

Extracorporeal Life Support (ECLS) Recommendations For COVID-19 in Alberta

Provincial Critical Care ECLS Group Recommendations
Critical Care Strategic Clinical Network
Alberta Health Services
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Note: This document has been developed by the Provincial Critical Care ECLS Subgroup.

Purpose:

- To describe the principles behind ECLS resource management during COVID-19 pandemic ensure critically ill patients in Alberta are considered for and receive ECLS fairly and equitably
- To describe the operational structure and principles for providing ECLS in both adult and pediatric critically ill patients in the setting of COVID-19 pandemic.

Assumptions:

1. Both adult and pediatric patients are at risk for COVID-19 disease.
2. [Resource limitations will increase over time as the pandemic progresses.](#)
3. Expectation that any resource limitation to ECLS will be equally applied to all disease processes potentially benefiting from ECLS including CV surgery.
4. [The decisions of how and when to limit ECLS resources will be made at an executive AHS and/or provincial level.](#)
5. There is a high risk of supply chain disruptions for critical disposables required for ECLS delivery (e.g. oxygenators).

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Definitions

Extracorporeal life support (ECLS) is a collective term for extracorporeal therapies used for the support of cardiac and/or pulmonary failure through the use of an extracorporeal circuit.

Extracorporeal membrane oxygenation (ECMO) is the provision of oxygen and carbon dioxide exchange through the use of an extracorporeal circuit consisting of (at a minimum) a blood pump, a membrane oxygenator, and vascular access cannulae to support oxygenation and decarboxylation of the blood.

Historically, the term ECLS has been used interchangeably with the term ECMO, but ECMO is the preferred term when the goal is oxygenation and carbon dioxide removal with the use of an extracorporeal circuit.

Veno-Venous ECMO (VV-ECMO) is 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.

Veno-arterial ECMO (VA-ECMO) support is the application of extracorporeal circulation primarily for cardiac or circulatory support, in which the extracorporeal circuit drains blood from the patient's venous system and returns it back to the systemic arterial system. Although used primarily for cardiac support, VA-ECMO can be used also for combined cardiac and respiratory support as well.

Background

COVID-19, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), is a novel coronavirus and is the cause of a worldwide pandemic (as declared by the World Health Organization).

COVID-19 is believed to be spread via respiratory droplets (similar to influenza, MERS, and SARS) or contact (e.g. contaminated hands to mucous membranes). Human-to-human transmission has been evidenced from spread of the virus between family members and also to health care workers, at much higher rates than seasonal influenza.

Patients with confirmed COVID-19 infection have reportedly had mild to severe respiratory illness with symptoms of fever, cough, and shortness of breath. Current estimates suggest the incubation period for COVID-19 is similar to other novel coronaviruses, between 1 and 14 days. The period of communicability for COVID-19 is not currently known. People known to be sick with COVID-19 will be isolated until they are confirmed by medical tests to no longer carry the virus.

Older individuals and people with medical co-morbidities, especially related to cardiovascular disease, chronic respiratory illnesses, diabetes and hypertension appear to be at the highest risk. Studies demonstrating these risk factors have not assessed the role of age as a confounder for these findings at this time, and the pathophysiology of these risk factors is still under investigation. Progressive illness early after presentation may also be a predictor of a severe clinical course. The proportion of individuals who get COVID-19 who develop severe disease is still under investigation but is under 20% of diagnosed cases. A significant proportion of hospitalized patients require critical care admission for mechanical ventilation.

Feb 21, 2020 the hospitalized patient cohort published in Lancet Respiratory Medicine.

Largest cohort of ICU patients

([https://www.thelancet.com/journals/lanres/article/PIIS2213-2600\(20\)30079-5/fulltext](https://www.thelancet.com/journals/lanres/article/PIIS2213-2600(20)30079-5/fulltext))

52 patients admitted to ICU between late Dec 2019 - Jan 26 2020 (from a population of 710, 7%)

- 71% needed mechanical ventilation (invasively or non-invasively)
 - 56% NIV (non-invasive ventilation)
 - 42% INV (invasive ventilation)
- 11.5% needed ECMO
- 17% needed renal replacement therapy

GUIDING PRINCIPLES FOR ECLS

1. Early assessment and intervention are preferable. Consultation for ECLS may result in additional management suggestions prior to consideration for transfer to an ECLS center, or cannulation.
2. Conventional medical therapy for ARDS should be optimized prior to consideration for ECLS cannulation. Early consultation with critical care medicine at an ECLS center to assist with maximization of medical management is desirable.
3. There is unlikely to be an additive therapeutic benefit with ECLS above and beyond conventional management for patients with: age > 65 (at the discretion of 2 ECLS intensivists), significant burden of medical co-morbidities, and poor likelihood to recover sufficient lung function to promote meaningful, independent recovery. These patient are, therefore, unlikely to be deemed suitable ECLS candidates. Age (beyond gestational age greater than 34 weeks) is not a factor for the guidance of ECLS in the pediatric population.
4. Timing of referral from non-ECLS centers should take into consideration the risks for transport of the critically ill, including weather limitations, transport time, patient stability and transport personnel availability.
5. Mechanical ventilation with high ventilator settings and high FiO₂ > 7 days portend poor outcome, even with rescue ECLS. In general, these patients are not candidates for ECLS after prolonged support, as lung recovery is less likely.
6. All cases are considered on an individual basis. 24-hour consultation with the ECLS Intensivist is available. Depending upon circumstances, relative contraindications are not absolutely prohibitive to proceeding with attempts at salvage extracorporeal support, if consensus is achievable. Shared decision-making is a core principle of the ECLS program, routinely incorporating multiple ECLS consultants.
7. ECLS must only be provided in strict abeyance of all infection control practices related to COVID-19 disease (e.g. only in single patient rooms or cohorted areas where multiple patients with COVID-19 can be managed in the same enclosed space). ECLS will not be provided in open patient areas where non-COVID-19 patients are managed.

REFERRAL CONSIDERATIONS - ADULT

Consider referral to ECLS centre when the following criteria are met:

- PaO₂:FiO₂ ratio < 120 mm Hg for > 3 hours **with inability to maintain lung protective ventilation (LPV)**
- PaO₂:FiO₂ < 100 mm Hg for > 6 hours **even with maintenance of LPV**
- An arterial blood pH of <7.25 with a partial pressure of arterial carbon dioxide [PaCO₂] of ≥60 mm Hg for >6 hours
- Endotracheal intubation and high pressure mechanical ventilation for **less** than 7 days
- Near maximization of conventional therapies
- No severe life-limiting chronic illnesses. Expected life expectancy of at least 2 years of independent functioning, should the patient survive.

Lung Protective Ventilation (LPV) Strategies:

- Pressure limited (to avoid barotrauma): Plateau pressure (P_{plat}) < 30 cm H₂O
- Volume limited (to avoid volutrauma): Tidal volume (V_t) < 8 mL/kg, optimized with a driving pressure < 15 cm H₂O
- Appropriate PEEP (to avoid atelectrauma): Consider PEEP study and recruitment maneuver

Common Therapeutic Modalities to consider prior to escalation to ECLS rescue:

Paw (mean) – ensure that the Paw (mean airway pressure) has been increased as much as possible within the limits of LPV. Most patients who are candidates for ECLS have Paw (mean) of at least 20 cm H₂O.

Sedation - adequately sedated to avoid spontaneous efforts/dyssynchrony, which impair ventilation and gas exchange, and also contribute to lung injury through large oscillations in intrathoracic pressure.

Neuromuscular Blockade – has demonstrated mortality benefit in severe ARDS, likely by inhibiting spontaneous effort/dyssynchrony. Most patients who are candidates for ECLS are hypoxemic despite a trial of paralysis.

Diuresis or CRRT – removing excessive lung water (edema) can improve gas exchange and compliance.

Prone Positioning - has demonstrated mortality benefit in severe ARDS when used appropriately and should be trialed prior to escalation to ECLS.

Rule out alternative causes of hypoxemia – most commonly missed diagnoses included large pleural effusions, pneumothoraces, mucous secretions requiring bronchoscopy, atelectasis, and low mixed venous saturations due to high intrapulmonary shunt.

REFERRAL CONSIDERATIONS - PEDIATRIC

If advanced PICU respiratory care has failed to improved oxygenation or can only be accomplished by applying mechanical ventilation that is not lung protective, consult ECLS Team. Follow current pediatric referral guidelines.

CURRENT ALBERTA ECLS RESOURCES

ECMO is available at select centers in Alberta. In the north it is available at University of Alberta (UAH) and the Stollery Children's Hospital in Edmonton. In the south it is available at the Foothills Medical Center (FMC) in Calgary and the Alberta Childrens Hospital. It is typically provided within the CVICU's and PICU of these centers.

ECMO requires circuits (pumps, oxygenators, and lines), access cannulae, perfusionists, ECMO Specialists, critical care nurses, respiratory therapists, and physicians with ECMO expertise.

FMC – Currently able to support 4 patients on ECMO without any impact to routine operation of the CV surgery program. Maximum potential for 12 patients, however with implications to service delivery across Cardiac Surgery. In the setting of COVID-19, management of ECLS patients will occur at Foothills Medical Center and location of those patients to be determined locally. There is potential for one perfusionist to supervise multiple patients if cohorted.

UAH – UAH – currently able to support 6 patients on ECMO with continued operation of CV surgery program. Able to support 7 to 10 patients on ECMO with impacts to cardiac surgery program. Maximum potential is for 11-13 patients with cardiac surgery only being offered in emergent situations. All COVID- 19 patients will be cared for in the CVICU. ECMO is managed by perfusionists and ECMO Specialists on a one to one basis with the potential for one perfusionist or ECMO Specialist to cover multiple patients if cohorted.

Stollery Children's Hospital - currently able to support 3-4 patients on ECMO with continued operation of CV surgery program. Able to support up to 6 patients on ECMO with impacts to cardiac surgery program. Maximum potential for 10 patients with cardiac surgery only being offered in emergent situations. All COVID- 19 patients will be cared for in the PICU. ECMO for primary cardiac support is provided in the PCICU. ECMO is managed by ECMO Specialists on a one to one basis with the potential for one ECMO Specialist to cover multiple patients if cohorted.

Alberta Children's Hospital – Alberta Children's Hospital – As a rescue program, currently able to support 1 patient while awaiting the Stollery ECLS transport team to retrieve the patient. ELCS is managed by ECLS specialist and perfusionist (therefore dependent on perfusion availability from the FMC).

ECLS PANDEMIC STAGING

ECMO is a limited resource in Alberta. A resource capacity status report has been created for ECMO for use during current or impending pandemic (Appendix A). The report reflects current operating capacity, and will be updated routinely during a pandemic by the Critical Care Strategic Clinical Network to reflect real time resource availability and active running cases.

It is understood and agreed that resources will be shared and allocated where needs arise whether it be between Edmonton and Calgary zones or between adult and pediatric resources. Within Edmonton staff are trained and are able to function in both pediatric and adult capacities. Sharing of staff, supplies and expertise is a common practice.

ECLS may need to be allocated in a graded fashion; being more restrictive as a pandemic limits the availability of resources. Pandemic ethics imply a balance of patient triage, and redirection or restriction of resources to focus on areas of greatest need or greatest perceived benefit. Pump driven ECMO is an invasive therapy that requires a significant amount of resources. It is generally applied as a rescue therapy for patients who are failing other means and who would not likely survive without it.

Given the magnitude and length of time such resource utilization can be expected to be required in the setting of constantly changing demands that a pandemic would place, a graded approach to the use of ECLS is warranted. Inclusion criteria should be adjusted for differing levels of a pandemic focusing on patients with the best perceived prognosis. As demand for ECLS increases and/or the amount of available ECLS resources decreases, more restrictive entry and exit criteria will need to be applied eventually culminating in a stage where ECLS would not be offered at all.

Three ECLS stages have been identified:

1. GREEN level indicates business as usual, no shortage of disposables and operating at normal capacity levels. No limitation to currently available ECLS resources.
2. YELLOW level indicates operating at above normal levels and/or at low levels of disposables with probable impacts to Cardiac Surgery program and need to exam triage guidelines and exit strategies during a pandemic. See ANNEX A – ECLS Pandemic Triage Planning
3. RED level indicates operating at near or maximum levels and/or extreme shortage of disposables. Severe impacts to Cardiac Surgery program and resource limitations such that ECMO may not be available. Advanced levels of triage and exit strategies should be examined during pandemic as outlined in ANNEX A – ECLS Pandemic Triage Planning.

Appendix A

Provincial ECLS program - Resource Capacity Report

Calgary Zone			
		Active Cases Range	Disposables Range
RED	Crisis Resource Management Situation, with active rationing of ECLS resources	9 to 12	<10
YELLOW	Above average volume with impacts on ECLS service delivery and Critical Care	5- 8	10 to 19
GREEN	Delivery of ECLS Care is not impacted by current case volume/inventory	0 to 4	>19

Calgary Zone – Pediatric			
		Active Cases Range	Disposables Range
RED	Crisis Resource Management Situation, with active rationing of ECLS resources	>1	<2
YELLOW	Above average volume with impacts on ECLS service delivery and Critical Care		3 to 4
GREEN	Delivery of ECLS Care is not impacted by current case volume/inventory	0 to 1	>5

Edmonton Zone – Adult				
			Active Cases Range	Disposables Range
	RED	Crisis Resource Management Situation, with active rationing of ECLS resources	11 to 13	<10
	YELLOW	Above average volume with impacts on ECLS service delivery and Critical Care	7 to 10	10 to 19
	GREEN	Delivery of ECLS Care is not impacted by current case volume/inventory	0 to 6	>19

Edmonton Zone – Pediatric				
			Active Cases Range	Disposables Range
	RED	Crisis Resource Management Situation, with active rationing of ECLS resources	7 to 10	<10
	YELLOW	Above average volume with impacts on ECLS service delivery and Critical Care	5 to 6	10 to 19
	GREEN	Delivery of ECLS Care is not impacted by current case volume/inventory	0 to 4	>20