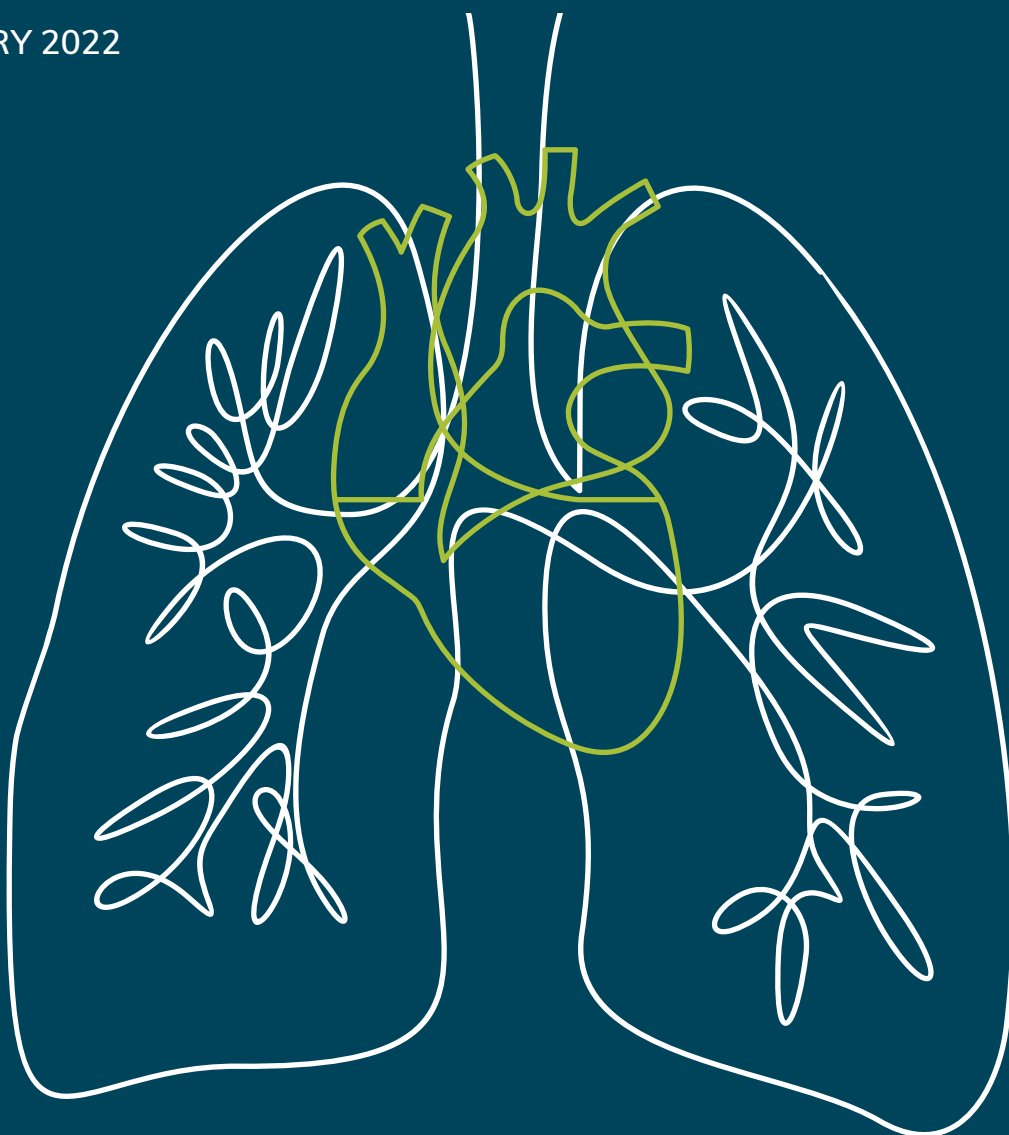


# Minimum equipment requirements to support a paediatric ECMO retrieval service

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# Summary

Extracorporeal membrane oxygenation (ECMO) is a means of providing prolonged cardiopulmonary support, focused on the heart and lungs for very sick patients.

There are two types of ECMO:

- Venovenous (VV), which provides respiratory support
- Venoarterial (VA), which provides respiratory and cardiac support.

This clinical practice guide outlines the minimum equipment required to safely support a paediatric ECMO retrieval. It identifies the equipment needed for the team to either cannulate a child on site, or transfer a child who is already established on ECMO.

There are three types of ECMO-related transfers:

- Transfer on conventional support to an ECMO centre.
- Cannulation at a referring site and transfer on ECMO to an ECMO centre for ongoing support.
- Transfer on ECMO between ECMO centres.<sup>1</sup>

Equipment used in ECMO transport should have the capacity to maintain a child on ECMO for at least 24 hours. It should be the same (or compatible) with the ECMO equipment used in hospitals to avoid risk to the patient, and to reduce time in the retrieval process.

This guideline outlines:

- equipment components for an ECMO retrieval service
- equipment components for a child requiring ECMO
- additional equipment required from a referring hospital
- a checklist for instruments and equipment
- equipment for site cannulation.

It is recommended that the equipment is stored and replenished from a centralised store by the ECMO retrieval service, which will work collaboratively with the two paediatric ECMO centres.

# Introduction

Extracorporeal membrane oxygenation (ECMO) is a means of providing prolonged cardiopulmonary support focused on the heart and lungs for very sick patients.

It is crucial to have standardisation of ECMO services to support safe and quality care for referral, triage, retrieval services, equipment and processes across the hospital.

In order to safely transfer a patient on ECMO to an ECMO centre, specialty equipment is required for an ECMO retrieval team.

## Purpose of this guide

This guide outlines the equipment required for the ECMO retrieval team to either cannulate a neonate or paediatric patient on site, or transfer the child already established on ECMO.

It aims to support the need for a standardised approach to ECMO transport equipment across sites and jurisdictions, if retrieval is required, to ensure minimal adverse events in the process of retrieval.<sup>2</sup>

This guide is intended for the use of NSW Ministry of Health, pillar organisations, retrieval services, local health districts (LHDs), speciality health networks and clinicians.

This guide supplements the existing [ECMO retrieval services in NSW. Model of care for neonatal and paediatric patients](#), which has now been operationalised by Sydney Children's Hospitals Network (SCHN) and used alongside the Kids ECMO Retrieval Service (KERS).

## Evidence

The literature in this area is quite limited; however, this guide was informed by Extracorporeal Life Support Organization (ELSO) guidelines and expert clinicians in the field of ECMO and retrieval in Australian and overseas adult and paediatric health settings.<sup>1</sup>

# Background

Paediatric ECMO retrieval services are not a formalised or coordinated process. They are established on a case-by-case basis when a retrieval is required. The retrieval is performed by expert clinicians with paediatric intensive care, cardiac surgery and perfusion services within Sydney Children's Hospitals Network (SCHN) and the NSW Newborn and Paediatric Emergency Transport Services (NETS).

ECMO equipment is highly specialised and expensive. It requires speciality training and competence to operate. In principle, the medical equipment used in ECMO transport should be the same (or compatible) with ECMO equipment used in hospitals, due to the following:

- The need to avoid risk to the patient, with changing circuit, oxygenator and/or pump when retrieval is required.
- Clinician operator knowledge of the equipment.
- Clinician familiarity of the equipment to identify problems or issues.
- Reduced time in the retrieval process.<sup>2</sup>

Standardisation of equipment across services has been shown to reduce the risk of adverse events and improve staff familiarity and knowledge, with significantly less re-education of clinicians in time-critical situations.

Staff need to have experience and skills in ECMO and retrieval, which includes optimal cannulation and initiation of ECMO.

A program of training in ECMO is required within each organisation on designated roles, responsibilities and emergency situation management of the equipment and child. This will improve teamwork, delivery of care, reduce adverse effects and maintain a low mortality rate.<sup>2, 3, 4</sup>

This guideline is a PICNIC (Paediatric Intensive Care Neonatal Intensive Care) recommendation.

# Equipment

The correct equipment is vital when transporting a paediatric patient on ECMO. This equipment needs to be in working order, appropriate for the patient size and safe for use in the retrieval environment.

The anticipated number of paediatric ECMO retrievals is small. For this reason, it is recommended that the equipment is stored and replenished from a centralised store by the ECMO retrieval service, which will work collaboratively with the two paediatric ECMO centres.

ECMO retrieval equipment needs to:

- be readily accessible and secured
- be kept in clearly labelled packs
- be checked regularly
- have the capacity to maintain a child on ECMO for at least 24 hours.<sup>5,6</sup>

Retrieval staff should be familiar with the contents of the retrieval packs. A checklist for the retrieval pack should be completed before departure by two retrieval team members. This will ensure all equipment is present and accounted for in case of an emergency and that weight limits are met for aviation planning.

Air retrievals require equipment to be tested for electromagnetic interference that may affect flight controls. The equipment must also withstand vibrational and acceleration and deceleration forces of the flight environment.<sup>4</sup>

Equipment should be integrated into ambulance and air-ambulance configurations and be field and flight-tested in order to ensure compliance with work, health and safety and Civil Aviation Safety Authority regulations.

The transporting vehicle, whether air or road, will require a power output facility sufficient enough to manage the ECMO equipment and maintain battery capacity for the entire transport.<sup>7</sup>

There is essential equipment that is required to establish an ECMO retrieval service. Many items are similar to what would be required to initiate ECMO on a child in a hospital.

Where possible, equipment should be standardised across NSW. Table 1 demonstrates the essential equipment required to establish an ECMO retrieval service and the specific components that would be needed for a child. These items are required to be transportable and taken with the ECMO retrieval team when retrieving a child.

**Table 1: Equipment required to initiate or maintain ECMO, for an ECMO retrieval service and for a child**

Equipment components for an ECMO retrieval service	Equipment components for a child requiring ECMO
A suitable centrifugal blood pump that incorporates a back-up battery supply.	ECMO cannulas in multiple sizes according to the weight of the patient and extras. <b>Age dependent</b> (see Appendix 1): <ul style="list-style-type: none"> <li>• Arterial cannulas</li> <li>• Venous cannulas</li> <li>• Angled venous cannulas</li> <li>• Chest drain</li> <li>• Chest drain bottle</li> </ul>
An emergency pump or manual control mechanism in the event of primary pump failure or power failure.	Circuit that is size appropriate for the neonate or paediatric patient, and a spare circuit and circuit components as part of the pack (see Appendix 1).
Device(s) for heating and regulating circuit blood temperature (essential to maintain normothermia). <sup>8</sup>	Plateau pressures > 30cmH <sub>2</sub> O Tidal volumes > 6ml/kg predicted body weight Driving pressure (peak pressure OR Pplat-PEEP) >15cmH <sub>2</sub> O
Medical gas tanks, regulators, hoses, connectors, flow meters and blenders for provision and adjustment of blended sweep gas to the oxygenator.	A membrane oxygenator that is size appropriate and a spare oxygenator considered as part of the pack (see Appendix 1).
Uninterruptable battery power source(s) capable of meeting the electrical power needs of all equipment during transfer between transport vehicles and in the event of transport vehicle power source failure.	Haemodynamic monitoring device which includes venous and arterial pressure waveforms.
A portable ultrasound machine and probe suitable for transthoracic echocardiography, and vascular probe for percutaneous technique (if not provided by the referring facility).	Point-of-care anticoagulation monitoring equipment available (e.g. activated clotting time).

Source: Adapted from the Extracorporeal Life Support Organization (ELSO) patient transfer guidelines.<sup>1</sup>

In addition to the essential ECMO machine, other emergency, resuscitation, and patient management equipment components are required for ongoing conventional intensive care support and monitoring, to safely transport a child on ECMO.<sup>8</sup>



**Table 2: Additional equipment components required to provide intensive care support and monitoring, for the ECMO retrieval service and for a child**

Additional equipment components for the ECMO retrieval service	Additional equipment components for a child
Medical gas tanks, regulators, hoses, connectors, flow meters, and blenders for provision and adjustment of blended gas to the patient ventilator.	Patient ventilator, appropriate for the patient's size and clinical needs.
<p>Sterile surgical instruments and operating equipment in surgical transportable packs.</p> <p>Surgical instruments and trays may include:</p> <ul style="list-style-type: none"> <li>• major pack</li> <li>• cardiac minor tray</li> <li>• Cardiac neonatal vascular clamp feeder</li> <li>• ECMO clamp feeder tray</li> <li>• ECMO instrument feeder tray</li> <li>• sternal retractors (for larger patients)</li> <li>• sternal saw with batteries</li> <li>• ECMO retrieval black box</li> <li>• portable headlight case</li> <li>• batteries for headlight</li> <li>• sterile gloves.</li> </ul> <p>(See Appendix 2 and 3).</p>	Suction system and catheters including yankauer suction.
Patient consumables with infusion lines, pressure infusion lines, needles, syringes and dressing materials.	Airway adjuncts which are size appropriate. Medication and fluid infusion pumps.
Surgical disposables such as sutures and surgical dressings.	Blood products for circuit preparation, cannulation and ECMO initiation.
iSTAT and extra cartridges.	Intravenous fluids and volume expanders.
Activated clotting time (ACT) kit.	Long extension tubing to administer fluids and medications while being transported.
Portable defibrillator with external defibrillator pads.	Packed red blood cells to travel (referring hospital to prepare and package).
<p><b>Emergency resuscitation equipment and drugs</b></p> <p>Emergency drug pack may include:</p> <ul style="list-style-type: none"> <li>• adrenaline</li> <li>• amiodarone</li> <li>• atropine</li> <li>• calcium chloride 10%</li> <li>• sodium bicarbonate (NaHCO<sub>3</sub>).</li> </ul> <p>Additional fluid and drugs include:</p> <ul style="list-style-type: none"> <li>• 4% normal serum albumin 20ml/kg (or appropriate fluid for boluses)</li> <li>• packed red blood cells (PRBC)</li> <li>• adrenaline infusion</li> <li>• additional inotrope infusions, as required</li> <li>• sedation and neuromuscular blockade</li> <li>• heparin infusion</li> <li>• sodium nitroprusside infusion (or appropriate vasodilator).</li> </ul>	
Strapping to secure ECMO heater/cooler onto vehicle floor and for any loose ECMO equipment.	

Sources: Adapted from ELSO additional equipment guide and NETS transport guide.<sup>1,8</sup>

## Additional equipment required from a referring hospital

The following staffing and equipment should be ready when an ECMO retrieval team arrives to retrieve a child that requires ECMO initiation, or to transfer them to a paediatric intensive care unit (PICU) with already established ECMO.

- Blood products (type-specific)
- Procedure trolleys x2
- Diathermy machine and diathermy plate (from operating theatre)
- High suction
- Extra sponges
- Scout nurse (from operating theatre)
- Defibrillator with external defibrillator pads
- Warm/cold intravenous normal saline

The referring hospital is responsible for organising the staffing and equipment while the ECMO retrieval team is on their way.

# Appendix 1: Equipment used for ECMO retrieval

## ECMO cannula sizes

Arterial cannulas	Venous cannulas
8 Fr Bio-Medicus A	8 Fr Bio-Medicus A
10 Fr Bio-Medicus A	10 Fr Bio-Medicus A
12 Fr Bio-Medicus A	12 Fr Bio-Medicus A
14 Fr Bio-Medicus A	14 Fr Bio-Medicus A
15 Fr Art. HLS Cannula - BE-PAS 1515	15 Fr Art. HLS Cannula - BE-PAS 1515
17 Fr Art. HLS Cannula - BE-PAS 1715	17 Fr Art. HLS Cannula - BE-PAS 1715
19 Fr Art. HLS Cannula - BE-PAS 1915	19 Fr Art. HLS Cannula - BE-PAS 1915
21 Fr Art. HLS Cannula - BE-PAS 2115	21 Fr Art. HLS Cannula - BE-PAS 2115
23 Fr Art. HLS Cannula - BE-PAS 2315	23 Fr Art. HLS Cannula - BE-PAS 2315
	25 Fr Ven HLS Short - BE-PVS 2538
	21 Fr Ven HLS Long - BE-PVL 2155
	23 Fr Ven HLS Long - BE-PVL 2355
	25 Fr Ven HLS Long - BE-PVL 2555
	16 Fr Avalon Elite - 10016-CE
	19 Fr Avalon Elite - 10019-CE
	20 Fr Avalon Elite - 10020-CE
	23 Fr Avalon Elite - 10023-CE
	27 Fr Avalon Elite - 10027-CE
	31 Fr Avalon Elite - 10031-CE

## ECMO circuits

3/16 x 1/4 ECMO Custom Pack  
 1/4 x 1/4 ECMO Custom Pack  
 3/8 x 3/8 ECMO Custom Pack

## ECMO oxygenator sizes

Paragon neonatal  
 Paragon infant  
 Paragon adult midi oxygenator

Source: Examples of equipment used for ECMO retrieval in Sydney Children's Hospitals Network (SCHN).<sup>9</sup>

## Appendix 2: ECMO retrieval service checklist for instruments and equipment

### ECMO retrieval instruments/equipment list

Meet at Children's Hospital at Westmead OR conduct team time out before leaving hospital – check circuit size, cannulae, equipment and **clarify patient weight**.

Retrieving team: \_\_\_\_\_ Date: \_\_\_\_\_ Hospital: \_\_\_\_\_

To be collected on day	Collected	Returned
<b>Age dependent – discuss with surgeon and perfusionist:</b>		
• Pack central cannulae	<input type="checkbox"/>	<input type="checkbox"/>
• Perfusion will pack peripheral cannulae	<input type="checkbox"/>	<input type="checkbox"/>
– Biomedicus arterial cannulas		
– Biomedicus venous cannulas		
– Angled venous cannulas		
– Sterile gloves for the team going		
– Chest drains, including blake drains to size		
• Instruments and trays	<input type="checkbox"/>	<input type="checkbox"/>
• Pack the following into the black box:	<input type="checkbox"/>	<input type="checkbox"/>
– Cardiac minor tray (blue wrap)		
– Micro scissors tray		
– Cardiac neonatal titanium clamp feeder		
– ECMO clamp feeder tray		
– ECMO fine instrument tray		
– Retractors (sternal for >30kg patients)		
– Stryker sternal saw with batteries (found in heart retrieval box)		
– Transport trolley		
– ECMO disposables box (this is prepacked)		
• From clinical nurse specialist 2 office:	<input type="checkbox"/>	<input type="checkbox"/>
– Xenosys portable headlight case		
– Batteries for headlight (x2)		
• Load all equipment onto fold-out cardiac transport trolley	<input type="checkbox"/>	<input type="checkbox"/>

Check-out nurse full name: \_\_\_\_\_ Signature: \_\_\_\_\_

Check-in nurse full name: \_\_\_\_\_ Signature: \_\_\_\_\_

Source: Checklist developed by SCHN for ECMO retrieval.<sup>9</sup>

## Appendix 3: ECMO retrieval equipment for site cannulation pack

### ECMO retrieval kit (inside black box)

Restock and zip tie upon return

Contents	Signature	Date
3x baldwin IV spikes		
Integuseal		
2x large plastic		
4x 2/0 silk taper		
5x 3/0 ticron		
4x each of:		
4/0 prolene RB-1		
5/0 prolene C-1		
6/0 prolene C-1		
6/0 prolene BV-1		
1x 2 Silk and 1x 2/0 Silk ties		
2x nylon tape		
2x rubber shods		
2x vessel loops		
2x 0012M insulated diathermy tips		
Colorado tip		
2x snares		
2x beaver blades		
2x 11 blades, 2x 15 blades		
Square drapes		
3x disposable gowns		
2x neuro towels		

Source: Checklist used at Children's Hospital Westmead for ECMO retrieval – equipment required for cannulation at site.<sup>10</sup>

**ECMO retrieval kit (cont.)**

Contents	Signature	Date
2x lobann 6640		
Biomedicus wiring kit		
Masks/hats		
4x Yellow contaminated bags		
2x each of connectors:		
3/16X1/4		
1/4 x 1/4		
1/4 x 3/8		
3/8 x 3/8		
3/8 x 1/2		
1/4 x 1/4		
3/8 Y		
2x blue steristrips		
2x dressing gauze		
4x small primapore		
3x 1/4 ribbon gauze		
Fibrillar 1x large, 1x small		
Mepilex 10x10		
Comfeel		
1mm goretex patch		
1x Sternum blade of each (fresh: Ref # 298-97-100, redo: Ref # 2296-003-106)		
Paperwork pack		
Weck clips - yellow		
Weck clips - blue		
Weck clips - green		
Weck clips - orange		

Date: \_\_\_\_\_ Checked by: \_\_\_\_\_

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## Glossary

ACI	Agency for Clinical Innovation
ACT	Activated clotting time
ECMO	Extracorporeal membrane oxygenation
ELSO	Extracorporeal Life Support Organization
iSTAT	A whole blood analyser
ICU	Intensive care unit
NETS	Newborn and Paediatric Emergency Transport Services NSW
NSA	Normal serum albumin
NaHCO <sub>3</sub>	Sodium bicarbonate
PICNIC	Paediatric Intensive Care Neonatal Intensive Care
PRBC	Packed red blood cells
SCHN	Sydney Children's Hospitals Network
VA ECMO	Venoarterial extracorporeal membrane oxygenation
VV ECMO	Venovenous extracorporeal membrane oxygenation



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- ACI ICNSW Paediatric Intensive Care Advisory Group (PICAG)
- ACI ICNSW ECMO Advisory Group.

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