VA-ECMO Provincial Model of Care

November 2024

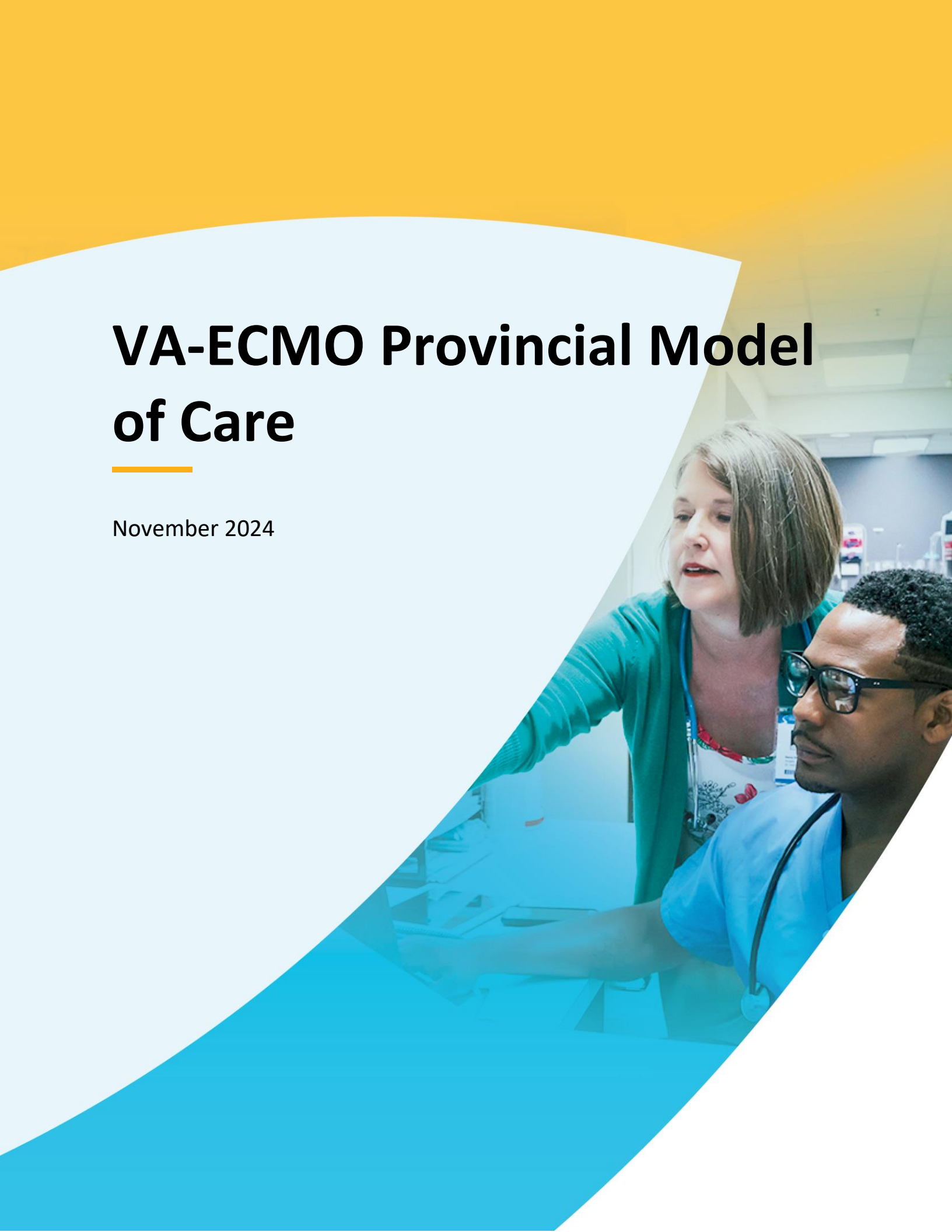


Table of Contents

Table of Contents 2
Abbreviations and Acronyms 3
Background 4
VA-ECMO Service Types 6
Appendix 14
Acknowledgments 16
References 17

Abbreviations and Acronyms

CS	Cardiogenic Shock
VA-ECMO	Venoarterial Extracorporeal Membrane Oxygenation
LVAD	Left Ventricular Assist Device
MCS	Mechanical Circulatory Support
ICU	Intensive Care Unit
CICU	Cardiac/Coronary Intensive Care Unit
CVICU	Cardiovascular Intensive Care Unit
DI	Diagnostic Imaging

Background

Evolution of VA-ECMO Care

Venoarterial (VA) extracorporeal membrane oxygenation (ECMO) is a form of temporary mechanical circulatory and oxygenation support used to stabilize patients with hemodynamic compromise such as refractory cardiogenic shock or cardiac arrest. Similar to venovenous (VV)-ECMO for acute respiratory failure, VA-ECMO provides life support for both the heart and lungs. VA-ECMO is used to support patient recovery, or as a bridge to transplant or durable mechanical support (i.e. LVAD) in the setting of acute or acute on chronic heart/lung failure. In Ontario, current guidance from Critical Care Services Ontario (CCSO) is that use of VA-ECMO may be considered for the following indications[1] (see Table 1 below). Circumstances in which VA-ECMO is contraindicated are also outlined.

Table 1. Cardiac ECMO Consultation Guidelines[1]

Consider ECMO for the following Diagnostic Indications	DO NOT Consider ECMO for the following Diagnostic Indications
Indications: • Refractory Cardiogenic shock (see Appendix: Society for Cardiovascular Angiography & Interventions (SCAI) SHOCK Stage Classification as needed) • Fulminant myocarditis • Pulmonary hypertension • Graft failure after heart transplantation o Amniotic fluid embolism • Massive Pulmonary Embolism • Cardiotoxicant poisoning (e.g. SSRI and SNRI overdoses, calcium-channel or beta-blockers) • Accidental hypothermia (Hypothermia Outcome Prediction after ECLS (HOPE) calculator available at https://hypothermiascore.org/)	**Contraindications:** • End-stage heart failure AND not a transplant or LVAD candidate • Disseminated malignancy (dependent on life expectancy < 1 year) • Known or suspected severe brain injury • Prolonged CPR without adequate tissue perfusion • Unrepaired aortic dissection • Severe aortic regurgitation • Severe end-stage organ dysfunction (emphysema, cirrhosis) • Severe peripheral vascular disease • Non-recoverable advanced comorbidity such as CNS damage or terminal malignancy and not already deemed to be a transplant candidate **Potential Contraindications:** • Where anticoagulation precluded • Advanced age • Morbid obesity • End-stage renal disease

Utilization of VA-ECMO has been growing rapidly worldwide. In 2019, the Journal of the American College of Cardiology Scientific Expert Panel analyzed data from the Extracorporeal Life Support Organization (ELSO), highlighting a substantial increasing trend in both VA-ECMO cases and the number of ECMO centres over the prior decade[2]. During the period studied, the overall number of adults worldwide who underwent ECMO for cardiac indications increased by 1180%, from fewer than 200 between 1997 and 2007 to more than 2,000 in the decade following. The number of ECMO centres increased by 133%, from 131 to 305 centres between 2006 to 2016.

Reasons behind the international increase in the use of ECMO in cardiology include the following[2]:

- Availability of durable membranes and portable circuits
- Ability of ECMO to provide left, right, and biventricular support
- Ease of implantation in a catheterization laboratory or at the bedside
- Increased familiarity with the technology by cardiologists and surgeons
- The need for a short-term bridge to transplantation or mechanical support
- Progress in durable (long-term) mechanical circulatory support devices, which allow ECMO to be used as a bridge to LVAD

In light of these international trends and the evolution of practice in Ontario, the Ontario Health Technology Advisory Committee (OHTAC) made a recommendation in 2020 that ECMO for cardiac indications be publicly funded at selected Ontario hospitals[3]. These cardiac indications specifically included VA-ECMO used to treat refractory cardiogenic shock, and extracorporeal cardiopulmonary resuscitation (ECPR) used to treat refractory cardiac arrest.

In Ontario, VA-ECMO cases have been growing by an average of approximately 15% annually over the period from 2013 to 2023. This trend is based on an Ontario Health (OH) analysis of the Canadian Institute for Health Information's Discharge Abstract Database, using methodology consistent with the OHTAC Health Technology Assessment for adult VA-ECMO[4].

OHTAC also recommended that a provincial strategy be developed to promote equitable access to VA-ECMO care, including a clear definition of the patient population that is eligible for ECMO in Ontario, and clearly defined roles and responsibilities for various health system partners[3].

Implementation of the OHTAC recommendations is underway to ensure Ontario hospitals are adequately resourced to provide high quality, evidence-based and coordinated VA-ECMO services. VA-ECMO care in Ontario exists within a larger envelope of hospital ECMO programs, which are connected and coordinated through partnerships with Critical Care Services Ontario (CCSO), ORNGE, local Emergency Medical Services (EMS), regional cardiac programs, Ontario Health, and the Ministry of Health.

VA-ECMO Service Types

VA-ECMO Service Levels Within the Regional Cardiac Program Framework

The Ontario Health Regional Cardiac Program Framework[5] aims to transparently define the roles and responsibilities of a Regional Cardiac Program (RCP) and standardize the services that patients can expect across Ontario. The RCP Framework outlines responsibilities of a RCP, a combined cardiac service entity providing a comprehensive suite of cardiac services. The RCP Framework should also be consulted by hospitals when considering service expansion for the delivery of advanced cardiac services.

Each RCP is expected to coordinate and deliver a comprehensive range of cardiac services to patients, either at the regional cardiac provider site (e.g., hospital), or through coordination with referral cardiac centres. The RCP Framework further describes distinct levels of cardiac providers based on the complexity of cardiac services they provide. Each level is additive, in that the levels each have minimum criteria, and the additional criterion in the subsequent levels supports the advancement of the services (see Figure 1).

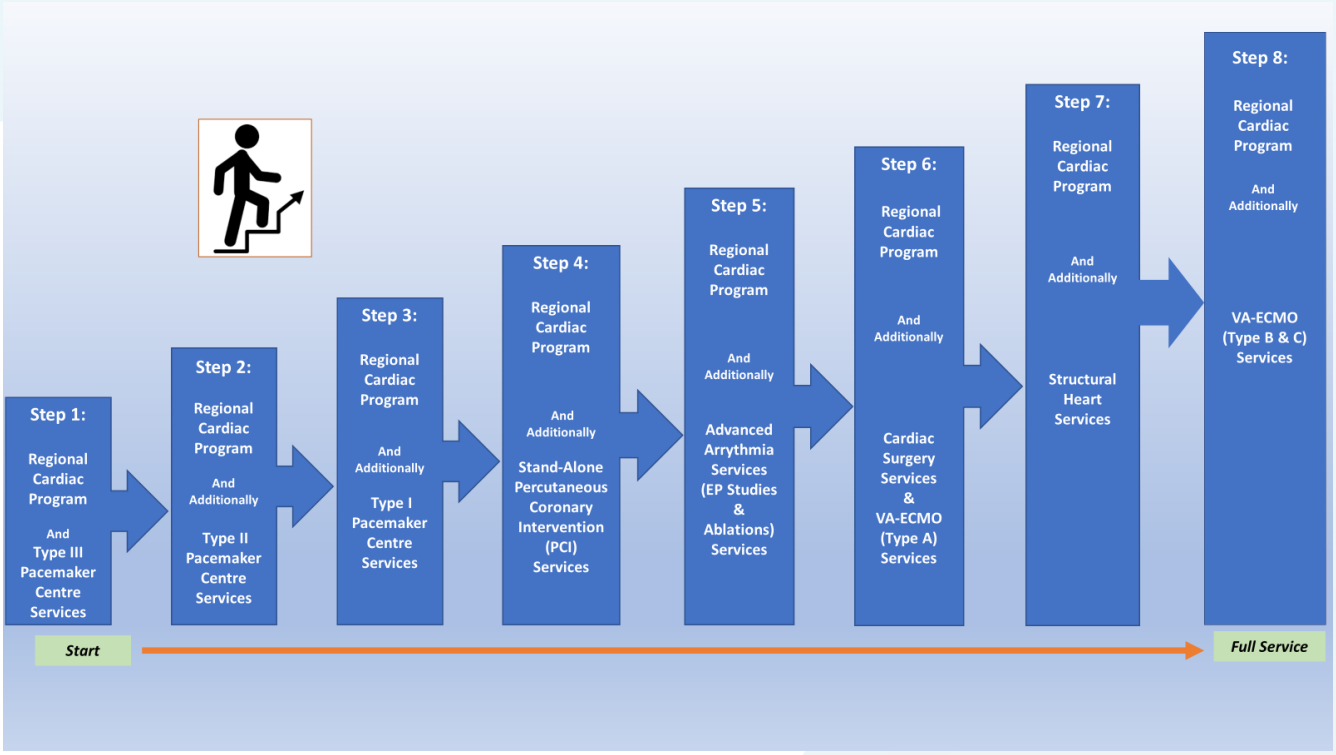
A robust process for cardiac services expansion requests exists between the hospitals, OH and the Ministry. The RCP Framework document provides a high-level overview of the process RCPs are required to follow when requesting new services or expanding existing services from one level to the next level. Each progression from one level to the next will require a fulsome business case to support the service expansion proposal, which includes impact on existing RCPs.

As of 2024, additional detail has been added to the RCP framework to reflect the different levels of VA-ECMO services a hospital may provide. These are VA-ECMO service types A, B, and C. Type A is part of Level 6, and type B and C are part of Level 8, as follows:

- Type A) Cannulate - transfer
- Type B) Cannulate - manage
- Type C) Cannulate - destination/transplant

Characteristics of service types A, B, and C are described further in the section below, including minimum criteria to support provision of VA-ECMO services of each type.

Figure 1


Step 1:
Regional Cardiac Program
And
Type III Pacemaker Centre Services
Step 2:
Regional Cardiac Program
And Additionally
Type II Pacemaker Centre Services
Step 3:
Regional Cardiac Program
And Additionally
Type I Pacemaker Centre Services
Step 4:
Regional Cardiac Program
And Additionally
Stand-Alone Percutaneous Coronary Intervention (PCI) Services
Step 5:
Regional Cardiac Program
And Additionally
Advanced Arrythmia Services (EP Studies & Ablations) Services
Step 6:
Regional Cardiac Program
And Additionally
Cardiac Surgery Services & VA-ECMO (Type A) Services
Step 7:
Regional Cardiac Program
And Additionally
Structural Heart Services
Step 8:
Regional Cardiac Program
And Additionally
VA-ECMO (Type B & C) Services
Start
Full Service

Characteristics of VA-ECMO Service Types

Hospital Type

All cardiac surgery centres should have the ability to provide VA-ECMO to patients. However, the extent to which the hospital can provide longer-term VA-ECMO and the comprehensiveness of related services will determine whether a hospital provides type A, B, or C VA-ECMO care. Type A hospitals provide short-term VA-ECMO service, as needed, exclusively for their own post-cardiac surgery patients or on-site cardiogenic shock. Type B hospitals are cardiac surgery centres that have capacity to provide longer-term VA-ECMO therapy to patients (beyond 48 hours), and potentially receive VA-ECMO patients from other centres. Type B sites manage patients on VA-ECMO until decannulation or transfer to a type C partner site, and may also receive patients from other sites. Type C are Ontario's heart transplant centres as they provide the most comprehensive services and destination therapies for patients on VA-ECMO[6]. Type C sites can receive VA-ECMO patients from other sites and normally do not transfer VA-ECMO patients elsewhere.

	Hospital Type
Type A) Cannulate - transfer	Cardiac surgery centre
Type B) Cannulate - manage	Cardiac surgery centre (expanded VA-ECMO capacity)
Type C) Cannulate - destination/transplant	Transplant centre

Consultations

If VA-ECMO is being considered for a patient, initiation of a consultation with a type B or C partner site should occur prior to or immediately upon cannulation (if the patient is not already located at a type B or C site). Consultations regarding VA-ECMO should be coordinated through CritiCall Ontario (1-800-668-4357)[1]. Type B and C centres must be available 24 hours a day, 7 days a week, for consultations. The CCSO ECMO Consultation Guidance Document provides guidance on indications and contraindications for VA-ECMO that should be considered in the consultation process (see also Table 1 above) [1]. Consultations would include advice on appropriateness of initiating VA-ECMO as well as most appropriate destination hospital.

	Consultations
Type A) Cannulate - transfer	• Consultation type B or C partner site prior to or immediately upon cannulation
Type B) Cannulate - manage	• Available for consultation from type A partner sites • Advise on most appropriate destination

Type C) Cannulate - destination/transplant	• Available for consultation from type A and B partner sites • Advise on most appropriate destination

Transfers

It is critical to coordinate efficient and timely transfers of VA-ECMO patients when necessary, and to avoid unnecessary transfers whenever possible. Protocols for transfers should be detailed in formal MOUs between partner sites. Type A sites will transfer VA-ECMO patients to a type B or C partner site as soon as clinically stable (ideally within 48 hours). Type B sites may receive patients from type A partner sites, as well as transfer patients to type C partner sites. Type C sites may receive patients from both type A and B. Type C sites normally do not transfer VA-ECMO patients to other sites.

	Transfers
Type A) Cannulate - transfer	• Initiates ECMO on site, exclusively for post-cardiac surgery patients or on-site shock • Transfer to type B or C partner site as soon as clinically stable (ideally within 48 hours)
Type B) Cannulate - manage	• Initiates ECMO on-site and can accept shock patients transferred from any hospital • May receive transferred ECMO patients from type A partner sites • Manage ECMO patients until decannulation, or transfer to type C partner site
Type C) Cannulate - destination/transplant	• Receives transferred ECMO patients from type A or B partner sites, and manages them until discontinuation of therapy, transplant, or durable VAD implantation. • Normally does not transfer ECMO patients to other sites

Inter-facility Relationships/MOUs

The relationships between type A, B, and C partner sites should be defined in formal memoranda of understanding (MOUs). All type A sites must have a formal MOU with at least one type B and/or C partner site, so that VA-ECMO patients can be transferred as needed under the policies and procedures outlined in the MOU. Likewise, all type B sites must have a formal MOU with at least one type C partner site. These MOU documents may be requested by Ontario Health as part of the cardiac services expansion request process. The purpose of the MOU is to ensure safe and timely transfer of appropriate patients to the receiving site for VA-ECMO care. The MOU should define key details regarding the relationship between the two organizations, including but not limited to: consultation process and patient selection, availability of mobile teams to consult on-site at the

sending hospital, timeframes for transfers, decision-making accountabilities, patient transport considerations/accountabilities, use/transfer of equipment, transfer of accountability for patient care, and quality review process. The sending site should also accept repatriation of patients as per the Ontario Life or Limb Policy[7].

	Inter-facility Relationships/MOUs
Type A) Cannulate - transfer	• Requires formal MOU with type B and/or C partner site • Accepts repatriation of patients as per MOH Life or Limb policy
Type B) Cannulate - manage	• Requires formal MOU with type A and/or C partner sites • Accepts repatriation of patients as per MOH Life or Limb policy
Type C) Cannulate - destination/transplant	• Requires formal MOU with type A and/or C partner sites

Care Team

The structure of the healthcare team responsible for patients on VA-ECMO depends on the VA-ECMO service type.

In type A, care is managed by the Cardiac Surgery, Anaesthesiology, Cardiology, and CVICU teams.

Type B hospitals should have an established **cardiogenic shock team** and a **cardiac ECMO program**. The recommended structure for the shock team is outlined in the Ontario Cardiogenic Shock Team Model[8]. The cardiac ECMO program should have an identified medical director who is a board-certified cardiovascular specialist with expertise in critical care; a thoracic, vascular, or trauma surgeon; or other board-certified specialist with specific training and experience in ECMO[9]. There should be 24-hour availability of an on-call physician comfortable with managing patients receiving ECMO both to assist with urgent or emergent management of patients and to evaluate patients from referring hospitals. Selected members of the ECMO team should be trained in vascular and cardiac ultrasonography for insertion, maintenance, and surveillance of the ECMO device.

Fully trained ECMO specialists should be immediately available for circuit-related concerns, including ECMO circuit exchange. ECMO specialists should be trained to prime and set up the circuit. Depending on the centre-specific caregiver model, the ECMO specialist may also be responsible for managing equipment and supplies, daily rounds, troubleshooting, education, and performing administrative duties. The ECMO program should also have an ECMO coordinator identified (often one of the lead ECMO specialists) who will assist the medical director with various aspects of the ECMO program, including training, staffing, quality improvement, and patient data entry into relevant databases.

Roles and responsibilities for staff who manage specific aspects of patient care, including circuit setting adjustments, ventilator changes, anticoagulation, and cannula care and adjustments, should be clearly outlined, with role-specific training organized by the ECMO program. Consideration should

be given for whether staff taking on ECMO Specialist roles are also simultaneously responsible for other key patient care roles such as primary nurse for the patient and/or concurrently caring for multiple patients.

In addition to the above, type C hospitals will also have transplant and ventricular assist device (VAD) specialists. Details regarding how the care teams from partner hospitals interact may be included in the formal MOU.

	Care Team
Type A) Cannulate - transfer	• Care managed by Cardiac Surgery/Anaesthesiology/ Cardiology/CVICU team
Type B) Cannulate - manage	• Established cardiogenic shock team[8] and ECMO program*
Type C) Cannulate - destination/transplant	• Same as type B, with addition of transplant and VAD specialists

*See elements of an ECMO program as described above

Facility Quality Criteria

All hospitals providing VA-ECMO (type A, B, & C) must have access to the facilities, equipment, and staffing necessary for both routine ECMO management and management of unanticipated emergencies of ECMO complications. The following table provides a list of equipment and facilities required (including but not limited to)[9]:

Table 2. Equipment and Facilities Needed Within the Intensive Care Unit Providing ECMO [9]

Equipment and facilities needed in the ECMO unit
Backup components of the ECMO system and supplies for all circuit components
Uninterrupted power system for all equipment, monitors and pumps for at least 45 min
Clamps
Surgical instruments for revision of cannulae or exploration for bleeding complications
Adequate lighting to support surgical interventions
ECMO water heater
Equipment for intrahospital transport
Mobile ECMO cart
Uninterrupted power system for all equipment, including mobile equipment
Mobile ECMO monitoring device

Emergency transport backpack with clamps and emergency drugs
Wet-primed circuit available for immediate use recommended
Ultrasonography machine with Doppler-echocardiography capabilities
Monitoring device to assess distal perfusion of cannulated limbs (e.g., vascular Doppler ultrasound, near-infrared spectroscopy (NIRS))
Fiberoptic bronchoscope
Device(s) capable of venting the left ventricle, e.g., intra-aortic balloon pump or percutaneous LVAD

The ECMO program must also have quality monitoring processes in place and participate in data collection initiatives as required.

	Facility Quality Criteria
Type A) Cannulate - transfer **Type B) Cannulate - manage** **Type C) Cannulate - destination/transplant**	• Access to the facilities, equipment, and staffing necessary for both routine ECMO management and management of unanticipated emergencies of ECMO complications • Quality monitoring processes in place • Participation in data collection initiatives as required

Training/Education of ECMO Team

Every member of the team should receive specific ECMO training and demonstrate competencies on an ongoing basis[9]. Training and education should include both theoretical and practical aspects of ECMO, including simulation training whenever possible. The training must be reflective of existing hospital policies on VA-ECMO, and specific equipment and monitoring parameters used in the hospital's ECMO program. Staff participation in the education program should be recorded and their proficiency evaluated, with retraining of team members as needed, on the basis of criteria set forth by the ECMO program.

Additionally, all staff involved in ECMO should meet the requirements of their subspecialty training as set forth by their specific governing body[9]. Selected members of the ECMO team should be trained in vascular and cardiac ultrasonography for insertion, maintenance, and surveillance of the ECMO device. Fully trained ECMO specialists should be immediately available for circuit-related concerns, including ECMO circuit exchange. ECMO specialists should be trained to prime and set up the circuit.

	Training/Education of ECMO Team
Type A) Cannulate - transfer **Type B) Cannulate - manage** **Type C) Cannulate - destination/transplant**	• Every ECMO team member should receive regular training and education on theoretical and practical aspects of ECMO • Staff training must be reflective of existing hospital policies on VA-ECMO • Include simulation training whenever possible • Staff should have their participation in training recorded, proficiency evaluated, and demonstrate competencies on an ongoing basis. • Fully trained ECMO specialists should be immediately available for circuit-related concerns, including ECMO circuit exchange. • Select team members should be trained in vascular and cardiac ultrasonography for insertion, maintenance, and surveillance of the ECMO device

Minimum Volumes

In their position paper on the organization of ECMO programs for cardiac failure in adults, Abrams et al. (2018) recommend that, in order to optimize patient outcomes, centres providing VA-ECMO should perform a minimum of 30 ECMO cases per year, with a substantial proportion being for cardiac failure[9]. Based on this recommendation and the advice of Ontario experts, minimum annual VA-ECMO volumes have been defined as follows:

	Minimum Volumes
Type A) Cannulate - transfer	No minimum volume
Type B) Cannulate - manage	>10 VA-ECMO cases annually
Type C) Cannulate - destination/transplant	>30 VA-ECMO cases annually

Appendix

Figure 1. Shock Stage Classification by Society for Cardiovascular Angiography & Interventions (SCAI)

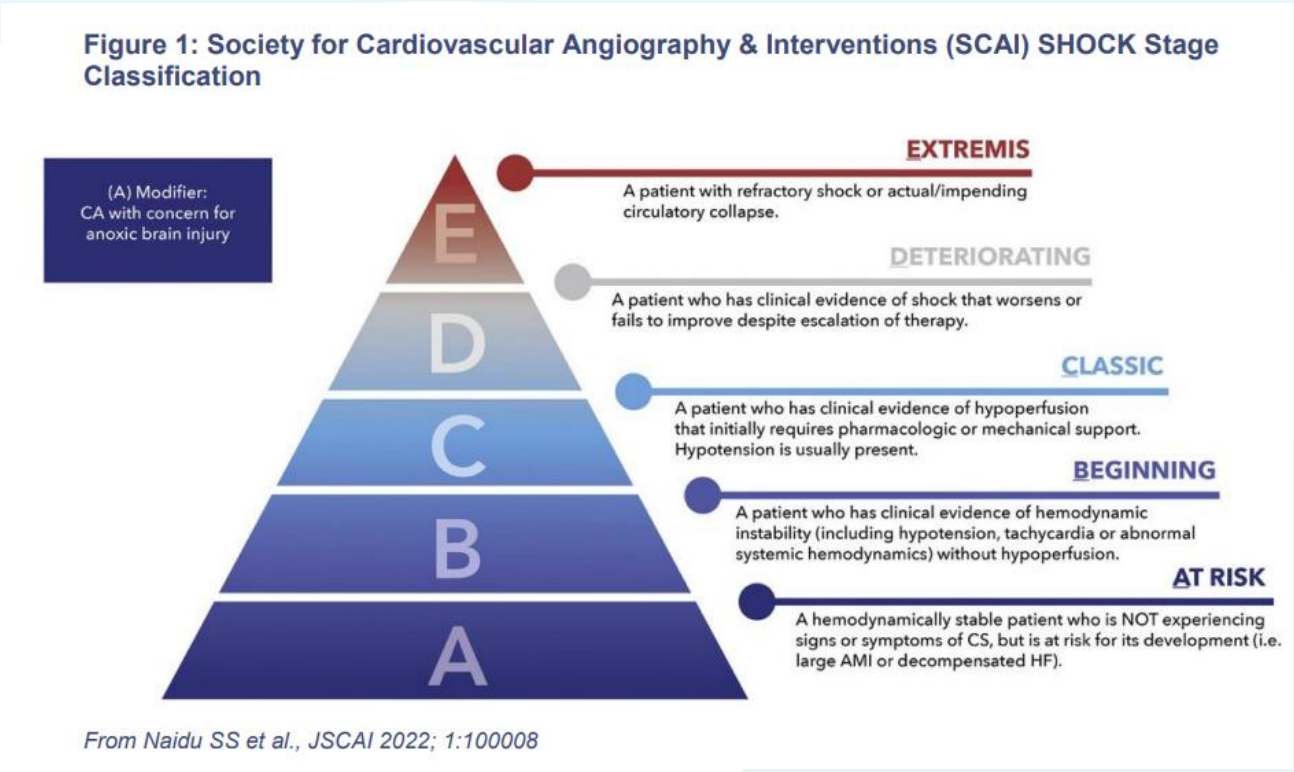
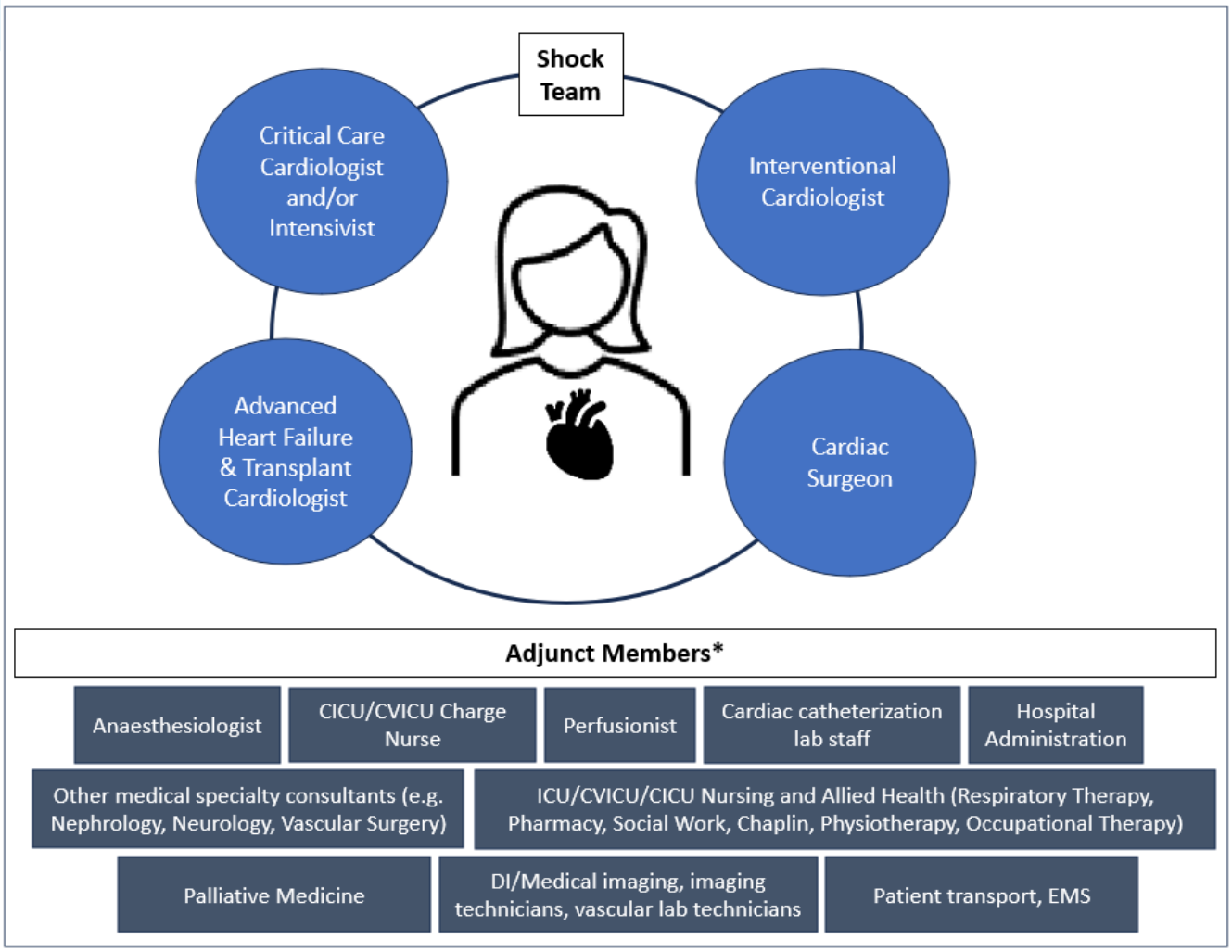


Figure 2. Diagram of Shock Team Structure: Core Shock Team and Adjunct Members*



The core Shock Team is focused on management and care decisions for the patient with cardiogenic shock. The Adjunct Members provide critical services to achieve the patient care goals. *Note that Adjunct Members may vary dependent on specific patient case and local organizational structure (including involvement of trainees). ICU=Intensive Care Unit; CVICU=Cardiovascular Intensive Care Unit; CICU=Cardiac/Coronary Intensive Care Unit; DI=Diagnostic Imaging; EMS=Emergency Medical Services.

Acknowledgments

We would like to thank the following individuals for their contributions to this document:

Name	Organization
Dr. Faizan Amin	Hamilton Health Sciences
Dr. Phyllis Billia	University Health Network
Ms. Amy Burke	Ontario Health
Dr. Michael Chu	London Health Sciences Centre
Ms. Jana Jeffrey	Ontario Health
Ms. Erika MacPhee	University of Ottawa Heart Institute
Dr. Madhu Natarajan	Hamilton Health Sciences
Dr. Barry Rubin	University Health Network
Ms. Rachel Rushton	London Health Sciences Centre
Dr. Harindra Wijeysundera	Ontario Health

References

1. Critical Care Services Ontario. (2024). *Extracorporeal Membrane Oxygenation (ECMO) – Guidance Document for Ontario Hospitals*. https://criticalcareontario.ca/resources/extracorporeal-membrane-oxygenation-ecmo-guidance-document-for-ontario-hospitals/
2. Maya Guglin, Mark J. Zucker, Vanessa M. Bazan, Biykem Bozkurt, Aly El Banayosy, Jerry D. Estep, John Gurley, Karl Nelson, Rajasekhar Malyala, Gurusher S. Panjrath, Joseph B. Zwischenberger, Sean P. Pinney. (2019). *Venoarterial ECMO for Adults: JACC Scientific Expert Panel*, Journal of the American College of Cardiology, Volume 73, Issue 6, pp 698-716. https://www.sciencedirect.com/science/article/pii/S073510971839449X
3. Ontario Health (Quality). (2020). *Extracorporeal membrane oxygenation for cardiac indications in adults: recommendation* [Internet]. Toronto (ON): Queen's Printer for Ontario https://hqontario.ca/Evidence-to-Improve-Care/Health-Technology-Assessment/Reviews-And-Recommendations/Extracorporeal-Membrane-Oxygenation-for-Cardiac-Indications-in-Adult
4. Ontario Health (Quality). (2020). *Extracorporeal Membrane Oxygenation for Cardiac Indications in Adults: A Health Technology Assessment* [Internet]. Toronto (ON): Queen's Printer for Ontario. https://hqontario.ca/Evidence-to-Improve-Care/Health-Technology-Assessment/Reviews-And-Recommendations/Extracorporeal-Membrane-Oxygenation-for-Cardiac-Indications-in-Adult
5. Ontario Health (CorHealth). (2023). *Regional Cardiac Program Framework.* https://www.corhealthontario.ca/resources-for-healthcare-planners-&-providers/program-proposal/Regional_Cardiac_Program_Framework_Revised_2023_FINAL.pdf
6. Trillium Gift of Life Network. (2018). *Clinical Handbook for Heart Transplantation*. https://www.giftoflife.on.ca/resources/pdf/transplant/Clinical_Handbook_for_Heart_Transplantation_January_2018_FINAL.pdf
7. Ministry of Health. (2013). *Ontario Life or Limb Policy*. https://www.ontario.ca/files/2024-04/moh-ontario-life-or-limb-policy-en-2024-04-24.pdf
8. Ontario Health (CorHealth). (2024). *Ontario Cardiogenic Shock Team Model*. https://www.corhealthontario.ca/Ontario_Cardiogenic_Shock_Team_Model_Final.pdf
9. Abrams, D., Garan, A. R., Abdelbary, A., Bacchetta, M., Bartlett, R. H., Beck, J., Belohlavek, J., Chen, Y.-S., Fan, E., Ferguson, N. D., Fowles, J., Fraser, J., Gong, M., Hassan, I. F., Hodgson, C., Hou, X., Hryniewicz, K., Ichiba, S., Jakobleff, W. A., … Brodie, D. (2018). *Position paper for the organization of ECMO programs for cardiac failure in adults*. Intensive Care Medicine, 44(6), 717–729. https://doi.org/10.1007/s00134-018-5064-5