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ELSO Guidance Document: ECMO for COVID-19 Patients with Severe Cardiopulmonary Failure

The Extracorporeal Life Support Organization (ELSO) and all of the ELSO worldwide chapters have prepared this document to **describe when and how to use extracorporeal membrane oxygenation (ECMO) in COVID-19 patients** during this pandemic. It is a consensus guideline intended for experienced ECMO centers.

COVID-19 is a disease caused by the novel SARS-CoV-2 virus which appeared in December 2019 and is now a worldwide pandemic. Because it is a new viral disease, this guidance document is based on limited experience and written with the intention to be updated frequently as new information becomes available. A link to the latest version of this document will be found at http://covid19.elso.org .

Although most COVID-19 patients have moderate symptoms and recover quickly, some patients develop severe respiratory failure and acute respiratory distress syndrome (ARDS) requiring intensive care admission. The mortality in COVID-19 patients who require mechanical ventilation is high. ECMO can be lifesaving in patients with severe forms of ARDS, or refractory cardio-circulatory compromise. **Initial experience in Japan and South Korea with ECMO in >50 COVID-19 cases has had survivors, with many still receiving treatment**.

An overview article in Lancet Respiratory Medicine (March 2020) examines the role of ECMO and ECMO centers during the COVID-19 pandemic. Additionally, guides detailing the requirements for an ECMO program are available in both the medical literature and the ELSO website. The Society of Critical Care Medicine also has promulgated guidelines for the management of COVID-19 patients and recommends the use of ECMO when conventional management fails. Due to the intensive hospital resource utilization, substantial staff training, and multidisciplinary needs associated with starting an ECMO program, **ELSO recommends against starting new ECMO centers for the sole purpose of treating patients with COVID-19.** As mentioned in a recent article by ELSO leaders in JAMA, for inexperienced centers, "ECMO is not a therapy to be rushed to the front lines when all resources are stretched during a pandemic." A list of experienced ECMO centers is provided on the ELSO website. During the COVID-19 surge it is reasonable to concentrate those patients with the greatest chance of benefit from receiving ECMO in a hospital where an experienced ECMO team is available.

ECMO Indications, access, and management are described in the ELSO Guidance for Adult Respiratory and Cardiac failure on the ELSO web site (elso.org). ECMO is indicated in patients who have a high risk of mortality. There are several ways to measure mortality risk in ARDS. All include PaO2/FiO2 below 100, despite and after optimal care. For adult respiratory failure, the recently published EOLIA trial contains three indications that define severe ARDS where ECMO may be useful. Many standardized algorithms for ARDS therapies, such as the figure below, have been published and may be of aid to clinicians. When patients meet indications, ECMO should be initiated immediately in an experienced center, and not days later.

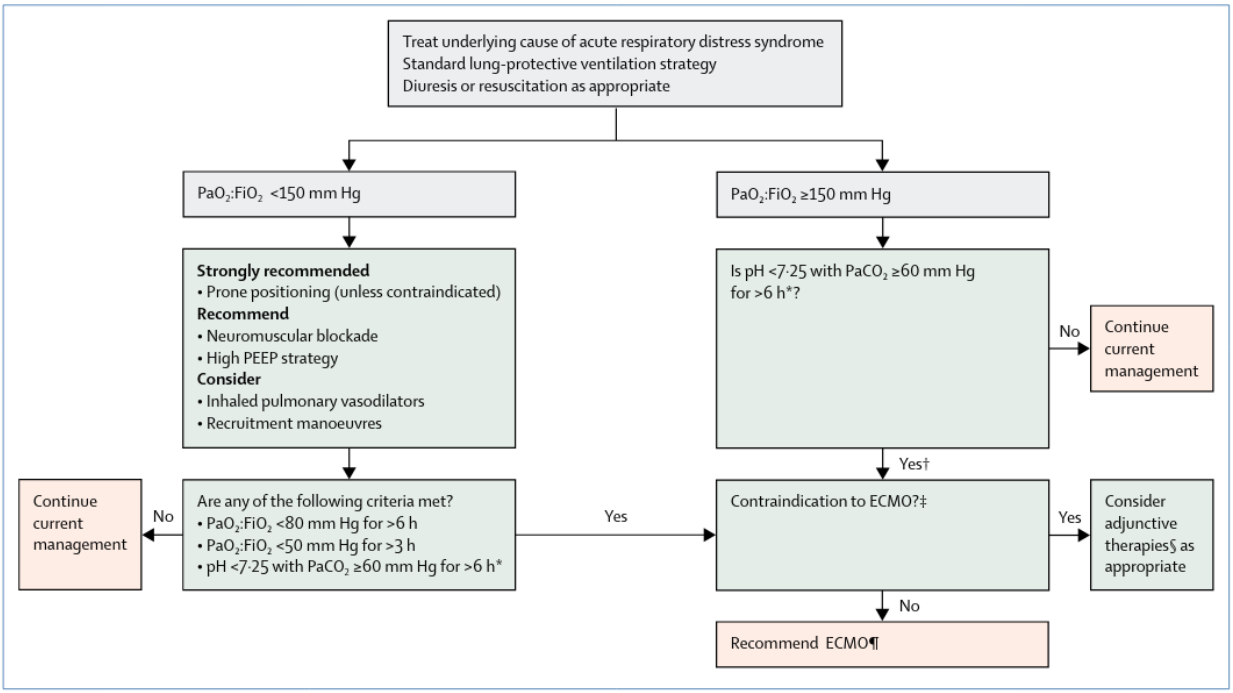

Figure: **Algorithm for management of acute respiratory distress syndrome**
PEEP=positive end-expiratory pressure. PaO_2:FiO_2=ratio of partial pressure of oxygen in arterial blood to the fractional concentration of oxygen in inspired air. ECMO=extracorporeal membrane oxygenation. $PaCO_2$=partial pressure of carbon dioxide in arterial blood. *With respiratory rate increased to 35 breaths per minute and mechanical ventilation settings adjusted to keep a plateau airway pressure of ≤32 cm of water. †Consider neuromuscular blockade. ‡There are no absolute contraindications that are agreed upon except end-stage respiratory failure when lung transplantation will not be considered; exclusion criteria used in the EOLIA trial[1] can be taken as a conservative approach to contraindications to ECMO. §Eg, neuromuscular blockade, high PEEP strategy, inhaled pulmonary vasodilators, recruitment manoeuvres, high-frequency oscillatory ventilation. ¶Recommend early ECMO as per EOLIA trial criteria; salvage ECMO, which involves deferral of ECMO initiation until further decompensation (as in the crossovers to ECMO in the EOLIA control group), is not supported by the evidence but might be preferable to not initiating ECMO at all in such patients.

Because the use of ECMO for COVID-19 is occurring during a pandemic which can overwhelm hospital resources, **unique considerations for ECMO in COVID-19 patients are:**

Should ECMO be considered for COVID-19 patients?

This decision is a local (hospital and regional) responsibility. It is a case by case decision that should be reassessed regularly based on overall patient load, staffing, and other resource constraints, as well as local governmental, regulatory or hospital policies. If the hospital must commit all resources to other patients, then ECMO should not be considered until the resources stabilize. If the hospital feels that ECMO can be safely provided, then it should be offered to patients with a good prognosis with the use of ECMO, and perhaps to other patients who qualify for ECMO support (See below). Use of ECMO in patients with a combination of advanced age, multiple co-morbidities, or multiple organ failure should be rare.

Based on current medical evidence and outcomes, it is not appropriate to state "ECMO will never be considered for COVID-19 patients."

Should ECMO during CPR (E-CPR) be considered for COVID-19 patients?
Due to the complexity and extensive team training associated with doing E-CPR, centers who do not currently provide these services, should not initiate programs during times of limited resources. Inexperienced ECMO centers should consider whether to continue these programs during resource-limited times. At experienced centers, E-CPR may be considered for in-hospital cardiac arrest depending on resource availability. However, in patients with COVID-19, the potential for cross-contamination of staff and the use of personal protective equipment (PPE) by multiple practitioners when in short supply, should be considered in the risk-to-benefit ratio of performing E-CPR. Initiating E-CPR in patients with multiple co-morbidities or multiple organ failure should be rare.

Should ECMO be considered for traditional indications during the COVID-19 pandemic?
Understanding hospital resource limitations as above, standard ECMO should continue when that is possible related to overall hospital resources.

When ECMO is used:

What patients are the highest priority?
Younger patients with minor or no co-morbidities are the highest priority while resources are limited. Health care workers are a high priority. It should be acknowledged that this is a dynamic prioritization. As resources change, priorities should shift based on what can be safely done in the hospital-specific setting.

What patients should be excluded?
Standard contraindications apply: terminal disease, severe central nervous system damage, Do Not Resuscitate status, or advanced directives refusing such therapy.

- *Exclusions for COVID-19 during limited resources are hospital or region-specific.*
- *Because prognosis is worse with co-morbidity, patients with significant co-morbidities should be excluded.*
- *Because prognosis is worse with age, older age should be considered when balancing resource availability with the potential to improve outcomes.*
- *Because prognosis is worse with time on invasive mechanical ventilation, patients on mechanical ventilation greater than 7 days* should be excluded.*
- *Renal failure is not an exclusion.*
- *Use of ECMO in patients with a combination of advanced age, multiple co-morbidities, or multiple organ failure should be rare.*

***What* protective measures for the team should be used?**
Standard COVID-19 precautions as recommended by WHO and national health organizations should be used. There are currently no special precautions recommended for blood contact.

What is the definition of futility for termination?

Not all patients will improve with ECMO support. As is standard with usual ECMO care, clinicians should be continuously evaluating when ECMO no longer provides a positive benefit:risk ratio and should at that point return to conventional management regardless of how long the patient has been on ECMO. During times of limited resources, this becomes especially important and while the definition will be hospital or region-specific, observing no lung or cardiac recovery after approximately 21 days on ECMO can be considered futile, and the patient can be returned to conventional management. (Note: for situations where withdrawal of life-sustaining therapies is not an option, this change of management does not constitute withdrawal.)*

What is the incidence of cardiac failure and how is it managed?

As in any patient, cardiac failure is defined as sustained hypotension despite other management. Failure is confirmed and measured by physiologic parameters and echocardiography. VA access is indicated, perhaps in the form of V-VA. Therefore, timely echocardiographic assessment in the presence of any clinical suspicion of cardiac dysfunction or sign of circulatory compromise should be undertaken.

> **These are general guidelines which may not apply to specific COVID-19 patients depending on local circumstances.*

For ELSO member centers, when you use ECMO for COVID-19, please enter your patient in the Registry at the time they go on (and later when discharged). Early registry entry allows ELSO to be able to provide member centers with real time and up to date outcome and complication data.

Centers which are using ECMO and are not ELSO members are encouraged to join ELSO and enter COVID-19 cases. Membership fee is waived during this pandemic.