



CLINICAL PRACTICE STANDARD – Aeromedical Operations AO.CLI.05 – ECMO RETRIEVAL

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	Appendices	N/A	
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Directorate	Aeromedical Operations		
Author Branch			
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Summary	This procedure provides guidance on the appropriate application of ECMO retrieval during retrieval missions		
Applies to	NSW Ambulance aeromedical clinical crew.		
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Approved by	Executive Director, Aeromedical Operations		
Related Legislation	Nil		
Related Documents	Nil		

Compliance with this operating procedure is **mandatory**



CLINICAL PRACTICE STANDARD – Aeromedical Operations HELI.CLI.05 – ECMO Retrieval

1. Introduction

NSW Ambulance Aeromedical is actively involved in the transfer of patients on Extra-Corporeal Membrane Oxygenation (ECMO). These transfers may involve road, helicopter or fixed wing vehicles. The requirement for specialised equipment and a trained perfusionist, in addition to the standard retrieval team, means that these transfers are inherently complex and often lengthy. A high degree of planning, co-ordination and communication is required.

2. Purpose

This procedure provides guidance on the appropriate application of ECMO retrieval during retrieval missions

3. Procedure

3.1 INDICATIONS

Veno-venous (VV) ECMO:

Failure of oxygenation and ventilation despite maximal medical therapy (mechanical ventilation, inhaled NO, prone ventilation etc). Pathologies that respond well to VV ECMO are: ARDS, asthma, pneumonia.

Veno-arterial (VA ECMO):

A requirement for circulatory support where inotropes and vasopressors are no longer effective and are causing severe end organ damage.

Pathologies that respond well to VA ECMO are: first presentation cardiomyopathies, myocarditis, AMI with acute MOF.

Options include transferring the patient to an ECMO capable tertiary centre, or instituting ECMO at the referring hospital prior to transfer.

3.2 ECMO TEAMS

Currently St Vincent's Hospital (SVH) and Royal Prince Alfred Hospital (RPA) provide on call teams for adult ECMO transfers across the State, on a week about roster. This roster is held by the ACC. The ECMO teams usually transfer patients back to their own ICUs.



Rarely, a patient will be transferred to another ECMO capable tertiary ICU in Sydney. The majority of patients requiring VA ECMO with a view to potential cardiac transplant are transferred to SVH.

The ECMO team consists of a perfusionist and a cannulator. The role of the ECMO team is to achieve cannulation, establish and manage the ECMO device. The medical retrieval team is required to manage the remaining usual aspects of the patient's care as well as logistic and transport related oversight. Due to the involved nature of these jobs, a consultant or senior registrar is generally preferred. Where there is no operational consultant on the roster the Duty Retrieval Consultant (DRC) and State Retrieval Consultant (SRC) should discuss available options.

3.3 PLANNING

At the time of tasking, potential ECMO cases require a conference call co-ordinated via the ACC. This initially involves the referring and receiving intensivists and the on-call ECMO physician.

The referring hospital will be asked to fill out a form located on the website: nsw-ecmo.net A pdf is generated. The SRC will receive a copy and the treating retrieval team can request a copy.

If an ECMO transfer is agreed upon then a second conference call occurs between:

- Duty Retrieval Consultant
- State Retrieval Consultant
- ECMO retrieval doctor and paramedic/flight nurse

At the time of the conference call it should be noted whether the patient is already being supported with ECMO and whether the device is a Rotaflow or Cardiohelp, as this will impact the mode of transport.

3.4 PATIENT WEIGHT

A bariatric measurement chart should be completed and an accurate weight obtained for all larger patients (actual or potential weight given as >100kg).

Bariatric ECMO transfers require the appropriate stretchers for each vehicle type. Planning for bariatric ECMO transfers should also refer to Bariatric Transfer HOP.

3.5 EQUIPMENT:



The Cardiohelp is the standard ECMO device that is used if the patient is not already supported with ECMO at the referring hospital. The ECMO team provides the Cardiohelp. However, there are times when a patient may already be established on ECMO at the referring hospital and the machine being used may be the Rotaflow. The two devices have crucial differences which impact on the mode of transport used.



3.5.1 Cardiohelp

Weight 10kg

Battery Life: 90min

DC 28V or AC 240V compatible

EMI rated for AW 139 and Air Ambulance B350 aircraft.

Pump and oxygenator sit **INSIDE** the console

Standard retrieval bridges are required.

For use in road retrieval ambulances, fixed wing and AW 139.

3.5.2 Rotaflow

Weight: 15kg

Battery life: 90mins

AC 240V

Pump and oxygenator sit **OUTSIDE** the console. The multiple parts mean Rotaflow transfers are only to occur in MPV or FW

Require MPV extension bridge

Take bariatric ventilator kit from retrieval base

The tie down straps used to secure the Zoll monitor in the MPV will secure the Rotaflow to the MPV bridge.

3.5.3 Extra Equipment

Depending on the chosen cannulation site, ECMO circuit length must be sufficient to allow for a variety of mounting options discussed below

ECMO transfers are often very protracted. Battery life, drug infusions and oxygen supply need to be considered.

Patients are often on multiple infusions, extra syringe drivers may be required

During transfer from the hospital to the vehicle, two sources of oxygen will be required for the ventilator and the ECMO unit.

Typical oxygen requirements for the ECMO device are 2-5L/min via standard flow meter.

3.6 VEHICLE TYPE

Cardiohelp

Road:

The ECMO device can be strapped on top of the middle workstation of a Mercedes Sprinter Ambulance, including the retrieval road ambulances. (Figures 1 and 2).



When loading the patient the ECMO device should be passed forward first and “staged” on the rear seat as circuit length permits.

The perfusionist should sit within reach of the device, with the retrieval doctor in the second clinical seat. The retrieval paramedic should travel in the front of the vehicle. Note that in the rare circumstances of a combined ECMO/IABP transfer the NSW retrieval ambulance is the only vehicle that has a dedicated IABP loader.

MPV:

For ECMO transfers requiring the use of the MPV, the MPV Duty Officer at the Sydney Operations Centre should be notified, and extra time allowed for the vehicle and team to be arranged. The ECMO device and Zoll X-series monitor can be secured to the bariatric retrieval bridge carried on the current generation of bariatric vehicles.

AW 139:

In the case of a helicopter ECMO transfer, a height adjustable trolley and concrete helipad is required at each end. Where this is not available an ambulance transfer will be required from the nearest suitable landing site. Note that St Vincent's Hospital has no helipad. Depending on the time of day and anticipated traffic, suitable landing sites may include Bankstown Base or another hospital (eg RPAH, RNSH).

Bariatric stretcher and extension foot plate are required (Figures 3 and 4). To avoid microbubble formation due to vibration a foam mat is required under the pump unit.

To avoid draining the aircraft battery and potentially damaging voltage spikes the ECMO unit should only be plugged into the aircraft rectifier once the second aircraft engine has started.

Fixed Wing Aircraft:

ECMO transfers can be done on the B350 Air Ambulance aircraft. In these cases the Senior Flight Nurse should be notified and will be responsible for arranging the equipment and staff.

A second flight nurse is required for these flights. Hence two road ambulances will be required at the referring hospital end for transport of equipment and crew from and to the local airport.

For interstate transfers, road vehicles will be arranged by the AMRS. In Queensland and South Australia, an MPV should be requested. For the ACT, a standard Mercedes



ambulance should be requested from Queanbeyan station. Note that at this time Ambulance Victoria are not able to provide a suitable road vehicle for ECMO jobs.

The bariatric (special purposes) stretcher must be used. During the aircraft leg an ECMO attachment plate is secured to the foot end of this stretcher, and the ECMO device attached in its bracket onto the plate (Figure 5).



Rotaflow

MPV vehicle required with bridge extension (will need to request this during initial conference call). (Figure 6)

3.7 KEY TIMINGS

Depending on patient factors, choice of vehicle and distances involved, an ECMO transfer might be expected to take between six and twelve hours to effect. Where possible a fresh team during daylight hours should be tasked.

The cannulation and stabilisation of the patient by the ECMO team typically requires 45-60 minutes. At the time of the initial conference call the mode of transport of the ECMO and Retrieval teams to the patient should be determined. The AOC is responsible for making these arrangements.

Where possible the ECMO and Retrieval teams should travel together to the referring hospital. The ECMO team can meet the retrieval team at Bankstown base or be picked up en-route.

At times it may be preferable to arrange for advance deployment of the ECMO team to referring hospital by AW 139, Air Ambulance, or charter flight from Bankstown Airport. Within a 100km radius the ECMO team can travel by taxi using a Cabcharge provided by ASNSW. In these cases the retrieval team should aim to arrive at the referring hospital no later than 45min after the ECMO team.

If a road transfer is planned, the MPV duty officer at Sydney Operations Centre will arrange for a road crew to man one of the vehicles. This may take time to organise.

3.8 CLINICAL CONSIDERATIONS

Although the perfusionist's primary consideration is the operation of the ECMO device, they can be highly experienced cardiac anaesthetists. Clinical decisions should be made in close consultation while maintaining clear role delineation.

Prior to commencement of ECMO please discuss anticipated difficulties, special requirements and haemodynamic goals with the ECMO specialists

3.8.1 Cannulation

These procedures have the potential for massive blood loss and haemodynamic instability
Ensure that the patient has large bore IV access



2 units of packed cells crossed matched or in the room

Preparedness to manipulate and titrate vasopressors and inotropes as required

3.8.2 Oxygenation and Ventilation:

Veno-venous configuration

The aim of VV ECMO is to oxygenate and ventilate the patient

Oxygenation and ventilation is determined by the cannula size, flow rate and sweep speed

Effective oxygenation occurs when > 60% of the patient's cardiac output is captured by the ECMO circuit. In high cardiac output states eg sepsis, this may be difficult to achieve. Aim for an SpO₂ > 85%

The primary aim of VV ECMO is to allow for least damaging lung ventilation whilst still facilitating oxygenation and CO₂ removal. Atelectrauma can be avoided with the application of PEEP, reduced TV (3-4ml/kg), PIP < 30 and an FiO₂ < 0.5

It is not uncommon for patients to de-recruit and lose TV once established on ECMO, TV should not be increased at the expense of raised transpulmonary pressures.

Veno-arterial configuration

The aim of VA ECMO is to provide circulatory support to end-organs. The primary aim is NOT ventilation.

If oxygenation is an issue then a hybrid configuration of ECMO eg V-AV needs to be considered.

Blood returning from the lungs to the heart is preferentially ejected by the native circulation to the cerebral and coronary circulations. If the lungs are not returning oxygenated blood to the heart this will result in cerebral and coronary ischaemia. It is therefore CRUCIAL that the VENTILATOR IS NOT TURNED OFF AT ANY STAGE.

Ventilator strategies are similar to those employed for VV ECMO perhaps with more of an emphasis on reducing RV strain.

SpO₂ measurements should be taken from RIGHT HAND as this is the furthest point from the blood returning from the ECMO circuit and will be a surrogate marker of systemic perfusion.

3.8.3 Circulation

Significant cardiac dysfunction should prompt VA ECMO at the time of cannulation.



A period of haemodynamic instability can occur in the initial commencement of the ECMO run. Be prepared to volume resuscitate and titrate vasopressors as required.

Once the ECMO run is established, inotropes and vasopressors may be weaned for a variety of reasons, including reduction in the acidosis that was causing myocardial depression and a decrease in intrathoracic pressures resulting in improved venous return.

During VA ECMO loss of pulsatile flow leads to loss of arterial pressure wave; MAP is reliable.

Cardiac arrest should be treated along standard lines, noting however that in the case of VA ECMO the patient's circulation is supported by the pump even during cardiac arrest.

3.8.4 Neurological

Many of the sedation agents used are dialysed through the pump. Long acting agents like morphine and midazolam should be used for sedation with plenty of redundancy taken for transfer. Expect to need to run the sedation at a higher rate than is usually required.

3.8.5 Trouble shooting

Utmost care should be exercised during patient handling to avoid kinking or disconnection of the circuit, air entrainment, or de-cannulation, which may cause serious patient harm or death. All 3-way taps in the circuit should have bungs and have stopcocks closed during transport.

Access Insufficiency

- CAUSE:** Vein containing cannula is collapsing around cannula causing a "suck down" effect
- SIGNS:** Kicking of the line; unable to maintain circuit flows- unstable or dropping flows
- CAUSES:** Decreases in venous return (hypovolaemia; cardiac tamponade; coughing/straining; acute vasodilation (sedation bolus); increased abdominal pressure); excessive RPM/pump speed.
- TREATMENT:** Drop the revs; give volume; remove the obstruction; consider a second cannula.



Hypoxia on VV ECMO

CAUSE: Shunt

Shunt is the blood that enters the arterial system without going through the pump. Shunt will occur when $CO > ECMO$ blood flow. If patient is hyperdynamic eg circulation running at 10L/min your ECMO circuit is only going to capture 5L/min. There is always going to be a shunt unless you match the patient's cardiac output with the ECMO flow

TREATMENT: Increase the ECMO flow ie increase the proportion of venous return going to the oxygenator; Increase your oxygen carrying capacity by improving your Hb; Increasing the O_2 will not improve this (just like a physiological shunt)

Recirculation

CAUSE: Oxygenated blood from the return cannula is drained by the access cannula prior to entered the systemic circulation

SIGNS: Low arterial SaO_2 and high access cannula SaO_2 is an indication this is occurring; pulsating blood in the access line; flashes of bright red blood in the access line; access line and return line are the same colour.

TREATMENT: Access cannula needs to be 10-12cm away from drainage cannula otherwise you start to get recirculation



APPENDICES

Figures 1 and 2 – ECMO Device on Retrieval Road Ambulance

Figures 3 and 4 – Bariatric stretcher extension foot plate in AW139

Figure 5 – ECMO attachment plate and device attached in its bracket onto the plate in Fixed Wing

Figure 6 – MPV vehicle bridge extension

REVISION HISTORY

Version (Document #)	Amendment notes
Version 3.0 WI2020-079 Issued 29 July 2020	Comprehensive update including: Rotaflow/CardioHelp procedures Vehicle specifics Troubleshooting guide Transition to new template and naming convention Approved by A/Executive Director, Aeromedical Operations
Version 2.0 Issued 2014	Updated to new version Approved by Executive Director, Health Emergency & Aeromedical Services
Version 1.0 Issued April 2013	Approved by Executive Director, Health Emergency & Aeromedical Services.



Figure 1 - ECMO Device on Retrieval Road Ambulance





Figure 2 - ECMO Device on Retrieval Road Ambulance

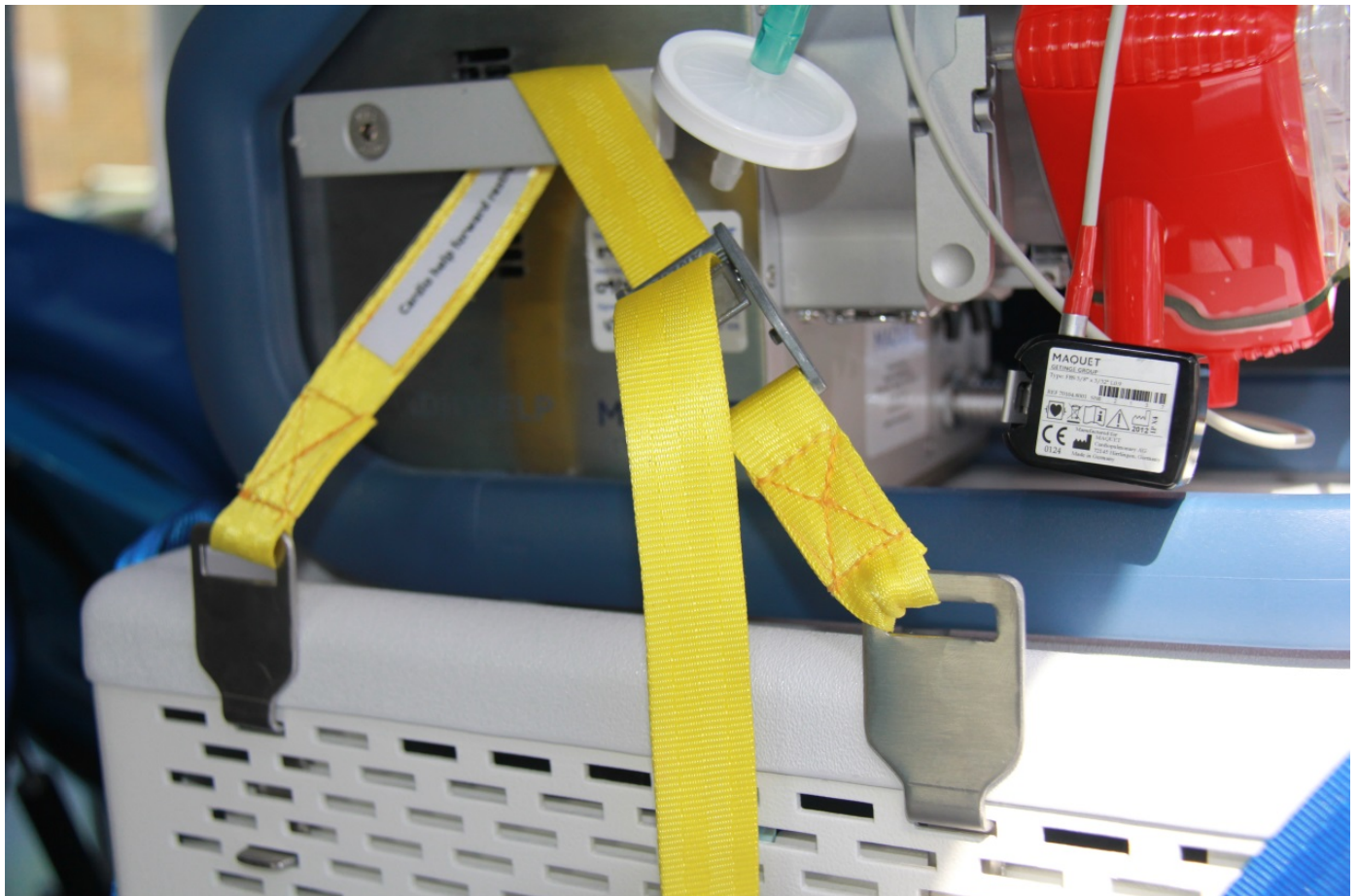




Figure 3 - Bariatric stretcher extension foot plate in AW139

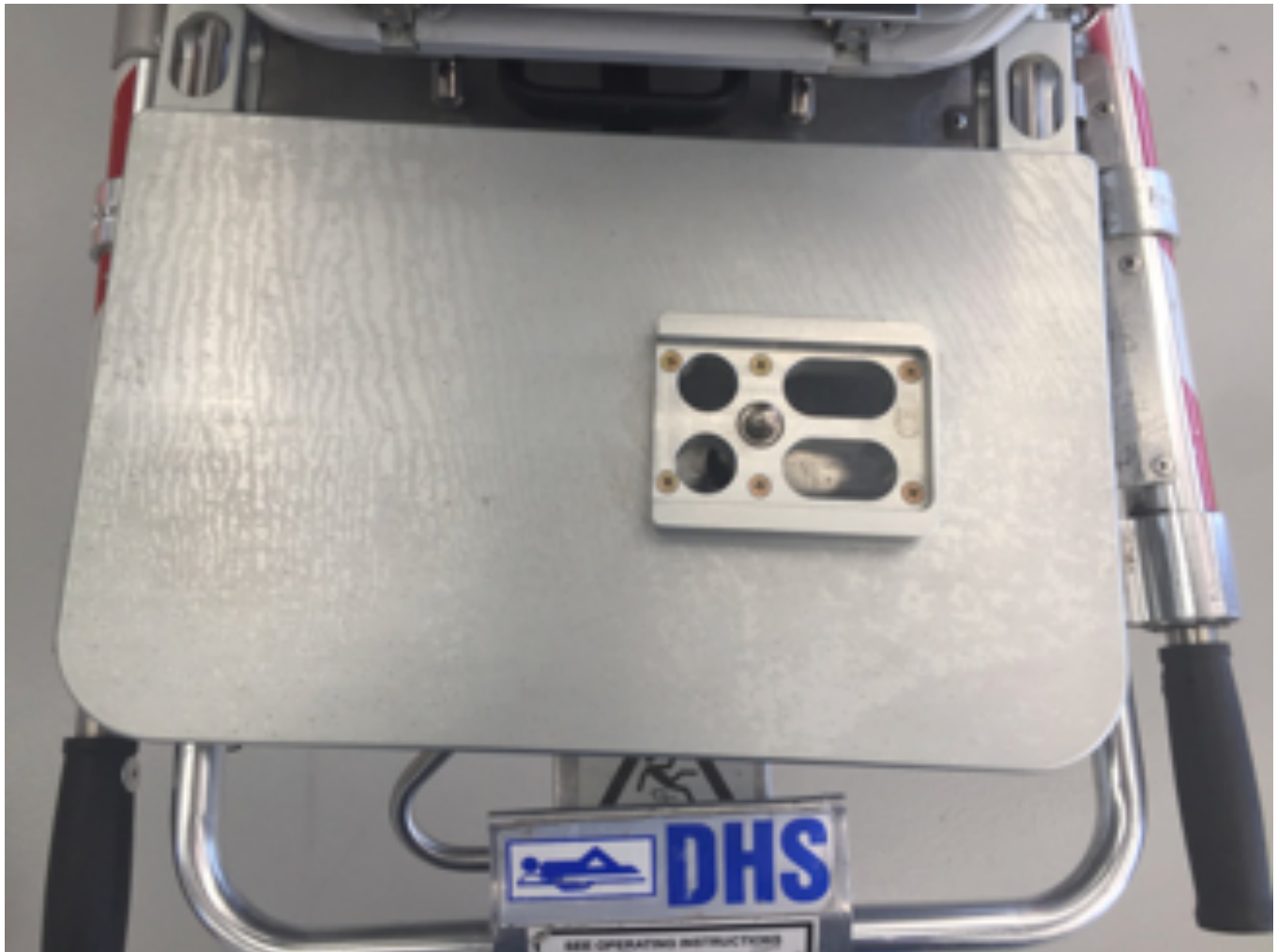


Figure 4 - Bariatric stretcher extension foot plate in AW139

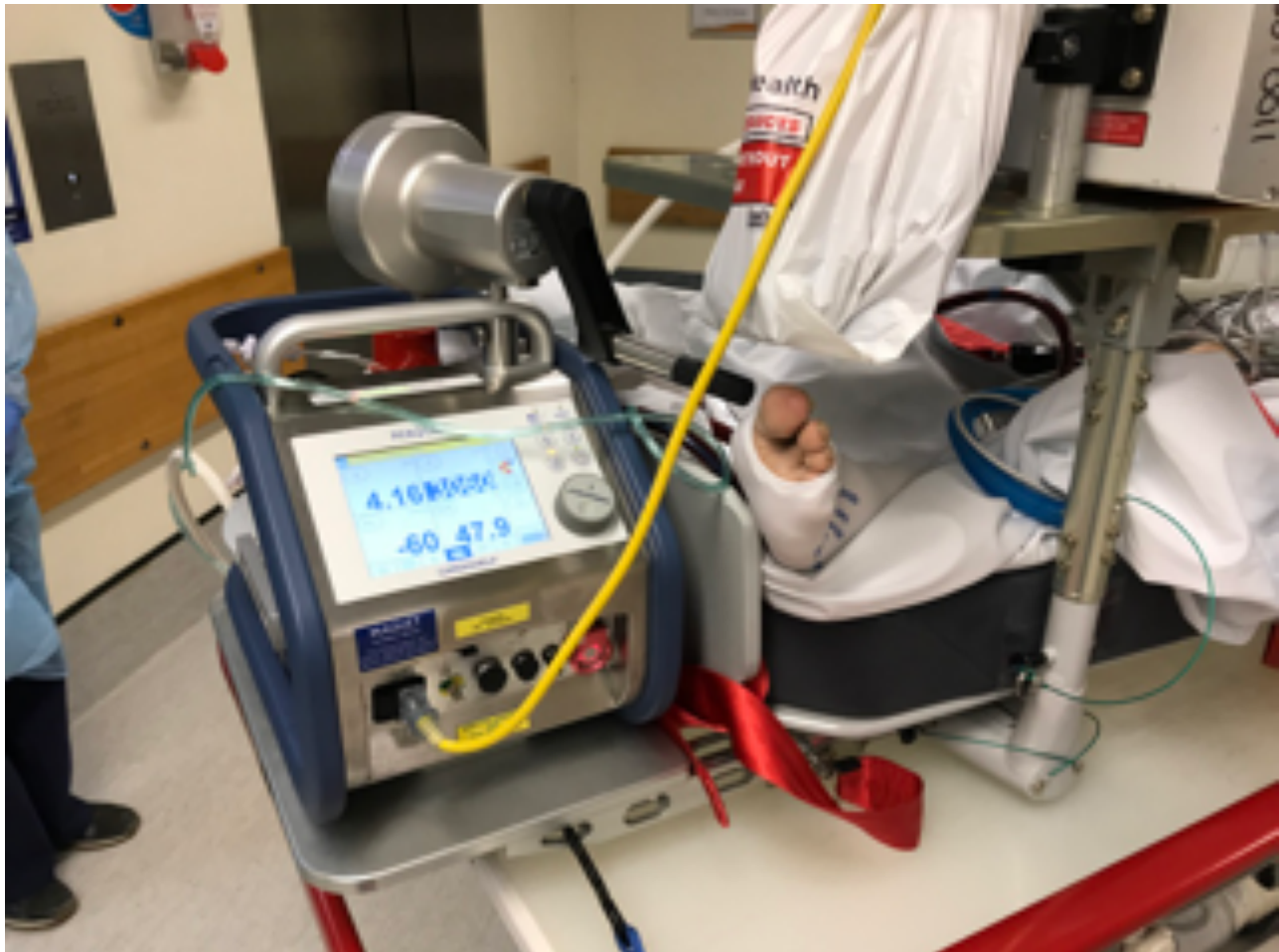


Figure 5 - ECMO attachment plate and device attached in its bracket onto the plate in Fixed Wing





Figure 6 - MPV vehicle bridge extension

