EXTRACORPOREAL MEMBRANE OXYGENATION (ECMO) CICU - SCH

PRACTICE GUIDELINE ©

DOCUMENT SUMMARY/KEY POINTS

- Extracorporeal Membrane Oxygenation (ECMO) is a supportive therapy for infants and children with cardiorespiratory failure in the Children's Intensive Care Unit.
- Initiation and management of ECMO support in CICU SCH requires a multidisciplinary team approach with defined roles and clear communication.
- Nursing management of a patient receiving ECMO requires 2 RNs. 1 for patient and 1 for pump, the pump nurse is required to have undertaken at a minimum the SCH ECMO training and deemed ECMO competent.
- Documentation of the ECMO parameters is the responsibility of the SCH CICU Consultant or Fellow.
- Daily Circuit checks will be undertaken by the perfusionist on call.
- Hourly circuit checks will be performed by the ECMO nurse.

Approved by:	SCHN Policy, Procedure and Guideline Committee	
Date Effective:	1st September 2022	**Review Period**: 3 years
Team Leader:	CNC	**Area/Dept**: CICU SCH

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CHANGE SUMMARY

- New Document

READ ACKNOWLEDGEMENT

- Training/Assessment Required – Nursing Staff caring for patients receiving ECMO in CICU SCH must have completed the SCH ECMO training.
- Read Acknowledge Only – CICU Consultants, CICU Fellows, CICU Registrars, CICU ECMO nursing staff, Perfusionists, Cardiothoracic Surgeons.

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1 Introduction

This document provides a guideline for staff managing a paediatric patient on Extracorporeal Membrane Oxygenation (ECMO) within the Children's Intensive Care Unit (CICU) at Sydney Children's Hospital in Randwick (SCH-R).

This guideline will support the staff in the safe and effective delivery of ECMO.

Definition

ECMO is the use of a cardiopulmonary bypass circuit for temporary life support of the heart and/or lungs during cardiopulmonary failure. ECMO involves the transport of blood from the patient through tubing, via a centrifugal pump, through an artificial oxygenator to oxygenate and remove carbon dioxide, then returned back to the patient.

Types of ECMO

Veno-Arterial (VA) – for management of cardiorespiratory failure or isolated cardiac failure.

Veno-Venous (VV) – for management of isolated respiratory failure with adequate cardiac function.

The decision to go onto ECMO and which type of ECMO is to be commenced is made by the CICU Intensivist and Cardiothoracic Surgeon within CICU.

2 Indications and selection criteria for ECMO

Patients requiring ECMO must meet certain selection criteria as determined by Extracorporeal Life Support Organisation (ELSO).

- Acute severe cardiac or lung failure with high mortality risk despite optimal conventional therapy.
- Congenital Cardiac Defects
- Bridge to transplant
- Severe Sepsis
- Acute Respiratory Distress Syndrome (ARDS)
- Status Asthmaticus
- Mediastinal Masses
- Pulmonary haemorrhage
- Severe Pneumonia (viral or Bacterial)
- Oxygen Index (OI) >40 for over 4 hours. (OI = Mean Airway Pressure (MAP) x Fraction of Inspired Oxygen (FI02) x 100 / Post Ductal Pa02)
- Persistent Pulmonary Hypertension of the Newborn (PPHN)
- Congenital Diaphragmatic Hernia (CDH)
- Meconium Aspiration Syndrome (MAS)

3 Contraindications for ECMO

- Major intracranial haemorrhage (> grade II or above)
- Severe neurological injury
- Uncontrollable bleeding
- Hypoxic cardiac arrest without adequate CPR
- Severe genetic abnormalities
- Lethal chromosomal disorders or anomalies
- Neonatal Intraventricular haemorrhage (IVH) grade III or greater
- Conditions incompatible with normal life if the patient recovers
- Pre-existing conditions which affect the quality life (end stage malignancy, CNS Status).
- < 34 weeks gestation
- Weight < 2kg
- Irreversible organ damage (not considered for transplant)

4 ECMO Team Members, roles and responsibilities

- Intensivist – ECMO coordinator. Responsible for coordinating ECMO activation, to liaise with cardiothoracic team, CICU team and family. Decision maker.
- Cardiothoracic Surgeon – Primary cannulator. 24 hours support for cannula issues.
- CICU Fellow – second ECMO coordinator, support CICU team
- Perfusionist – Provides 24 hour cover for support and ECMO machine/circuit issues.

  Perfusionist role when establishing ECMO:

  - Ascertain patient's weight/height/BSA and select appropriate ECMO console and circuit.
  - Bring ECMO trolley/circuit from ECMO Pump store room to CICU.
  - Check drugs drawn up by ECMO nurse as per the CICU calculator (calcium chloride, heparin, sodium bicarbonate) and blood.
  - Ensure pump is primed and air free.
  - Inform surgeon when circuit is ready for connection
  - Establish patient on ECMO and manage until stable
  - Provide circuit handover to ECMO nurse
- ECMO Nurse - to manage the ECMO circuit, complete daily safety checks, ensure emergency plan is available and support and assist patient nurse.
- Patient Nurse (preferably ECMO trained) – care for patient on ECMO. Complete daily safety checks, support and assist ECMO nurse.
- Nursing Team Leader/NUM – Allocating ECMO and patient nurse, plan for ECMO nursing allocation for subsequent shifts.

5 Pre ECMO cannulation preparation

CICU Consultant

- Decision made to initiate ECMO
- Inform NUM/ TL of decision to initiate ECMO
- Contact Cardiothoracic Surgeon (via Switch)
- Contact Perfusion on Call (via Switch)

CICU NUM/Team Leader (0472879306)

- Alert After Hours Nurse Unit Manager
- Ensure ECMO trained staff available to care for patient.
- Contact social work if required
- Ensure patient is in appropriate location with adequate space

After-Hours Nurse Manager (0411414210 pager 44103)

- Call in on-call cardiothoracic theatre team

ECMO Nurse

- Alert blood bank that a patient will be commencing ECMO
- Work with bedside nurse to facilitate ECMO bedspace set-up

Patient Nurse (preferably ECMO trained)

- Ensure Weight, Height and BSA have been attended to and documented – handover to perfusionist (for circuit preparation)
- Ensure NGT and IDC are inserted **prior to heparin load**
- Attend to investigations and prepare patient for procedure

Investigations

Prior to cannulation and commencement of ECMO, where possible, make sure that the following have been completed:

- Chest X-ray
- Urgent full bloods (FBC, EUC, LFT, Coagulation profile including fibrinogen, AT III, ACT) and valid cross match.
- Arterial blood gas (ABG)/ Venous blood gas (VBG)
- ECHO
- Cranial ultrasound in neonates with open anterior fontanelle

Blood Products

Once the decision has been made to initiate ECMO, blood bank must be informed and on standby, and the on-call haematologist should be made aware to ensure the supply of blood products will be available. An adult pack of cross matched blood and a unit of platelets should be requested.

Altered coagulation - correct with Vitamin K, Fresh Frozen Plasma or cryoprecipitate to reduce risk of bleeding post ECMO cannulation.

Consider activation of the Massive Transfusion Protocol (MTP) - Paediatric in the likelihood of the patient requiring an open chest.

The on call perfusionist will deliver the primed ECMO circuit to CICU as the cardiothoracic team prepare the patient for cannula insertion to facilitate commencement of treatment immediately.

Patient cross match is valid for 72 hours; the team must ensure this is valid at all times to prevent a delay in the availability of blood products.

Bedspace Set up and Equipment

A standard CICU bedspace should be set up (see checklist – Appendix 1), ensuring that the adjoining bedspace is empty.

In addition to the standard CICU bedspace the following should be checked and ready for use:

- ECMO trolley
- Chest opening trolley with internal defibrillator paddles
- Surgical light
- Surgical Suction
- iSTAT machine with a supply of ACT, CHEM8+ and CG4+ cartridges (stored in the fridge).
- Supply of syringes, blood gas syringes and blood tubes available for frequent sampling.
- Adrenaline infusion, prepared as per CICU infusion guide on resus calculator, primed and attached to the patient prior to commencement of ECMO.
- Resuscitation drugs prepared based on the patients weight as per SCH CICU drug calculator: (must be changed every 24 hours)
    - Adrenaline 1:10,000
    - Atropine 600 microg in 1mL or 1.2 mg in 1mL.
    - Calcium chloride 10%
    - Sodium bicarbonate 8.4%
- 4% Albumin, 2x 500mL bottles available
- Clamps
- Sedation and neuromuscular blockade infusions prepared and ready as per Intensivist.

6 ECMO Equipment and Set up

Circuit selection

SCH has two different ECMO consoles and three circuit sizes. Circuit selection is based on anticipated flow requirements and available patient information. The details are provided in the table below:

Console	Circuit	Oxygenator	Approx weight	Max. circuit flow
Centrimag	1/4	Quadrox iD	<13 kg	1500mL/min
Cardiohelp	3/8	HLS 5.0 (integrated)	13-60 kg	5000mL/min
Cardiohelp	3/8	HLS 7.0 (integrated)	>60 kg	7000mL/min

Perfusion blood product requirements

1 x Adult Packed Red Blood cells (PRBC) available in ICU if blood prime required.

Perfusion medication list

The following syringes are to be prepared by CICU nursing staff for the perfusion team:

- 1 x 5mL syringe containing 3mL of 8.4% sodium bicarbonate
- 1 x 3mL syringe containing 0.5mL heparin (1000 international units/mL)
- 1 x 3mL syringe containing 0.5mL calcium chloride (10% w/v).

Expected blood flow rates

Weight (kg)	BSA (m^2)	Flow (L/min)	Cardiac index (L/ m^2/min)
2	0.17	0.50	3
4	0.25	0.75	3
6	0.33	0.92	2.8
8	0.39	1.10	2.8
10	0.46	1.29	2.8
12	0.54	1.51	2.8
14	0.61	1.58	2.6
16	0.68	1.76	2.6
18	0.74	1.93	2.6
20	0.81	2.10	2.6
22	0.86	2.24	2.6
24	0.91	2.37	2.6
26	0.96	2.50	2.6
28	1.01	2.63	2.6
30	1.06	2.76	2.6
32	1.10	2.87	2.6

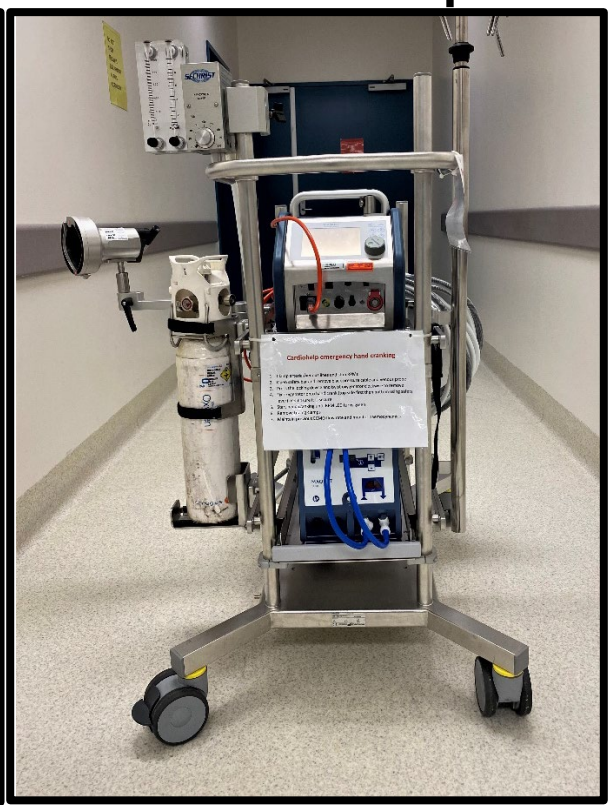
34	1.15	2.99	2.6
36	1.20	3.11	2.6
38	1.25	3.24	2.6
40	1.29	3.35	2.6
>40			2.4

ECMO Consoles

The ECMO cart/console and primed circuit are delivered to CICU by the perfusion dept. Photographs of the two console types are shown below:

CentriMag

Cardiohelp



The Centrimag ECMO cart contains:

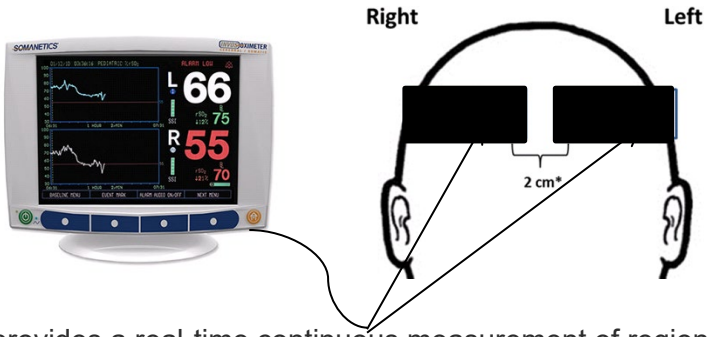
- Two CentriMag consoles (primary console 1 on top and spare console 2 on bottom)
- Two CentriMag motors (primary motor 1 and spare motor 2)
- One CentriMag display/monitor
- ECMO heater with hoses
- Sechrist Air and Oxygen blender and ‘wall’ gas lines
- Back-up oxygen cylinder
- Two pressure transducers with bubble isolators (negative and pre-membrane pressures)

- Tubing clamps x 6
- Torch
- Clipboard with daily perfusion checklist
- Perfusionist on-call sheet

The Cardiohelp ECMO cart contains:

- One Cardiohelp console with internal motor and touchscreen display/monitor
- Three integrated pressure transducers (negative, pre and post-membrane)
- Manual hand crank
- ECMO heater with hoses
- Sechrist Air and Oxygen blender and ‘wall’ gas lines
- Back-up oxygen cylinder
- Tubing clamps x 6
- Torch
- Clipboard with daily perfusion checklist
- Perfusionist on-call sheet

Near Infra-Red Spectroscopy (NIRS)



NIRS provides a real-time continuous measurement of regional cerebral blood oxygenation.

The sensors sit on both sides of the forehead and are connected to the monitor, real time oxygenation is displayed on the screen.

7 ECMO Cannula options

The cannula size decision is made by the surgeon in consultation with the perfusionist. If time permits measure the vessel sizes in the neck and groin.

V-A Cannula selection

Arterial cannula		Venous cannula	
FLOW (mL/min)	**SIZE (Fr)**	**FLOW (mL/min)**	**SIZE (Fr)**
0 – 400	8	0 – 350	8-12
400 – 750	10	350 – 500	10-12
700 – 1200	12	500 – 700	12-14
1200 – 1800	14	700 – 1100	14-16
1800 – 2000	16	1100 – 1400	16-18
2000 – 3200	18	1400 – 2000	18-20
3200 – 3800	20	2000 – 2400	22
>3800	22	2400 – 3200	24
		3200 – 3900	28
		3900 – 5000	32

V-V Cannula selection

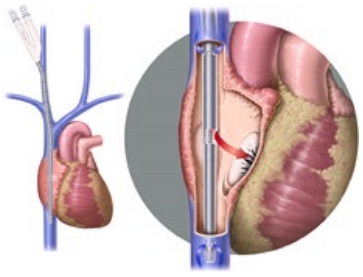
Dual-lumen Avalon cannula selection as listed below:

Patient (kg)	Cannulae	Flow (L/min)
< 5.0	13 Fr	0.5
4 - 9	16 Fr	0.9
9 - 12	19 Fr	1.2
12 - 15	20 Fr	1.5
15 - 20	23 Fr	2.0
20 - 65	27 Fr	3.5
> 65	31 Fr	5

- **Avalon** – single cannula with double lumen. **Only used in VV ECMO.**

  Avalon cannulas size: 13/16/19 are located in the TL cupboard. If other cannulas are required, the cardiothoracic team will bring them.

- The cannula is inserted into the jugular vein. This cannula draws blood from the inferior vena cava (IVC) and the superior vena cava (SVC) and returns the blood via a return port. The cannula must be positioned to allow the return post to shoot the jet of blood directly into the tricuspid valve.



- **Dual cannula**
- VA ECMO

  Central cannulation requires a sternotomy and open chest. Both venous and arterial cannulas are inserted directly into the heart. The venous cannula is placed into the right atrium (RA) and the arterial cannula is placed into the aorta (AO).
- Peripheral cannulation, smaller venous cannula is inserted directly into jugular vein (neonates) or femoral vein (larger children and adults). The arterial cannula is inserted into carotid artery (neonates) or femoral artery (larger patients)
- VV ECMO.

  One cannula to access venous blood from the jugular or femoral vein and one cannula to return oxygenated blood to the jugular or femoral vein (advanced into the right atrium)
- **Triple cannula**

  For older/larger children where more access flow is required, a third cannula may be inserted (usually the unused femoral vein) this is then connected to the other access line via a Y connector before connecting the circuit.

8 ECMO Initiation

- Once the surgeon and intensive care team are prepared to establish ECMO the perfusionist initiates blood flow by increasing pump speed >1000 RPMs and removing line clamps.
- The pump speed is gently increased to ensure gradual mixing of prime contents with patient's blood.
- Gas (sweep) flow should be commenced at a 1:1 ratio (sweep gas: blood flow e.g., 1 L/min gas flow: 1 L/min blood flow) once blood flow is established and then adjusted following arterial blood gas analysis.
- Patient blood pressure should be carefully monitored during ECMO commencement and inotropes adjusted by the intensivist.
- The ECMO line pressures and blood flow should be carefully monitored by the perfusionist on initiation to assess adequacy of support and cannulae positioning.
- The perfusionist must complete the Perfusion record sheet and handover to the ECMO nurse on duty.

9 Anticoagulation Management

Any coagulation abnormality should be corrected with Vitamin K, FFP/Cryoprecipitate and platelets before patient is cannulated. Pre correction reduces the risk of bleeding on ECMO.

Cannulation - Unfractionated Heparin (UFH) Bolus

<1yr	1-10yrs	>10yrs
75 - 100units/kg	75 – 100 units/kg (max 5000units)	50 units/kg (Max 5000units)

Post Cannulation

UFH Infusion - Commence 10 units/kg/hr once ACT <250

Ongoing management - Unfractionated Heparin continuous infusion dosing ranges

<1yr	1-10yrs	>10yrs
10-40 units/kg/hr	10-30 units/kg/hr	10-20units/kg/hr

- If ACT < lower end of target range increase heparin infusion by **20%**.
- Similarly if above target range reduce heparin infusion by **20%**.
- Repeat ACT within 30 minutes of change
- ACT must be repeated in an hour of any change in heparin infusion rates

When the decision to transfuse platelets has been made increase heparin infusion by 10% for 30 minutes prior to commencing platelet transfusion. Keep increased rate of heparin infusion until transfusion is over. Check ACT once the transfusion is finished and adjust heparin dose accordingly

Twice daily coagulation profile including aPTT, anti Xa, fibrinogen and d-dimer levels must be performed.

Target parameters and monitoring tests

Urgent bloods pre ECMO should include a full baseline coagulation profile including fibrinogen levels and Anti thrombin 3 (AT III) levels.

ALL BLOOD TESTING WILL BE DETERMINED BY THE INTENSIVIST THEREFORE MAY DIFFER FROM THE GENERAL GUIDE BELOW.

Check at least twice daily

Hb >120 g/L
Platelet count >80,000/L
ACT 180-200 seconds
INR <1.5
Fibrinogen level > 2 mg/dL

- INR >2 and patient bleeding give10 mL/kg of FFP
- Fibrinogen level <1.5 gm/L Give 20 mL/kg of FFP.
- If Fibrinogen <1.5 gm/L and bleeding, consider cryoprecipitate.

ACTs to be taken every 30 minutes until ACT < 250, then hourly ACT measurements until patient stable and no concerns of bleeding (<4 mL/kg/hr). Once the patient is stable, follow the table below.

<1yr	1-10yrs	>10yrs
ACT 2-3 hourly 180-200	aPTT 6 hourly 60-90	aPTT 6 hourly 60-90
Anti Xa 12 hourly 0.3-0.7*	Anti Xa 12 hourly 0.3-0.7*	Anti Xa 12 hourly 0.3-0.7*

*Discretionary. Consult with intensivist. # See document in ECMO bedside folder.

Approach to high heparin requirements

<1yr (>35 units/kg/hr)	1-10yrs (>30 units/kg/hr)	>10yrs (>20 units/kg/hr)
AT III level <30%	AT III level<50%	AT III level<50%
Consider AT3 infusion (consult haematology)	Consider FFP or AT3 concentrate	Consider FFP or AT3 concentrate

Viscoelastic testing

In clinical situations where titration of UFH is proving to be challenging due to patient bleeding, concerns of circuit integrity and/or high blood product Rotational Thromboelastometry (ROTEM) testing may be done to aid management. Refer to Rotem use - SCH.

The Intensivist must be informed of any major change in the bleeding or clotting status of the patient.

See extra coagulation information in the bedside resource folder.

10 ECMO Circuit Management

- Ensure that the cannula is safely secured at the patient site and to the bed.
- Hourly checks of the circuit are to be conducted and entered on the ECMO observation chart by the ECMO nurse – see appendix 3.
- Hourly circuit checks for air bubbles and clots are to be conducted using the dedicated light source by the ECMO nurse and documented on the ECMO observation chart. Any changes are to be reported to intensivist and perfusionist.
- Continuous monitoring for circuit integrity, circuit changes with patient repositioning such as brief reduction of flows or fluid bolus – as per clinical assessment.
- Confirm ECMO heater is functioning and contains adequate water via level indicator.
- Ensure anticoagulation measurements are measured according to anticoagulation management section.
- Fluid infusions and blood samples are not to be accessed via the ECMO circuit. The ECMO circuit must only be accessed by the perfusionist (emergencies accepted).
- Continuous monitoring for 'chattering' of the circuit, management with position change, brief reduction of flows or fluid bolus – as per clinical assessment
- Ensuring all pressure bubble isolators remain attached and reading.
- Ensure that the water bath is on at all times, as loss of power will lead to rapid hypothermia and instability.
- Initially hourly Blood gases and 4th hourly bloods, this will be changed as per the Intensivist.
- Daily circuit equipment checks and Free Hb check conducted by the on call perfusionist.

11 ECMO settings

Target ECMO flows will depend on underlying patient requirements and circuit considerations. **The senior team will individualise target numbers for ECMO flow, negative pressure on venous side, target MAP and pulse pressure.**

This should be clearly documented on the ECMO flow chart by the fellow/consultant.

ECMO Blood flow is measured by the flow meter attached to the arterial line of the circuit and helps determine the degree of ECMO relative to full cardiac output. This is displayed on the ECMO machine. ECMO flow is adjusted to maintain desired MAP and blood gas parameters. This involves interaction with vasopressors, inotropes and fluid status.

Sweep gas FiO_2: During VA ECMO the Sechrist air/oxygen blender attached to the ECMO circuit is adjusted according to patient arterial blood gas. With VV ECMO the objective is to fully oxygenate the venous return so the FiO_2 during VV ECMO should always be set to 100% to provide maximal oxygenation.

Sweep gas flow is used to regulate carbon dioxide removal. To calculate changes in sweep flow use calculation:

Current sweep flow x (current $paCO_2$ divided by desired $paCO_2$)

Various circuit pressures are measured during ECMO and displayed on the console monitor. The pressures common to both ECMO machines are the pre-membrane (positive) pressure and the venous access pressure (negative). The Cardiohelp has an additional pressure measurement as listed in the table below:

Pressure measured	Centrimag	Cardiohelp	Parameter meaning
Pre-membrane	✔	✔ (called P*int*)	Post pump, pre-membrane
Post-membrane		✔	Arterial line going to patient
Transmembrane (pre-post) ΔP		✔	Pressure gradient across membrane (membrane resistance e.g., clot)
Venous access	✔	✔	Negative access pressure (resistance to drainage e.g., hypovolaemia)

12 Nursing care and considerations of the patient on ECMO

Shift Checks

- Receive handover from ECMO nurse and patient nurse from previous shift.
- Check infusions and emergency drugs with previous shift nurses.
- Ensure patient's resus chart is correct.
- Standard CICU bedspace safety checks.
- ECMO nurse to complete ECMO machine, cannula site and circuit safety checks. Complete safety checklist (see appendix 2)
- Complete initial patient assessment.
- Verify clinical parameters with CICU consultant.
- Check valid cross match and blood products are available
- Replace emergency adrenaline infusion and resuscitation drugs every 24 hours.
- Ensure emergency plan is up to date and visible in the bedspace.
- Ensure emergency roles are discussed between the ECMO and patient nurse.
- Check the latest blood results – advise medical staff if any values are outside of targeted parameters.
- Ensure contact details for the on-call cardiothoracic surgeon and perfusionist are up to date and accurate each day.
- Ensure 2 x 500mL bottles of 4% albumin are available at the bedside at all times.
- Review alarm limits on monitor, ventilator and ECMO machine – set appropriate limits individual to the patient.
- Ensure that there are enough syringes/blood tubes/ ISTAT cartridges/Blood gas syringes for the shift to enable all blood sampling.

Clinical Observations:

- Continuous head to toe monitoring of the patient
- Documentation of hourly observations on the CICU observation chart as per Clinical Observations in CICU
- Document ECMO settings on the dedicated ECMO observation chart. (see Appendix 3)

Systems based management:

Respiratory:

- Ventilation should be maintained at lung rest parameters when on VA ECMO, as ordered by Intensivist. This includes minimising ventilator pressures, rate and FiO2.
- High frequency oscillatory ventilation (HFOV) may be required for some patients
- Ensure emergency ventilation settings are completed by intensivist and displayed on ventilator.
- Continue care as per Ventilated Patient: Patient Care in CICU - SCH

- As ECMO is being weaned ventilation will be increased accordingly as per the intensivist.
- Ensure ETT is taped and secured well.
- Frequency of ETT suction should be discussed with consultant.
- Suction catheter must not be inserted beyond the end of ETT due to risk of trauma in the heparinised patient. Likewise nasal suction should be avoided.
- If re-intubation is required, this must be carried out with great care due to the risk of bleeding in the anti-coagulated patient.
- Re-intubation with a nasal ETT should usually be avoided.
- Ensure any routine chest x-ray is performed during the day when a senior medical officer is present.
- Frequency of ABGs should be established by intensivist. Repeat ABGs 30-60 mins following changes to ECMO settings.

Cardiovascular

- Circulatory status is assessed by the warmth, colour of extremities, urine output and capillary refill, as the quality of peripheral pulses may not be a good indicator of systemic perfusion in V-A ECMO.
- The arterial waveform is usually dampened/flattened during VA ECMO but the arterial mean arterial pressure (MAP) remains accurate.
- As cardiac function improves, the arterial trace will become less dampened.
- ECG rhythm is still visible as the conduction system remains intact
- Check cannula placement and stability.
- Consider air-eliminating filters on all non-cellular intravenous infusions, and drug and fluid bolus lines.
- Monitor for bleeding and measure blood loss from around the cannulation site
- See section Coagulation Management for information relating to anticoagulation
- Ensure target haemoglobin, platelets, INR and fibrinogen levels, and transfusion thresholds are clearly documented on the patient's bedside observation chart daily.
- Note the presence/absence of oedema.
- When fluid replacement required due to increasing negative ECMO pressure- consider using small aliquots of fluid.
- Manage inotropes as per Vasoactive Infusions - CICU - SCH
- Ensure adrenaline infusion is attached to the patient and ready to infuse if required.
- If on **VA ECMO**, consider contractility aspects of inotropes in regards to cannula site and position.

Neurological:

- ECMO carries an increased risk of intra-cranial haemorrhage, cerebral oedema, or air embolus.
- For neonates and infants with open fontanelle- (when possible) conduct head ultrasound prior to commencing ECMO and perform 48-72 hourly.
- Observe for any clinical seizures. Consider low threshold for EEG
- Conduct hourly pupil checks and fontanelle assessment
- Discuss with intensivist regarding NIRS (near-infrared spectroscopy) cerebral oximetry
- Keep head midline and head elevation to facilitate venous draining.
- Ensure adequate analgesia and sedation. Consider need for ongoing neuromuscular blockade

Gastrointestinal

- Insert nasogastric tube prior to commencing ECMO
- Consider TPN if patient unable to start enteral feeds.
- Commence PPI if patient NBM.
- Assess abdominal distension, bowel sounds and record girth measurements.
- Monitor bowels opening and consider aperients.
- Avoid rectal administration of medications.

Renal

- Record strict fluid balance chart
- Where possible place IDC prior to commencing ECMO.
- Inform medical team if urine output is <1mL/kg/hr and consider use of diuretics
- There is a high risk of acute kidney injury on ECMO. If required, CRRT can be attached directly to the ECMO circuit. See section CVVDHF via the Prismax on the ECMO Circuit for commencing CRRT.
- Perform daily urine analysis.

Infection

- Scrupulous attention must be given to maintaining asepsis of the cannula entry sites as per management of other central lines
- Alcohol-containing cleaning solutions must NOT be used on ECMO pipes & cannula as they cause material degradation and can lead to rupture
- Infection & sepsis are common during ECMO. Antimicrobial stewardship is therefore of increased importance.
- Fever is masked by thermoregulation effect of heater/cooler on the ECMO circuit. The presence of fever despite this suggests a highly febrile state.

- Blood pressure effects of sepsis may be obscured in VA ECMO.
- The artificial surface area of the ECMO circuit can create an inflammatory response that may mimic sepsis. Clarification can be sought by use of cultures and procalcitonin.

Skin and pressure area care

- Patients on ECMO are at high risk of pressure injuries due to difficulty in repositioning, high number of medical devices and increased use of sedatives and muscle relaxants.
- Ensure a foam dressing is placed between skin and the EMCO cannula to protect the skin from pressure
- Liaise with intensivist regarding pressure care frequency and the degree that the head/body can be repositioned.
- Aim to place patient on appropriate pressure relieving mattress prior to placing on ECMO
- Memory foam can be used for neonates and for older patient's heads if air flow mattresses are not appropriate.
- Monitor skin assessment during cares and refer to NP Skin integrity/occupational therapist if concerns re pressure injuries
- Refer to physiotherapy and occupational therapy in regard to splints and passive exercises
- Ensure adequate team is available to safely reposition patient including a senior medical officer. Ensure there is a dedicated staff member to watch cannula and ECMO tubing, and a dedicated person to watch ECMO flows.
- If patient has an open chest with central cannulas, the Jordan frame may be required to safely move patient.
- Meticulous eye care is essential especially in patient receiving neuromuscular blockade.
- Utilise eye lubricant as well as placing hydrogel over eyes to keep eyes moist
- Oral care should be conducted gently to prevent oral bleeding

Family/Carers

- Social work referral should be made early to support the family.
- The Aboriginal Health Worker/social worker should be contacted to support Aboriginal families
- The family should be provided with full information regarding ECMO including the risks involved.
- The family should be kept informed and updated on any changes that significantly impact on their child.
- Parents/ carers should be supported to touch and talk to their child

13 Emergency management

Rapid ECMO separation

An emergency may require rapid separation from ECMO.

The steps are summarised below:

1. Press emergency buzzer
2. Clamp arterial and venous lines
3. Stop pump and sweep gas
4. Increase patient ventilator settings
5. Provide modified chest compressions if required
6. Commence adrenaline (0.5 microg/kg/min)
7. Give volume

14 Cardiac Arrest on ECMO

Action depends on the mode of ECMO support

Cardiac arrest on V-A ECMO

- CPR is *unnecessary* as cardiorespiratory support is provided by the ECMO circuit.
- As the only source of blood circulation, the ECMO flow should be optimised by increasing RPMs.
- IV fluid infusion may be necessary to make negative access pressure more positive.
- Notify Intensivist and perfusionist.
- Cause should be investigated (e.g., blood gas analysis, circuit inspection).

Cardiac arrest on V-V ECMO

- CPR is *necessary* since cardiac support is NOT provided by the ECMO circuit.
- Press emergency buzzer.
- Increase patient ventilator settings.
- Provide modified chest compressions.
- Give volume.
- Notify Intensivist and perfusionist.
- Cause should be investigated (e.g., blood gas analysis, circuit inspection).

15 Transferring the ECMO patient to another department

It may be necessary to transfer a patient on ECMO to another department such as CT or theatres.

All non-urgent transports should be performed during working hours **The decision to transport is made by the CICU Consultant only.**

- A 'Time Out' prior to transfer must occur involving all members of the transporting team – include role allocation, plan to move and emergency management with a clear team leader for the transfer process
- Inform all necessary staff & check availability for assistance - Intensivist, Surgeon, Perfusionist, ECMO Nurse, Anaesthetist as appropriate
- The CICU Consultant or Fellow is the designated Team Lead for the transfer.
- Minimum staff required for transfer:
  - CICU Consultant/fellow
  - ECMO Nurse, Patient Nurse
  - Perfusionist
  - Additional Support staff as required. Two porters may be required to facilitate the transfer.
- **Resuscitation drugs and emergency equipment must accompany the patient at all times**.
- The patient must remain on full cardiorespiratory monitoring at all times.
- All principles from the policy Internal Transport: Ventilated CICU Patients - SCH need to be adhered to.
- Ensure the receiving department is ready and waiting prior to leaving CICU in order to minimise delays.
- Where possible use priority lifts.

Important equipment essential for transfer:

- Adequate sedation & muscle relaxant
- Continuous monitoring
- Emergency equipment, volume and resuscitation drugs remain with patient
- Separate and spare full O2 cylinder with flow meter
- iSTAT machine and cartridges
- Additional blankets +/- hat – for expected heat loss once ECMO heater is disconnected – Do not cover ECMO tubing (must remain visible at all times) - For the neonatal and infant patients consider increasing patient temperature slightly via the ECMO heater prior to transfer

- **The perfusionist is responsible for the ECMO circuit/console during transport and must ensure that emergency equipment is available as follows**:
  - Back-up CentriMag console/remote drive or Cardiohelp hand crank.
  - Oxygen cylinder.
  - Tubing clamps.
- Check all equipment will fit through doorways prior to leaving CICU and that planned route is clear
- AC power, heater and air/oxygen must not be disconnected until departure and must be immediately resumed at destination
- ECMO tubing should remain visible at all times to ensure no tension is applied during transfer.
- If any issues or circuit alarms during transfer call out “Stop” and team will pause and troubleshoot

16 Invasive Procedure/Surgery on ECMO

- The surgical team will arrive to prepare the patient for the procedure/surgery.
- Ensure that the following equipment is available in the bedspace for their arrival:
  - Emergency Cart /trolley
  - Surgical lights
  - Bowl stand
  - Suction
  - Diathermy machine + paediatric diathermy plate (according to weight) (currently situated in our unit for radial harvesting. To be transferred to CICU once the new machine arrives).
  - Spare table or small trolley – to open the gowns and to put extra instruments.

Once the OT team take over the care of the patient, bedside nurses should be available to assist if the team require further equipment, medications or fluid.

17 Planned ECMO circuit change

Indications

An ECMO circuit change is indicated when the existing circuit is failing and compromising patient safety. Some common indications include:

- Circuit thrombus, particularly in the oxygenator
- Console failure

- Oxygenator leak, failure or infection

Circuit problems may evolve slowly or rapidly, therefore a circuit change may be planned or occur as an emergency. Emergency circuit changes require immediate separation from ECMO as indicated in the emergency management section.

Impending circuit changes should include a discussion with intensivist, surgeon and perfusionist.

Preparation

Once the decision is made to change the circuit the surgical team should be organised as required for ECMO initiation, but without cannulation. Circuit change-over involves disconnection and replacement of the ECMO circuit/console from the cannulae in the patient.

During this process the patient will not be supported by ECMO for a few minutes. This should be considered when planning the circuit change and appropriate physiological support should be available including preparation for acute decompensation, bleeding or arrest.

Preparations should include:

- Optimise native lung ventilation, FiO_2 100%.
- Order blood products.
- IV drug and volume infusions as instructed by intensivist.
- Have defibrillation pads attached.
- Have resuscitation trolley at the bed side.
- Bed-space should be made for theatre nurse setup.

The following team members are required during a circuit change:

Perfusionist – to prime and establish ECMO with the replacement circuit.
Cardiac surgeon – to detach old circuit and reconnect the replacement circuit.
Intensivist – to manage the patient during the circuit change.

Procedure

The procedure is at the discretion of and directed by the cardiac surgeon. The process must involve communication with the intensive care team supporting the patient during the procedure.

- ECMO ceased as per 'rapid ECMO separation' (see Section Emergency Management).
- Perfusionist hands surgeon primed circuit and appropriate connectors.
- Surgeon prepares new circuit: cuts, adds connectors and de-airs. Surgeon connects and de-airs the new circuit.
- ECMO re-established at previous settings.
- ECMO lines secured.

18 Weaning and Ceasing ECMO

The weaning process is dependent on the mode of ECMO support and will be discussed with the intensivist, surgeon and perfusionist.

If provision for continuing ECMO following unsuccessful weaning is required, the perfusionist should prime the backup ECMO circuit.

The surgical team should be organised as required for decannulation and parental consent sought.

- Weaning drugs and volume infusions should be prepared as instructed by anaesthetist and intensivist.
- Emergency drugs should be prepared.
- Blood products should be ordered.
- Bed-space should be made for theatre setup.

Weaning for V-A ECMO

V-A ECMO weaning involves the gradual reduction of ECMO flow (withdrawal of cardiac and respiratory support) while attempting to maintain normal physiological parameters using inotropes and increased ventilation settings.

- Reduced ECMO flows will require an increase to the heparin infusion rate to minimise circuit thrombosis. The perfusionist will determine minimum ECMO flow based on oxygenator type and circuit status.
- TTE or TOE may be required to assess cardiac function.
- If weaning is successful the ECMO lines are clamped and pump turned off. Gas flow and heparin infusion are turned off.
- Patient parameters are carefully monitored in the early post-ECMO phase prior to decannulation by the cardiac surgeon.

Weaning for V-V ECMO

V-V ECMO weaning involves the cessation of ECMO sweep gas (withdrawal of respiratory support) while attempting to maintain normal physiological parameters using increased ventilation settings.

- ECMO blood flow is maintained (to prevent clot formation).
- Sweep gas flow is turned off and gas line clamped. This eliminates gas exchange from the ECMO circuit. Respiratory function is now dependant on native lung performance which can be assessed. If weaning is successful the ECMO lines are clamped and pump is turned off. Heparin infusion is turned off.
- Patient parameters are carefully monitored in the early post-ECMO phase prior to decannulation by the cardiac surgeon.

19 CVVDHF via the Prismax on the ECMO Circuit

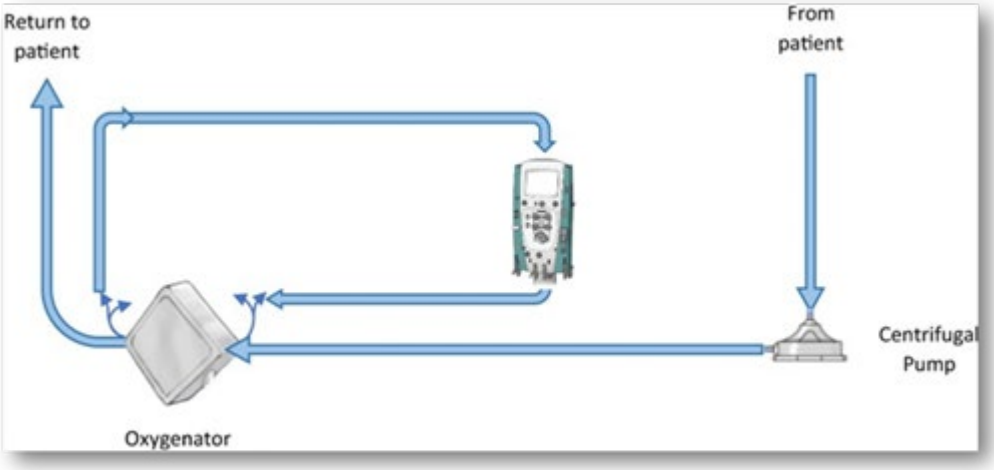
Commencing CVVHDF

Nursing staff to set up Prismax as per (Hyperlink to policy) with the appropriate sized circuit. Due to the higher pressures in the ECMO circuit **ST60 is the smallest size filter** that should be used (even in neonates).

Check prescription is appropriate and confirm with the Intensivist if a 0.9% sodium chloride or blood prime is required. If **a blood prime has been requested, it requires a blood prime in 'more options' then select 'blood prime.' NB for the ST150 manual prime is required on the Prismax.**

Contact on call perfusionist as Prismax is being prepared, they will attend CICU to place CVVDHF circuit into ECMO circuit. **This is not done by the nursing staff.**

The access line (usually RED) of CVVDHF circuit is to be attached to the ECMO circuit post oxygenator and the return line (usually BLUE) of the CVVHDF circuit is to be attached pre oxygenator via smaller 'pig tail' connections within the ECMO circuit. This configuration will reduce the risk of any air entraining into the ECMO circuit reaching the patient as it will be captured by the oxygenator.



Once the circuit is securely attached the Prismax can commence.

The access pressures will read more positive due to the positive pressure from the ECMO circuit and the position of the access line post pump.

If the CVVHDF circuit stops, ensure the access and return line of the CVVHDF circuit are clamped – call the on call perfusionist immediately.

As the patient will be heparinised either directly or via the ECMO circuit, the CVVHDF circuit will not require heparin.

Changing the circuit on the Prismax

If the CVVHDF circuit is clotting or has clotted, you have no option but to change the circuit.

Select End Treatment (if you have the option and the filter has not already clotted) **do not return the blood**. Clamp both access and return lines and 3 way taps attached to the ECMO circuit, the on call perfusionist will then disconnect the CVVHDF circuit.

If the filter has clotted and stopped, clamp both access and return lines and 3 way taps attached to the ECMO circuit. Call the on call perfusionist to disconnect the CVVHDF circuit.

Ensure that there is fluid bolus available in case the child becomes hypotensive and/or hypovolemic (the ECMO circuit may shudder or the access pressures increase).

If a CVVHDF circuit change is required, a second Prismax machine should be set up and ready for the on call perfusionist to connect.

If a second Prismax is not available, once disconnected, remove the old circuit and set up a new one. Call the on call perfusionist to reconnect the new CVVHDF circuit.

Ceasing and Disconnecting CVVHDF

Once the medical team has determined that the patient no longer requires CVVHDF, the treatment will cease. Select End treatment, **do not return the blood**. Clamp both access and return lines and 3 way taps attached to the ECMO circuit, the on call perfusionist will then disconnect the CVVHDF circuit.

Endure that there is fluid bolus available in case the child becomes hypotensive and/or hypovolemic (the ECMO circuit may shudder or the access pressures increase)

20 Medication and ECMO [8-10]

ECMO therapy can have significant implications on the success of drug treatment in critically ill patients. These effects can potentially lead to treatment failure, toxicity and/or antimicrobial resistance. Patients on ECMO may also require renal replacement therapy due to multi organ dysfunction syndrome which further complicates the interpretation of drug therapy. The age of the patient will also affect the pharmacokinetics and dosing of the drugs whilst on ECMO.

Highly lipophilic drugs may be adsorbed onto the large surface area of the ECMO circuit. This may require higher than expected doses to be used to achieve sedation targets.

Antimicrobials can be affected by the ECMO circuit. Seek advice from Infectious Diseases and Pharmacy for dosage adjustment and monitoring advice.

Some of the most common means by which ECMO may affect drugs are as follows:

Method	Mechanism of action	Potential outcome
Direct extraction by the circuit	Non-specific adsorption as a function of interaction between	Increased extraction of lipophilic drugs and highly protein bound

	the drug and material surface, affinity of drugs for the surface, and maximal amount of binding per unit of surface area	drugs. These may therefore require higher doses.
Increased volume of distribution	Factors that can influence volume of distribution include: -haemodilution -physiological changes due to ECMO support and illness -drug extraction due to interaction with the circuit	Drugs with a low volume of distribution are greatly affected. Its impact may also be inversely related to age.
Altered clearance	May be due to ECMO therapy's potential to alter pharmacokinetics of certain drugs through its effects on different organ systems e.g., renal	Increased clearance
		Unchanged clearance
		Decreased clearance

Medication	**Changes reported in ECMO**
Clonidine	Increased volume of distribution Increased clearance
Fentanyl	Direct extraction by the circuit Increased volume of distribution Decreased clearance
Dexmedetomidine	Direct extraction by the circuit Increased volume of distribution
Midazolam	Direct extraction by the circuit Increased volume of distribution Decreased and increased clearance reported
Morphine	Increased volume of distribution Less extraction by the circuit compared to fentanyl

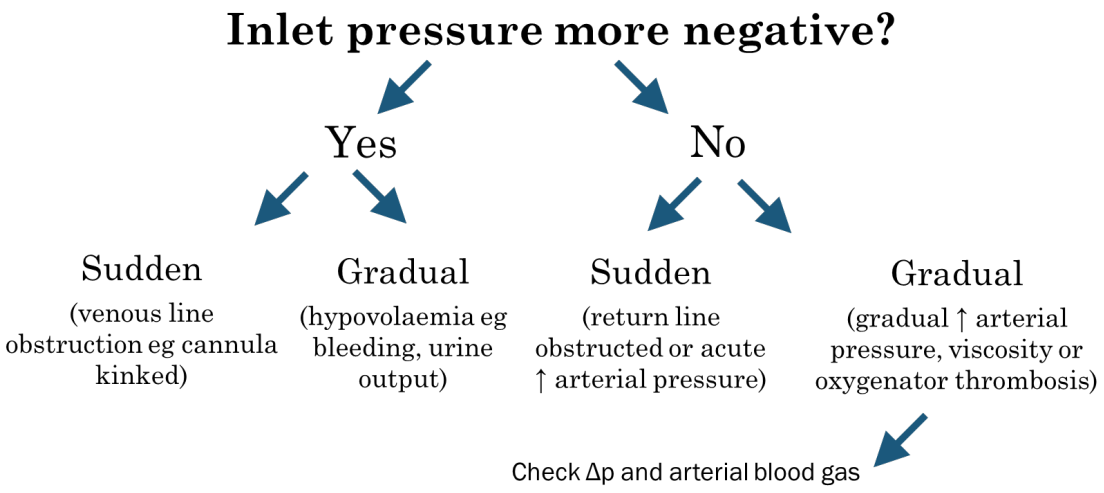
	Decreased and increased clearance reported
Propofol	Direct extraction by the circuit Increased volume of distribution

As a result, drug dose recommendations in this patient group can be complex and need to be led by the treating intensivists. Tools such as therapeutic drug monitoring and physiological based pharmacokinetic modelling should be used where possible.

21 Troubleshooting problems

Issues on ECMO

Although the centrifuge pump speed is used to adjust flow, ECMO blood flow is sensitive to pump preload and afterload. Patient and cannula position, blood volume, vascular resistance and circuit thrombosis can affect flow. Changes in circuit pressures (particularly the negative access pressure) and the rate of flow reduction can assist in determining the cause. A troubleshooting chart is provided below:



Blood flows

Inadequate blood flows result in insufficient oxygen delivery, hypotension or hypoxaemia.

Venous side: The most common site of problems to achieve adequate flows are on the venous side. This is manifested by high negative venous pressures.

Note: the perfusionist will set target negative pressure targets. This could be due to a number of factors including:

- Excess resistance associated with cannula being too small. Remember Pousielle's law. The patient may need additional venous drainage (i.e., femoral venous drainage) or upsizing of cannula.
- Malpositioned cannula.

- Hypovolaemia. Treat with crystalloids/albumin or blood product fluid bolus.

Exclude tension pneumothorax, pericardial tamponade or abdominal compartment syndrome.

Arterial side:

- Outlet pressure too high?
- Excess resistance associated with cannula being too small
- Malpositioned cannula
- Clot within the arterial limb/cannula
- High systemic vascular resistance (SVR) due to high doses of vasopressors and peripheral vasomotor tone, inadequate sedation or seizures

Hypoxaemia

- Check flow settings, has the flow decreased?
- Check cannula position, consider CXR for position confirmation.
- Recirculation is the most common cause for hypoxaemia. Check SvO_2 saturations for elevation
- Is the patient febrile and hypermetabolic causing increased oxygen consumption? Do an arterial blood gas and a pre oxygenator blood gas to check if SvO_2 has decreased or there has been a trend in falling SvO_2 - If the AV O_2 difference is widening it suggests increased oxygen extraction.
- Check the oxygenator – ensure that the oxygen connector is secure, observe for any clots and that the post oxygenator blood is bright red. N.B Primary oxygenator failure as a cause of hypoxaemia is very unusual. Call perfusionist if any concerns
- Check the patient's native cardiac output. Is it improving with the lungs not functioning well? - As the cardiac output goes up, more native blood flow goes through the lungs. If the blood does not get oxygenated, the patient will desaturate more. Increase Fi02 on the ventilator in the first instance, before considering changing ECMO settings. **Confirm with intensivist before any changes are made to the ECMO or ventilator settings.**

Circuit 'Chattering/Shuddering'

- Check for hypovolaemia, does the patient need a fluid bolus?
- If during pressure area care, check tubing and flows. Return the patient to their original position and observe for resolution.

Pump/console failure

The pump-head should always be checked to ensure it is securely coupled to the drive unit. For a console or remote pump drive failure, the emergency procedure is illustrated below:

CentriMag Pump failure (no hand crank)	Cardiohelp pump failure (hand crank)
Press emergency buzzer	Press emergency buzzer
Clamp arterial and venous lines	Clamp arterial and venous lines
Stop pump by holding stop button until audible alarm cycles are heard	Stop pump by RPM control knob
Remove pump head by loosening screw and rotating the pump head clockwise	Open safety bar and remove black pressure cable and venous probe
Insert the pump head into "Pump motor 2"	Press the locking device button and twist oxygenator/pump head clockwise to remove
Select "L" or "R" on Console 2	Fix oxygenator onto hand crank (top side first then by sliding bottom safety lever on hand crank) and secure
Increase RPMs on Console 2 >1000	Start hand cranking until RPM LED on hand crank turns green
Remove clamps	Remove clamps
Increase RPM till previous flow is established	Increase RPM till previous flow is established

Air in circuit

- Air may enter the venous or arterial system of the ECMO circuit.

Venous air

- Venous air is more common than arterial air due to the vacuum applied by the centrifuge pump on the venous system. Venous air may enter via IV lines, venous cannulae or connectors and may travel beyond the pump head into the oxygenator. Venous air may be in the form of minute bubbles or massive entrainment sufficient to de-prime the pump head. Massive air entrainment will therefore reduce or stop flow through the circuit and constitutes an emergency.
- For **venous air that DOES NOT** affect flow
    - Continue ECMO and remain vigilant, preparing to come off ECMO as stated in 'Rapid ECMO separation.'
    - Examine circuit for site of air entry and rectify if possible.
    - Air entry from venous cannula should be immediately reported to the cardiac surgeon and perfusionist.

- Small air bubbles in the pump head and/or oxygenator will be captured by the oxygenator. Removing the yellow venting cap (Cardiohelp/Quadrox) allows the air to escape without compromising flow rates.

- For **venous air that DOES** affect flow:
  - Come off ECMO as stated in "Rapid ECMO separation."
  - Attach 50mL syringe to pre-membrane de-airing port of oxygenator.
  - Remove venous clamp.
  - Aspirate and direct air from the circuit into syringe and push fluid into the patient.
  - When circuit is clear, increase RPMs to >1000.
  - Remove arterial clamp, resume previous ECMO flow and inspect circuit for air bubbles.

Arterial air

- Visible air distal to the oxygenator is rare.
- Come off ECMO as stated in 'Rapid ECMO separation'.
- Immediately place the patient in head down (Trendelenburg) position and aspirate air from the unclamped arterial line using a syringe connected to the post-membrane access.
- Re-institute ECMO with the de-aired circuit.

22 References

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4. Extracorporeal Life Support Organisation (ELSO) (2020) Indications for Pediatric Respiratory Extracorporeal Life Support.
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23 Related Documents

- Paediatric Intensive Care Patient - Patient Care in CICU - SCH
- Ventilated Patient: Patient Care in CICU - SCH
- Continuous Electrocardiographic (ECG) Monitoring
- Vasoactive Infusions - CICU - SCH
- Neuromuscular Blockade Agents (NMBA) - CICU - SCH
- Invasive Arterial Monitoring in CICU - SCH
- Continuous Renal Replacement Therapy in CICU - SCH
- Internal Transport: Ventilated CICU Patients - SCH
- Rotem use - SCH
- Massive Transfusion Protocol (MTP) - Paediatric

Appendix I: Bedspace set up

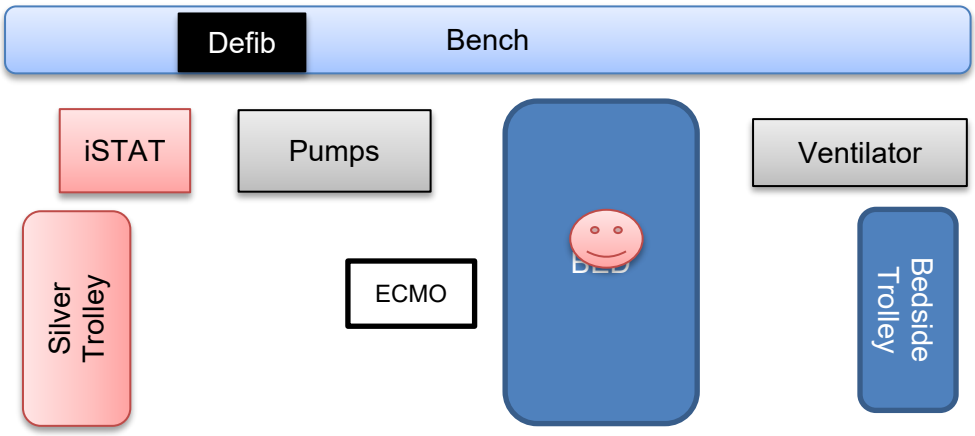
Ensure 2 bed spaces are made available. If able, the use of beds 5&6, 8&9 and 13&14 should be used.

Further machines may need to be added at a later date such as High Frequency Oscillatory Ventilation (HFOV)/Continual Renal Replacement Therapy (CRRT)/Nitric Oxide Therapy.

Set up the bed space with equipment:

- Drager monitoring system (ECG, SAO_2, IAL, CVP,Temp)
- Ventilator
- Large (8 pump) B Braun space station x 2 attached to double pole.
- Bed & Bedside trolley
- iSTAT Machine with a selection of cartridges
- Supply of syringes, including blood gas syringes, blood bottles, caps and alcohol swabs in a green tray.
- Defibrillator (including internal paddles if chest open)
- Silver Trolley for resus drugs and resus fluids.

ECMO machine will arrive, primed and ready, with the cardiothoracic team (perfusionist will assemble and prime).



Medication and fluids:

- Resuscitation drugs drawn up as per CICU drug calculator:
  Adrenaline 1:10,000
  Atropine 600 microg/mL or 1.2 mg/mL
  Calcium Chloride 10%
  Rocuronium 50 mg/5mL
- Vials at the bedside but doses not drawn up:
  Magnesium Sulphate
  Calcium Gluconate
  Vitamin K (Phytomenadione)
- 2x 500mL Bottles of 4% Albumin

Appendix II: ECMO Safety Checklist

Machine Safety Checks:

- Ensure power cord from ECMO machine is plugged in at all times
- Ensure 4x clamps are available and accessible
- Ensure there is a full oxygen cylinder is available in case of emergency at all times
- Check position of hand crank, ensure it is accessible
- Ensure ECMO machine and bed brakes are on at all times
- Ensure perfusionist name and contact details are up to date and visible for any emergency

Circuit Assessment

- Check flow alarms are set appropriately
- Inspect cannula site and check connection to circuit
- Ensure circuit is secured
- Ensure appropriate light source is available for circuit clot checks, check batteries if applicable.
- Check circuit for clots
- Check ECMO tubing connections from patient to machine

Oxygenator Assessment

- Confirm all gas lines connections are attached and secure
- Ensure gas exhaust port is unobstructed
- Confirm no air or foam are leaking from the oxygenator
- Confirm oxygenator position, ensure it is at or below the patient

Heat Exchanger Assessment

- Confirm water bath is on at all times. Recheck when water bath is exchanged
- Ensure blood temperature is constantly monitored
- Ensure circuit temperature is appropriate
- Ensure patient's temperature is stable
- Ensure water bath temperature is appropriate

Ventilator Setting Checks

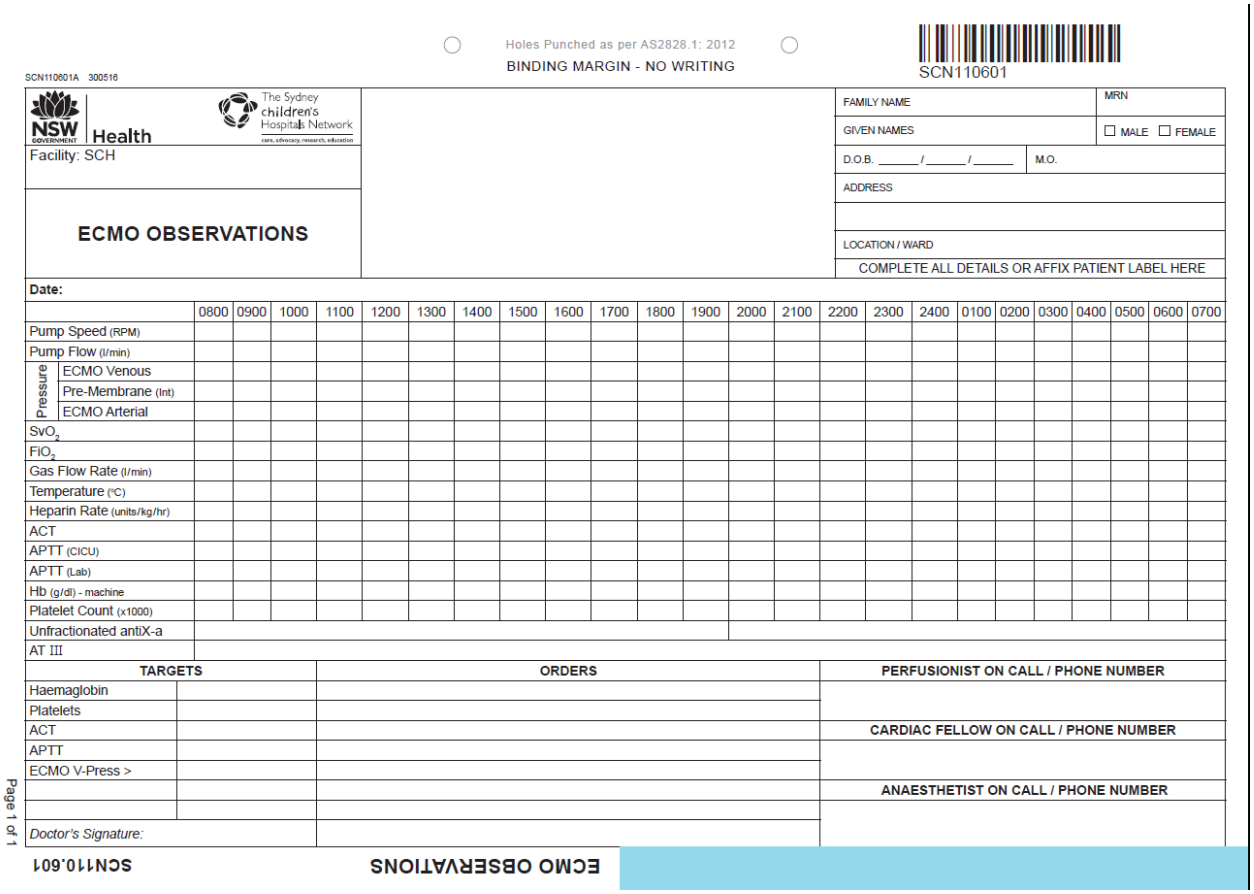
- Confirm ventilator settings as per Intensivist orders
- Ensure emergency ventilator settings are documented and confirmed by the Intensivist

Emergency Plan

- Establish and discuss emergency plan with bedside team, allocate roles
- Ensure emergency drugs and paralysis boluses are available at the bedside, replace every 24 hours
- Ensure Emergency adrenaline infusion is prepared and attached to patient at all times, ensure pump is correctly programmed and fully charged
- Check emergency bedside equipment and ensure arrest trolley is accessible
- Ensure blood product giving sets are available
- Ensure 2x 500mL of 4% albumin is at the bedside

Appendix III: ECMO Observation Chart

ECMO observation chart



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SCN110601

NSW GOVERNMENT Health
Facility: SCH

The Sydney children's Hospitals Network

ECMO OBSERVATIONS

FAMILY NAME | MRN
GIVEN NAMES | ☐ MALE ☐ FEMALE
D.O.B. _____/_____/_____ | M.O.
ADDRESS
LOCATION / WARD
COMPLETE ALL DETAILS OR AFFIX PATIENT LABEL HERE

Date:

	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	0100	0200	0300	0400	0500	0600	0700
Pump Speed (RPM)																								
Pump Flow (l/min)																								
Pressure: ECMO Venous																								
Pressure: Pre-Membrane (Int)																								
Pressure: ECMO Arterial																								
SvO_2																								
FiO_2																								
Gas Flow Rate (l/min)																								
Temperature (°C)																								
Heparin Rate (units/kg/hr)																								
ACT																								
APTT (CICU)																								
APTT (Lab)																								
Hb (g/dl) - machine																								
Platelet Count (x1000)																								
Unfractionated antiX-a																								
AT III																								

TARGETS		ORDERS	PERFUSIONIST ON CALL / PHONE NUMBER
Haemaglobin			
Platelets			
ACT			CARDIAC FELLOW ON CALL / PHONE NUMBER
APTT			
ECMO V-Press >			
			ANAESTHETIST ON CALL / PHONE NUMBER
Doctor's Signature:			

Page 1 of 1

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