolar pressures restricted to less than 30-35 cm H₂O
 - goal tidal volume less than or equal to 6 ml/kg predicted body weight
 - FiO₂ and positive end expiratory pressure (PEEP) titrated to optimize SaO₂ or SvO₂
- Consideration of prone positioning should be undertaken prior to VV-ECMO, however the process of referral can occur in parallel.
- Other rescue therapies such as inhaled nitric oxide, corticosteroids or oncotic manipulation are **NOT** required prior to referral for VV-ECMO.

Management of ECMO

The management of ECMO support will be conducted in a collaborative fashion between the cannulating surgeon (or delegate), the critical care attending, and perfusion. A daily meeting of these parties to review the management of an ECMO patient and document the findings is mandatory.

In general, the following principles will apply:

- Access
 - All ECMO patients will have central venous access and a peripheral arterial catheter
- Anticoagulation/hematology
 - During cannulation, the patient will be given a loading dose of IV heparin consisting of 100 units/kg
 - Following cannulation, IV heparin will be used to maintain an activated clotting time of 160-200 seconds
 - Heparin may be stopped if clinically indicated (i.e. bleeding)
 - The hemoglobin transfusion trigger is 70
 - The platelet transfusion trigger is 20 if there is no bleeding and 50 if there is active bleeding
- Ventilator support
 - Aim should be to prevent ventilator induced lung injury
 - Goals:
 - Peak inspiratory pressure less than 20-25 cm H₂O
 - PEEP less than 10-15 cm H₂O
 - FiO₂ 0.3-0.4
 - Oxygen saturation greater than 85%
 - Avoid recruitment maneuvers
- Goals for oxygenation and carbon dioxide on ECMO include:
 - PaO₂ greater than 60 mmHg
 - PaCO₂ adjusted to provide a pH 7.35 – 7.45
- Fluid management
 - The goal is a negative fluid balance, to achieve the lowest filling pressure possible, while maintaining adequate ECMO flow and minimizing vasopressor dosages
 - Diuretics will be considered to achieve fluid goals. CRRT can be considered if, after discussions with Nephrology, fluid goals are not met with diuretics alone.
 - If the administration of fluids is required, then consideration should be made for:
 - pRBC (if the hemoglobin is below the transfusion trigger or the patient is actively bleeding)
 - Plasma (if coagulopathic or fibrinogen is low)
 - Crystalloids if the above are not met
 - Albumin may be considered
 - Fluid choice should in conjunction with perfusion and surgeon

Weaning and Decannulation of ECMO

- The cannulating surgeon, intensivists, cardiac anesthesia and perfusion will coordinate efforts towards weaning of ECMO support and determining timing of decannulation
- Weaning of ECMO shall be considered after successful treatment of the underlying lung disease and improvement in lung function as per the discretion of the intensivists, cannulating surgeon and cardiac anesthesia

- VV-ECMO weaning will be conducted by gradually turning down the sweep in 0.5 L/min increments and turning down the FiO₂ by 0.1 increments and following arterial blood gases to maintain PaO₂ greater than 60 and PaCO₂ to provide a pH 7.35 – 7.45
- The FiO₂ and sweep of the VV-ECMO circuit should be turned to 0 for at least 30 minutes as a trial off ECMO
- The method of ECMO decannulation will be at the discretion of the cannulating surgeon **BUT** should occur in the patient's isolation room whenever possible

Failure to Separate from ECMO

- After 5-7 days of ECMO support, the cannulating surgeon and the intensivist should discuss the case to review the indications and contraindications of ongoing support. This does not preclude an earlier review if clinically indicated nor does it mandate discontinuation of support.
- With the knowledge that the prognosis generally worsens the longer a patient is on ECMO support, ongoing discussions to review the indications and contraindications of ongoing support should continue, at least on a weekly basis. As well, discussions with the family/substitute decision maker regarding the goals of care, realistic prognosis and appropriateness of withdrawal of treatment and palliation should also take place.

Insufficient ECMO resources

- Recognizing that in a pandemic, the resources for ECMO may become limited or ECMO may no longer be a possible service to maintain, it is important to have a process about how available resources are allocated
- Only patients with the lowest risk of death or poor outcome in the near future will receive ECMO; there is little justification for withdrawing life-sustaining measures from one patient in order to provide critical care resources to another patient with a similar prospect of benefit
- Removing patients from ECMO before they have had an opportunity to benefit will likely result in higher mortality overall, and is contrary to the principle of *Utility*; a first come-first served process will be more likely to provide benefit
- If demand for ECMO exceeds resources, patients should have a fair chance of recovery and should not be removed from ECMO unless they deteriorate or the treating physician believes further ICU care is unlikely to result in survival. This should be based on clinical considerations, integrating all relevant clinical information, including acute physiology, trajectory, and response to treatment, and not on the basis of demographic or socioeconomic factors or the needs of other patients awaiting ECMO.
- Patients eligible for ECMO when all ECMO resources are available should be managed expectantly with best available medical care, with the use of a transparent randomization process if multiple patients are eligible at the same time

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