The Heart Link / ECMO Programme

ECMO CentriMag Protocols Neonatal, Infant & Paediatric

Staff relevant to:	All UHL ECMO team members
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The Heart Link / ECMO Programme

ECMO CentriMag Protocols

Neonatal, Infant & Paediatric

This protocol manual contains clinical recommendations to be used for initiation, care and management of patients requiring Extracorporeal Life Support in the Adult Cardiac & Paediatric Intensive Care Units at Glenfield Hospital, Leicester and are therefore exempt from responsibility for its use outside of this institution.

All procedures in this manual should be used in conjunction with hospital policies, procedures and guidelines.

Please ensure that a Datix incident form is completed (http://insite.xuhl-tr.nhs.uk/homepage/clinical/incident-reporting) for any patient or circuit related incidents. This is to aid best practice and for audit & monitoring purposes.

Standard hand washing, appropriate gloving and sterile techniques should be used during any intervention on the ECLS circuit and patient, as per infection control policies and procedures.

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Title: **Admission Of Patients For ECMO (Duty ECMO Co-ordinator / ECMO Specialist Action)**

Description: To ensure the smooth running and efficient admission & cannulation of a patient onto ECMO

Personnel:
- Duty ECMO Consultant
- Duty ECMO Co-ordinator
- ECMO Specialist
- Theatre Team
- Transport Team
- Anaesthetist / Intensivist
- Paediatric / Cardiothoracic Registrar
- Cardiology Consultant / Registrar
- Radiographer On-call
- Haematologist On-call
- Perfusionist
- Nurse
- ODP

Equipment:
- ECMO Emergency Cart
- ECMO Cannulation Trolley
- Emergency Drugs / Fluids
- Hemochron Signature Elite ACT Machine
- Cannulation Drugs (as prescribed)
  - Heparin
  - Antibiotics
  - Ketamine
  - Atracurium
- Lead Aprons
- ECMO Documentation

ECMO Specialist Action:

1) Collect information on patient from ECMO Co-ordinator prior to patient admission - age, weight, condition, referral hospital and estimated time of arrival (ETA). * Duty ECMO Co-ordinator will inform the Nurse in Charge, Duty Intensivist & medical staff of referral and keep all staff members updated with regards to ETA.

2) Liaise with ECMO Co-ordinator for updated information.

3) Check and prepare essential equipment & ECMO cart.

4) Prepare ACT Heparin infusion:-
   5,000iu Heparin in 50mls 5% Dextrose for patients (<10kg)
   10,000iu Heparin in 50mls 5% Dextrose for patients (10kg - 30kg)
   20,000iu Heparin in 40mls 5% Dextrose/Normal Saline for patients (>30kg)

Title: ECMO Levitronix CentriMag Protocols – Neonatal & Infant UHL Children's Intensive Care
V: 3 Approved by: UHL Children's Quality & Safety Board: October 2023 Next Review: October 2026
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Prepare bolus dose Heparin for Anaesthetist / Intensivist to administer during cannulation:- 75iu Heparin/kg (to Theatre Team) or as directed by Duty ECMO Consultant.

Prepare infusions with Bedside Nurse as prescribed by medical team on CPICU.

5) Prepare / complete all necessary documentation:-
- Admission Form
- Parameter Sheet
- ECMO Chart
- ELSO Form (Duty ECMO Co-ordinator)
- ECMO Specialist Evaluation Form

NB: *Be aware of documentation for any research studies*

6) Prepare all necessary equipment for ACT monitoring.

7) Assist Perfusionist, as per Perfusionist's instructions.

8) When patient arrives, ensure unit of X-matched blood is available as soon as possible.

9) Ensure Nurse takes patient's blood for analysis.

10) Order appropriate blood products and ensure X-matching is performed.

11) Assist Nursing / Theatre / Medical / Perfusion Staff where needed, document time of cannulation / type of cannulae used and take formal handover from Perfusion.

12) Consider antibiotic cover at cannulation, for example Gentamicin: 2mg/kg. Flucloxacillin: neonates / paediatrics to a maximum of 25mg/kg and adolescents 1g. * check allergies *

13) Commence Heparin infusion once ACT is <250 seconds – monitor hourly until in prescribed range. Please refer to Heparin management policy / parameter sheet.

14) Commence Heparin on central venous access line or designated port on ECMO circuit (designated 2nd pigtail). Once ACTs are stable & within prescribed range, monitor 4 hourly or as directed on Parameter Sheet.

15) Perform a complete circuit check and document accordingly.

16) Perform chest x-ray post cannulation.

17) Monitor blood gases as required and maintain within prescribed parameters by adjustments to flows / sweep.

18) Ensure all necessary documentation is completed.

All VV ECMO cannulations are to be performed under x-ray screening in Theatre, unless severe instability of the patient mandates emergency cannulation in the ITU

Personnel Involved

Duty ECMO Consultant, Intensivist, Duty ECMO Co-ordinator, Perfusionist, ECMO Specialist, On-call Radiographer (need 30 minutes notice), Nurse, Transport Team, Cardiology SpR & Theatre Team

Comments (for guidance only)

- Maximum flow veno-venous ECMO patients < 10kg = 120ml/kg
- Maximum flow veno-arterial ECMO patients < 10kg = 100ml/kg
- Maximum flow veno-venous ECMO patients > 10kg = whatever is achievable due to limitations in cannula size
- Maximum flow veno-arterial ECMO patients > 10kg = whatever is achievable due to limitations in cannula size

Single Care: Applies To All Cases

This is standard practice for all ECMO patients. The Nurse Specialist: patient ratio is only changed to 2:1 if clinically indicated. This must be reviewed by the Duty ECMO Co-ordinator & Nurse in Charge jointly on a daily basis or if clinically indicated.

Accommodation

On acceptance of a patient for consideration of ECMO, the Duty ECMO Co-ordinator will inform the Nurse in Charge, Duty ECMO Specialist & Bedside Nurse of the ETA. Part of the admission process requires the Bedside Nurse / Specialist to book accommodation for the relatives (one room). This must be arranged in advance of the patient & family arriving at UHL. Any difficulties in securing accommodation needs to be escalated to the Duty ECMO Co-ordinator for further action.

In the event of no availability of accommodation, the Duty ECMO Co-ordinator will communicate directly with the transport team to make them aware of the situation. The family / relatives will then be informed during the assent process.

Title: **Documentation Protocol**

Description: To ensure all ECMO Specialists are familiar with and know how to complete the ECMO Specialist Documentation

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Document:

ECMO Patient Admission Form

To be used for each patient on admission for ECMO.
All sections to be completed by the Specialist on duty at the time of admission.
The reverse of the form is to document existing IV lines or skin damage etc that the patient arrives with, any IV lines that remain in once cannulated and any other relevant information.

ECMO Specialist Evaluation Form

One form to be completed by the Specialist for the shift worked.

Perfusion ECMO Record

To be completed by attending Perfusionist and handover to take place with Duty ECMO Specialist.

ECMO Chart

This is for hourly recording of patient and circuit observations.

Parameters Form / Physicians Orders

To be completed and reviewed daily by the ECMO Consultant / Intensivist, Duty ECMO Co-ordinator & ECMO Specialist.

Trial Off Form

This form documents each trial off ECMO and is completed by the Specialist during each trial off.

ELSO Registry Form

Should be completed for each ECMO patient by the Duty ECMO Co-ordinator & updated accordingly.

Inter-department Transfers

Checks need to be completed on handover.

Title: ECMO Cart (Emergency Drawer)

Description: Checklist for ECMO Specialist
Personnel: ECMO Specialist

Equipment:
Cable Tie Gun
Goggles
Sterile Gloves
Sterile Scissors
Tie-Straps
Chlorhexidine Spray / ChloraPrep Stick
Rapid Access IV Giving Set
50ml Luer Lock Syringe
1 x 500ml bag of 0.9% Hepsaline For Patients < 10kg
2 x 500ml bags of 0.9% Hepsaline For Patients > 10kg
Emergency Change-Out Box to include Connectors appropriate to tubing size / circuit configuration
Blue Box *****
Grey Box *****
***** (Assessment required to determine individual circuit components)

ECMO Specialist Action:

Action:	**Rationale:**
Ensure supplies are checked at the beginning of each shift	To ensure cart supply is ready in case of an emergency
Ensure above supplies are available and at hand at all times in case of circuit emergency	For immediate use in circuit emergency
Ensure absent items are replaced – absent items to be notified to Duty ECMO Co-ordinator and replaced immediately	To minimise delay in an emergency
Full assessment required to determine individual components relating to circuit configuration	To ensure the emergency change out box is sealed and in date – only to be opened in an emergency Expiry date must be checked

Title: Emergency Communication Protocol

Description: To ensure the ECMO Specialist is aware of the procedure for obtaining assistance if an ECMO emergency occurs

Personnel: ECMO Specialist
Nurse
On-call ECMO Team
- Duty ECMO Consultant
- Duty ECMO Co-ordinator
- Perfusionist
- CPICU Medical Team (Resus)

ECMO Specialist Action (in the event of an ECMO emergency):

1) Call for assistance.
At least three people are required:-
- One Nurse to hand ventilate & monitor the patient
- One person to telephone for support / instructions
- One person to assist the ECMO Specialist

Each person should be aware of his / her responsibilities and directed by the ECMO Specialist.

2) The ECMO Specialist must attempt to deal with the cause of the emergency immediately. The circuit is the total responsibility of the Duty ECMO Specialist.

3) Telephone numbers and on-call rotas are held at Switchboard.
In the event of circuit failure, call 2222 and ask for the ECMO Team to be called.
State “ECMO emergency, bed space number, CPICU, Kensington Level 5, Leicester Royal Infirmary”.

Title: **Dressing Cannulation Site**

Description: To apply dressing to cannula site following cannulation & redress PRN

Personnel: ECMO Specialist
Nurse

Equipment: Dressing Pack
Clear Occlusive Film Dressing
Normasol
Barrier Film Stick Applicator

ECMO Specialist Action:

Action:	Rationale:
Clean trolley as per unit protocol, wash hands and set up trolley as per UHL policy	Observe universal precautions
Remove existing dressing	
Observe cannula site for redness / swelling / breakdown of skin / sloughing – refer to Tissue Viability for further advice / opinion	To inform Duty ECMO Consultant / Duty ECMO Co-ordinator of skin condition
Ensure cannula sites are sutured securely Document placement of cannula by using markings on the cannula & reviewing chest x-ray – each Specialist to review at the start of each shift. Take a photo for Nervecentre	To prevent inadvertent decannulation Any issues, escalate to Duty ECMO Co-ordinator / Duty ECMO Consultant for further action & intervention
Clean wound observing asepsis as per UHL IV dressing policy	As above

If cannula site is oozing, apply pressure with small folded gauze & call the Duty ECMO Consultant or Surgical Assistant for further assessment regarding potential surgical intervention Also notify Duty ECMO Co-ordinator	To try to reduce oozing To aid assistance / communication
If there is excessive bleeding from the cannula site, perform a clotting screen and inform the Duty ECMO Co-ordinator / Duty ECMO Consultant for further advice & assistance	Surgical / medical intervention may be required
If cannula site is red or infected, take a swab – see Infection Screening Protocol (page 13)	
Redress; applying clear occlusive dressing Following assessment indication of use – use Barrier Film Stick prior to application of Clear Film Dressing	To prevent excoriation of the skin due to repeated dressing of the cannulation site
Dispose of waste & ensure patient comfort	

Title: Infection Screening

Description: To ensure the screening is in line with Trust protocols

Personnel: ECMO Specialist & Nurse allocated to patient

MRSA & MC&S
Ensure full MRSA, COVID and MC&S screens are performed & blood cultures taken within the first 24 hours of a patient's arrival.

Monday
Full MRSA screens to include wound sites and ECMO cannulae.
Also swab the ECMO cannulae for MC&S.
Perform WCC & Differential.

Only swab wounds and other invasive sites if they look infected.
Compulsory - Send urine, sputum and swabs for MC&S.

Please refer to MRSA / MC&S Screening Form – available on CPICU.

Title: Performing The Activated Clotting Time (ACT)

Description: To perform the ACT test from circuit access port (1st Pigtail)
Personnel: ECMO Specialist

Equipment:

Hemochron Signature Elite Test Cuvette	Gloves
Hemochron Signature Elite ACT Machine	Steret
1ml & 2ml Leur Lock Syringes	Bungs (Red)

ECMO Specialist Action:

Action:	Rationale:
Gather equipment & wash hands	
Remove the ACT – LR test cuvette from packaging & insert the test cuvette into the side of the Hemochron machine	
Once the Hemochron cuvette test is ready, it will signal with an audible tone (beep) and the display will indicate 'add sample & press start' – please note, the Hemochron cuvette test will remain in the ready mode for 5 minutes	
Clean arterial sample port using steret	
Attach a 2ml syringe to the 3-way tap	
Turn tap on & aspirate 2mls, then turn tap off	
Set aside this syringe and replace with a 1ml syringe	

Turn tap on & withdraw 0.2ml, then turn tap off	
Immediately dispense 1 drop of blood into the sample well of the pre-warmed ACT – LR test cuvette ~ fill the sample well from the bottom up with the blood	
Press the start key on the Hemochron machine	To start timing immediately blood starts to clot
Test completion will be indicated by a single bleep	
The ACT – LR result is automatically converted to a reference Celite ACT result and displayed as the Celite equivalent result in seconds ~ while on ECMO an ACT – LR value of 200 - 220 seconds is the recommended range or as prescribed by the Duty ECMO Consultant / Duty ECMO Co-ordinator * Always refer to the prescribed parameter sheet for guidance *	
Document the result on the ECMO Specialist Chart	
Dispose of equipment properly	Health & Safety

Title: Heparin Management

Description: To ensure safe & smooth running management of continuous Heparin infusion (to patient's central venous access)

Personnel: Duty ECMO Consultant
Duty ECMO Co-ordinator
ECMO Specialist

Equipment:

Heparin (1,000iu/ml)	Dilution Fluid
50ml Luer Lock Syringe	Syringe Pump
Hemochron Signature Elite ACT Machine	Infusion Line
Hemochron Signature Elite Test Cuvettes	3-way Tap

ECMO Specialist Action:

Action:	Rationale:
Heparin infusion must be connected & administered to the ECMO Circuit (designated 2nd pigtail) Heparin to commence when ACT <250 seconds – refer to parameter sheet for prescribed range Please titrate & follow the protocol for Heparin management until ACTs are within the prescribed range * Always refer to the prescribed written parameters *	To ensure continuous administration of Heparin infusion to the patient's central venous line
Ensure Heparin infusion is being delivered & administered as prescribed according to ACTs – these must be performed as per ECMO protocol Clotting screen to be performed twice daily – refer to parameter for guidance	To ensure correct dose & strength of Heparin is being administered, as prescribed To prevent coagulation of the circuit

Heparin Concentrations

5,000iu Heparin in 50mls 5% Dextrose for patients (<10kg)
10,000iu Heparin in 50mls 5% Dextrose for patients (10kg - 30kg)
20,000iu Heparin in 40mls 5% Dextrose/Normal Saline for patients (>30kg)

Above concentrations may need to be revised for patients with severe coagulopathies and therefore management is dependent upon the individual ACT / clotting results and written parameters – as directed by the Duty ECMO Consultant / Duty ECMO Co-ordinator

ACTs need to be monitored until within prescribed range Please sample ACTs from the designated port on the ECMO circuit (1st Pigtail) – please refer to Parameter Sheet for guidance / prescription *NB: Never discontinue a Heparin infusion – this is the decision of the Duty ECMO Consultant* *The Duty ECMO Co-ordinator must be informed of this decision*	To prevent clot formation in the circuit
Ensure Duty ECMO Specialist is aware of ACT parameters – documented & prescribed on the daily parameter sheet	Changes may be made, depending on the patient's status
Any concerns, contact the Duty ECMO Consultant / Duty ECMO Co-ordinator	For escalation to Duty ECMO Consultant / Duty ECMO Co-ordinator for advice and instruction

Title: Clamping On & Off ECMO

Description: Clamping patients on and off ECMO
Personnel: Duty ECMO Co-ordinator
ECMO Specialist
CPICU Medical Team

Equipment: Clamps x 2
Hand Ventilation Equipment
Emergency Drugs (as required)

ECMO Specialist Action (for elective period off ECMO):

Action:	Rationale:
Clamping off VV / VA ECMO: Clamp circuit **A** (clamp 1 - return to patient), then clamp circuit **V** (clamp 2 - drainage from patient)	To prevent cavitations in centrifugal head
When clamps are released, release **V** drainage line (pre-pump) then **A** the return line (post-pump) - V/A and check integrity of the tubing where the clamps have been placed *NB*: The pump should be turning before releasing the return line (post-pump)	To ensure patency

Comments

Ensure emergency drugs are available at all times and all IV lines are accessible & patent to ensure patient stability whilst off ECMO support.

Insertion of patient bridge into the circuit may be required – please refer to protocol for insertion of the patient bridge (page 34).

Title: Sampling – Post Oxygenator Gas

Description: To determine the function of the oxygenator(s)
Personnel: ECMO Specialist
Equipment: 2 x Luer Lock 2ml Syringes
1 x Gas Syringe
2 x Sterets
1 x White Cap

ECMO Specialist Action:

Action:	Rationale:
Gather supplies	To prepare for task
Identify P2 (red pressure line, post oxygenator) as sample port for post oxygenator gas	To ensure consistency in practice between all ECMO Specialists
Remove white cap, wipe with steret * & attach Luer lock 2ml syringe to P2 3-way tap port * Sampling / administration – allow to evaporate	To maintain asepsis 'scrub the hub' – refer to UHL Infection Control Policy / Guidelines
Turn 3-way tap on to 2ml Luer lock syringe & withdraw 2ml of blood (this sample must be kept to one side to be returned pre oxygenator post procedure using aseptic technique) – best practice to return sampled blood to a pigtail between pump head & oxygenator This sample must only be returned if no clots are observed	To prevent air entrainment / clots return to the patient
Turn 3-way tap off to the circuit, attach second 2ml Luer lock syringe & aspirate 1ml of blood	To ensure patient / Specialist safety

Inject the sample in to the gas syringe	
Clean the 3-way tap with a steret & replace with a white cap	To maintain asepsis
Ensure 3-way tap is back on to the circuit checking & ensuring P1 & P2 readings are active, process the sample & document results / actions	To ensure consistent monitoring
Flushing & calibrating P1 & P2 is recommended at this time – please refer to transmembrane flushing & calibrating protocol	

Comments

- Sample as indicated.
- Please refer to the prescribed daily parameters for post oxygenator values.
- Any variation to the prescribed range must be escalated to the Duty ECMO Co-ordinator.
- Further discussion will then be held with the Duty Perfusionist & Duty ECMO Consultant for further advice & instruction.

Title: **Trans-membrane Pressure Monitoring**

Description: To replace Transducer Lines, flush Transducer Lines and recalibrate & set alarms

Personnel: ECMO Specialist

Equipment: 2 x 50ml, 20ml or 30ml Luer Lock Syringes for each pigtail with pressure monitoring attached (P1 & P2)
Flush Bag (Saline)
Transducer Set (Triple Transducer Set)
2 x Sterets

ECMO Specialist Action:

Action:	**Rationale:**
<u>To Replace Transducer Sets</u> (every 7 days) • Ensure that the transducer lines are primed • Ensure change-out of 3-way taps is performed as per protocol prior to changing new transducer set • Turn off the three-way tap at the oxygenator and attach primed transducer set to three-way tap • Scrub the hub with a steret; leaving to dry for 30 seconds prior to replacing white cap • Ensure pressure bag is inflated to 300mm Hg • Ensure roller clamp is closed unless directed otherwise	Routine change-out of transducer set is not required unless clinically indicated Refer to UHL Infection Control Policy / Guidelines routine 'scrub the hub'
<u>To Flush Transducer Lines</u> • Attached 2ml luer lock syringe to three-way tap at oxygenator side of transducer line (aspirate 1ml sample to ensure patency of pigtail)	To maintain patency and remove back flow of blood

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• Turn off to circuit, attach 50, 30 or 20ml luer lock syringe to 3-way tap • Flush using flushing device from transducer sets • Turn tap back on to circuit, discard syringe, wipe with steret & attach new white cap	
<u>To Recalibrate</u> • Remove the cap, turn the transducer 'off' to the oxygenator and open the line to air • Access menu • Scroll down until 'Pressure Menu' highlighted • Scroll down until 'Pressure Calibration' highlighted • Press 'Cal P1' and 'Cal P2' until '0' is seen • If a '(0)' does not appear recalibrate as above • Once calibrated, turn the transducer to the 'on' position • Replace caps	To calibrate

<u>Comments</u>

P1 = pre-oxygenator pressure (Blue Transducer Line)
P2 = post-oxygenator pressure (Red Transducer Line)

If the patient is off Heparin flushing and calibrating may lead to oxygenator failure and should only be performed if instructed to do so by the Duty ECMO Co-ordinator or Consultant.

To flush & recalibrate at the start of each shift during the full circuit check.

If changes in the gradient are noted, please inform the Duty ECMO Co-ordinator immediately.

The pressure gradient serves as a trend – any deviations from the trend must be escalated for advice / intervention to Duty ECMO Co-ordinator (guide 50mmHg). Reduced flow, unresponsive to a fluid bolus for any given rpm is cause for concern and requires escalation.

Title: Administration Of Drugs & Blood Products

Description: The safe & appropriate administration of prescribed drugs & blood products in line with unit guidelines and UHL policy

Personnel: ECMO Specialist
Nurse

Equipment:
Drug
Dilutent
Dispensing Pin
Blood Product
Three-way Tap Connector
Giving Sets / Syringe
Bungs (White)

ECMO Specialist Action:

Action:	**Rationale:**
Check prescription chart / patient	Identity bracelet in place, as per UHL blood transfusion policy
Check product	For correct dose, correct dilution, expiry date, correct blood product & correct blood group
<u>Prepare drugs</u> As per UHL policy <u>Prepare blood products</u> Using appropriate filter and giving set	
Use a suitable port on the patient's central or other IV access to administer drugs / blood products *i.e. Blood into available ports on the circuit (for example identify pigtails between the pump head & oxygenator) only when no patient central or IV access is available – in adherence to the UHL drug administration policy*	To infuse as quickly as is required

All clotting factors directly to the patient or post oxygenator if administered directly into the circuit Administer bolus drugs into drug port only if IV access is compromised TPN must be administered on a designated line in adherence to the UHL TPN administration policy All other infusions must be administered to either an available pigtail or directly to patient's central access	To prevent destruction in oxygenator
Administer bolus or continuous infusions and ensure infusion pumps are checked hourly & administering correctly *NB: Ensure strict hand hygiene and non-touch technique*	For patient safety
Observe patient for side effects & reactions and stop infusions / inform Medical Staff as necessary	For patient safety

Title: Procedure For Applying & Removal Of Tie-straps

Description: Assess Tie-strap security and remove & replace as required
Personnel: ECMO Specialist
Perfusionist
Duty ECMO Co-ordinator

Equipment: Tie-straps
Tie-strap Gun

ECMO Specialist Action:

Action:	**Rationale:**
All tie-straps are to be checked at the beginning of each shift and at hourly intervals thereafter – document on Specialist's Hourly Checklist	To check the security of each tie-strap regularly
Check tie-straps by supporting tubing using both hands and examine each tie-strap by twisting gently with thumb & finger to see if secure	
If tie-strap is loose, prepare for replacement – if loose move to one side (if possible) on to tubing	
Gather supplies	To aid timely change out
Place new tie-strap around the tubing (serrated edge to be placed onto tubing to grip) Pull to secure; hand tight only – ensuring the tie-strap is placed onto the connector, NOT directly onto the tubing	To prevent occlusion of the tubing / line otherwise flow will be reduced / lost to the patient creating an emergency situation

Place tie-strap in gun, support the connector & tubing with both hands and secure a tie-strap with the gun Discard excess strapping & observe newly applied tie-strap & connector *Do not use scissors in tie-strap removal - seek assistance from the ECMO Co-ordinator*	For a tight & secure fit

Comments

One tie-strap must be applied to each connector (minimum standard).

Tie-strap gun to be set on a standard setting 6 - 8 (there are two other settings: intermediate & minimum - the gun is designed to be used with different thicknesses of ties which have different breaking strains, so the user selects a number in relation to the tie used & the amount of curvature required).

Title: Insertion / Change-out Of A Pigtail

Description: To replace an ECMO circuit Pigtail
Personnel: ECMO Specialist
Nurse
ECMO Fellow
Duty ECMO Co-ordinator

Equipment: 3 x Clamps
1 x Pigtail
2ml Luer Lock Syringe
Gloves

ECMO Specialist Action:

Action:	**Rationale:**
Gather supplies and inform Nurse & relatives	To have everything at hand for quickness
Wash hands and put on gloves	To observe universal precautions
Attach Luer lock syringe to the three-way tap on the replacement pigtail	To prevent air embolus
Clamp tubing using clamps either side of the affected pigtail	To prevent blood loss when the old pigtail is removed
Disconnect the old pigtail and connect the new pigtail with the three-way tap & Luer lock syringe attached (an additional clamp may be used cautiously to remove existing clamp)	
Remove the clamp nearest to the patient, draw back to de-bubble, turn tap off to circuit and release 2nd clamp	The patient is the reservoir for aspiration

Comments

1) Do not tighten three-way taps with a clamp: they need to be hand tight only.
2) Do not loosen affected pigtails prior to removal.
3) The 3-way tap on a new pigtail is only loosely attached and requires manual tightening before insertion into the circuit.
4) Assessment must be made by the ECMO Specialist prior to a change-out – if inotropes / other dependant drugs are running to the circuit, the Specialist must ensure emergency drugs are available for immediate administration.
5) In a routine / planned change-out, the pigtail must be primed before connecting to the circuit – in an emergency an un-primed pigtail may be connected.
6) 2 x sterile white caps must be in place on all 3-way tap ports on the circuit to prevent air entrainment into the circuit – please remember 3-way taps must be turned off to the circuit, unless transduced.

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Title: Changing An ECMO Circuit Three-way Tap

Description: To replace an ECMO circuit tap at prescribed intervals and in the event of cracking / clotting

Personnel: ECMO Specialist

Equipment:
- 1 x Sterile Three-way Tap
- 2 x Sterets
- Gloves
- Clamp
- 2ml Luer Lock Syringe
- White Caps

ECMO Specialist Action:

Action:	**Rationale:**
Gather supplies	
Wash hands and put gloves on	Observe universal precautions
Attach tap to Luer lock syringe (2ml)	To remove air from the tap
Place steret package around the pigtail, then clamp the packet over the pigtail	To protect the pigtail from damage by the clamp
Whilst holding the pigtail, remove the old tap	
Wipe lightly with steret, then attach new tap onto the pigtail & remove clamp – aspirate using 2ml Luer lock syringe then turn three-way tap off to the circuit; discard 2ml syringe & replace with a white cap on to both ports of the 3-way tap	Substances in plastic may be degraded by excessive exposure to alcohol To prevent air entrainment

Comments

1) Notify the Nurse prior to change, particularly if IV infusions will be affected
2) All taps must be turned off to the circuit when not in use
3) Taps should be changed every 72 hours
4) Sample / drug port changed every shift

Title: Circuit Failure Due To Overwhelming Air

Description: To remove air from the circuit
Personnel: Duty ECMO Consultant, Nurse, Duty ECMO Co-ordinator
ECMO Specialist, Perfusionist
ECMO Emergency Call-out Team – 2222

Equipment: Luer Lock Syringe (appropriately-sized to aspirate air)
Gloves
Rapid Access IV Giving Set
Emergency Priming Fluid (0.9% Hepsaline) – 500ml /1L bag
Clamps x 4 (six available per patient)

ECMO Specialist Action:

Action:	Rationale:
<u>If Gross Air Identified In The Circuit:</u> • Contact the ECMO team on 2222 • Clamp circuit **A** (clamp 1 - return to patient) above patient bridge access, then clamp drainage line **V** (clamp 2 - above patient bridge access), then proceed to clamp below the bridge access on drainage side (clamp 3), then clamp 4 on the return access side (A) * the bridge port is identified by the capped single Luer connector on the return & drainage lines * Clamp sequence: **1 (A) – 2 (V) – 3 (V) – 4 (A)** • Turn the pump on to standby • Hand bag the patient with 100% oxygen and initiate full resuscitation procedure as indicated • Add emergency bridge	Patients require isolation from the ECMO circuit due to the risk of air – a prolonged period of time off ECMO will cause the ECMO circuit to clot To prevent retrograde flow / cavitation

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• Add bag of fluid to rapid access line & connect access via pigtails between the head & oxygenator – fluid bag available in emergency cart (0.9% saline) • Remove clamps 4 (A) and 3 (V) • De-air the circuit with a Luer lock syringe; apply a Luer lock syringe to P1 3-way tap on top of the oxygenator & aspirate air • Once the circuit is de-aired, turn the pump back on, re-circulate through the patient bridge – when no air is observed go back on to ECMO **V - A - B** & ensure the rapid access IV giving set is clamped off to the circuit • Go back on to ECMO: release venous clamp first, release the arterial clamp second and then clamp the bridge **(V - A - B)** • Remove rapid access IV giving set • Remove bridge once patient is safely back on to ECMO support	To ensure rapid access fluid is not administered to the patient causing overload
Document total length of clamp off period in specialist evaluation	
Complete Datix incident form and consider immediate team debrief	Ensure learning from incident and determine root cause

Comments

1) Please be aware that emergency fluid may need to be administered to maintain pump flow using a rapid access line as this does not have a ball-valve (unlike a blood giving set). The Specialist must ensure that air is not entrained; this will only happen if the bag is allowed to empty completely. Emergency fluid of Hepsaline must be administered to prevent formation of clots in the circuit to counteract any prolonged delay before initiation of ECMO.
2) Once the emergency procedure has been initiated, hand bag the patient with 100% oxygen.
3) Please ensure a Datix incident form is completed for any circuit related incidents. This is to aid best practice and for audit & monitoring purposes.

Title: **Air Removal – Bridgeless Circuit**

Description: Emergency procedure in the event of overwhelming air entrainment

Personnel: Duty ECMO Consultant, ECMO Specialist, Duty ECMO Co-ordinator, Perfusionist, CPICU Medical Team
ECMO Emergency Call-out Team – 2222

Equipment: Emergency Drugs & Equipment
Gloves
50ml Syringes x 2
Clamps x 2
Fluid & Giving Set

ECMO Specialist Action:

Action:	**Rationale:**
Clamp patient off – clamp return line (A) nearest cannula site	
Tilt patient's head down and turn pump on to standby	
Contact ECMO Emergency Call-out Team on 2222 / pull emergency buzzer	To alert emergency team
Connect emergency fluid to patient's central venous access	Patient will then act as reservoir
De-air circuit with Leur lock syringe at top of oxygenator (P1) – if air entrained on venous side and once circuit de-aired, increase RPM to ensure patient is back on support, release clamp (A) and resume flow as previous settings NB: If air on return, clamp between pump head & oxygenator, release clamp (A) and back fill oxygenator from the patient Complete Datix incident form and consider immediate team debrief	 Ensure learning from incident and determine root cause

Title: Insertion Of The Patient Bridge

Description: To insert the patient bridge to manage & monitor a trial off VA ECMO; maintaining the function of the ECMO circuit & the safety of the patient.
To insert the patient bridge to maintain the function of the ECMO circuit and safety of the patient in the event of a circuit emergency

Personnel: ECMO Specialist

Equipment: Neonatal Bridge
50ml Luer Lock Syringe
Fluid (Heparinised Saline or Saline From Flush Bag c/o Transducer Set)
Clamps x 6

ECMO Specialist Action:

Action:	**Rationale:**
Gather all supplies	To ensure an efficient procedure
Clamp circuit **A** (clamp 1 - return to patient) above patient bridge access, then clamp drainage line **V** (clamp 2 - above patient bridge access), then proceed to clamp below the bridge access on drainage side (clamp 3), then clamp 4 on the return access side (A) Clamp sequence: **1 (A) – 2 (V) – 3 (V) – 4 (A)**	
Remove bung from arterial connector & attach bridge to arterial / return side (A)	

Attach 50ml Luer lock syringe (primed with Heparinised Saline or Saline from transducer set) to 3-way tap on P2	
Turn 3-way tap on P2 onto the circuit Release clamp 4 & prime bridge with Heparinised Saline Apply clamp 4 back to return line (A) Turn off 3-way tap to P2 (flush) Remove bung from venous connector port & connect the bridge to the venous side of the circuit & the release bridge clamp	
Remove clamp 4 (A) & 3 (V) below the bridge access ports	
Proceed to remove clamp 2 (V) & 1 (A) above the bridge access ports	
Proceed to place clamp 1 (A) onto the patient bridge Clamping sequence in order of removal: **4 (A) – 3 (V) – 2 (V) – 1 (A) & B**	To minimise cavitation
During the trial off release the bridge clamp momentarily (up to 20 - 30 seconds) every 10 minutes. Document actions on Trial Off Form / ECMO Specialist Evaluation Form & ensure one clamp remains on the bridge (B)	To maintain patency of the bridge

Commence trial off and refer to VA Trial Off Protocol (page 41) for further information / guidance	
Once finished with the bridge, clamp **1 (A) – 2 (V) – 3 (V) – 4 (A)**	
Remove the bridge & discard appropriately – apply white bungs x 2 onto bridge access ports	
Remove clamps in the following sequence: **4 (A) – 3 (V) – 2 (V) – 1 (A)**	
Replace supplies as necessary and inform Duty ECMO Co-ordinator	

Please Remember

For bridge insertion re: air removal, routine VA trial off or any other emergency situation, please see appropriate protocol and remember the correct clamping sequence.

To clamp off = A – V – B
To go back onto ECMO = V – A – B

Title: Weaning From VA Or VV ECMO

Description: To wean to minimal levels of ECMO support
Personnel: Duty ECMO Consultant
Duty ECMO Co-ordinator
ECMO Specialist
CPICU Medical Team
Nurse

ECMO Specialist Action:

Action:	**Rationale:**
Four - six hourly arterial / mixed venous blood gases - keeping within written parameters	In order to recognise any trends present and keep the levels within written parameters
If the patient is ready to wean, reduce the ECMO rpm gradually; checking saturations & gases with each reduction in rpm & adjusting sweep gas accordingly in accordance with written daily parameters	Weaning: as per Duty ECMO Consultant's decision / instruction
If the arterial or mixed venous blood gases remain within their set parameters whilst on minimal support, then a trial off could be discussed with the Duty ECMO Consultant and arrangements made for a trial off to take place	

Minimum Flow Parameters (guide / reference only)

Patient < 10kg	130mls
Patient 10kg - 30kg	750mls
Patient > 30kg	1000mls

Paediatric cases if circuit is configured with a Chalice Paragon Maxi Oxygenator minimum flow = 750mls

Comments

Weaning is the Duty ECMO Consultant's decision, otherwise leave RPM / flow to maximum for each individual patient.

Refer to parameter sheet for guidance / escalate to Duty ECMO Co-ordinator / Duty ECMO Consultant with any concerns or queries.

Title: **Trial Off Veno-Venous ECMO**

Description: To manage and monitor a trial off VV ECMO; maintaining the function of the ECMO circuit and the safety of the patient

Personnel:
Duty ECMO Consultant
Duty ECMO Co-ordinator
ECMO Specialist
Nurse
ECMO Fellow

ECMO Specialist Action:

Action:	**Rationale:**
Ensure Duty ECMO Co-ordinator is aware of decision to trial off *NB: Duty ECMO Co-ordinator must be present for trial off period, unless in the event of an overnight trial off*	
Check that any pre-decannulation ETT change is performed & check patient's CXR	It is easier to make changes to the ETT whilst the patient is not dependant on the ventilator
Ensure ventilator is changed prior to commencement of trial off, not during or immediately after	
Check that new IV / arterial access is gained	
Check the patency of the existing IV access	To assess the need for further IV access
Ventilation may be increased by the Duty ECMO Consultant / Intensivist	To ensure oxygenation after membrane gas supply is disconnected

Disconnect sweep gas supply to the oxygenator, increase the flow – documenting the time on the Trial Off Sheet	
Keep relatives & staff informed accordingly throughout *NB: The minimum trial off period is two hours, unless the patient's condition warrants going back on ECMO sooner or makes rapid decannulation advisable – this is at the discretion of the Duty ECMO Consultant*	To reduce anxiety, ensure patient safety and make sure the patient is suitable to remove from ECMO support
Document the trial off on appropriate Trial Off Forms & ECMO Chart	

Title: Trial Off Veno-Arterial ECMO

Description: To manage and monitor a trial off VA ECMO; maintaining the function of the ECMO circuit and the safety of the patient

Personnel: Duty ECMO Consultant,
Duty ECMO Co-ordinator
ECMO Specialist
Nurse
CPICU Medical Team

Equipment: VA Trial Off Documentation
6 x Clamps
Neonatal Bridge
Hemochron Signature Elite ACT Machine
Hemochron Signature Elite Test Cuvettes
Heparin Infusions (prescribed on prescription chart)
Emergency Drugs
Clock / Watch

ECMO Specialist Action:

Action:	**Rationale:**
Ensure Duty ECMO Co-ordinator is aware of decision to trial off *NB: Duty ECMO Co-ordinator must be present for trial off period, unless in the event of an overnight trial off*	
Check that any pre-decannulation ETT change is performed – check CXR / echocardiogram	It is easier to make changes to the ETT whilst the patient is not dependant on the ventilator
Check that sufficient IV / arterial access is available	
Check the patency of the existing IV access	To assess the need for further IV access

Transfer Heparin infusion from circuit to patient – continue at current rate This practice may vary according to Duty ECMO Consultant instructions – please refer to Trial Off document / instructions for guidance	Need to maintain heparinisation of the patient & patency of the cannula
Transfer necessary infusions from the circuit to the patient	To keep essential drug infusions maintained
Ventilator settings will be increased by the Duty ECMO Consultant / Intensivist	To ensure adequate oxygenation when off ECMO
Insert patient bridge (as per protocol – refer to page 34) and ensure the bridge is clamped (B)	
Clamp the patient off ECMO by clamping the arterial line (A) then the venous line (V) as near to the cannula as possible Release bridge clamp (B)	To remove the patient from ECMO, whilst ensuring they have sufficient blood volume for their own circulation
Disconnect sweep gas	To prevent a possible build-up of gas pressure and thus emboli
Document the time trial off commenced using the VA ECMO Trial Off Record Sheet	An accurate note of the commencement of trial off is required

To flush cannula release (V - A) and apply clamp to bridge (B) for 20 seconds – reapply clamps to A & V every 10 minutes Repeat this process every 10 minutes until a decision is made to a) go back on ECMO b) proceed to formal decannulation	To prevent clot formation in the cannulae and to maintain patency of cannulae & the ECMO circuit - more frequent unclamping may be needed if blood separation noted To release the venous clamp first to prevent retrograde flow / cavitation
Repeat as above for the entire duration of trial off period Full circuit checks must be maintained throughout the trial off period Any concerns escalate to Duty ECMO Co-ordinator / Perfusionist / Duty ECMO Consultant / Intensivist	
Maintain the circuit without sweep gas supply until decannulation or re-commencement of ECMO occurs (decision of the Duty ECMO Consultant)	
Perform patient ACT at start of the procedure in line with prescribed ACT range – documented on trial off sheet Bedside Nurse / ECMO Specialist to perform arterial blood gas & aspirate 0.2ml blood sample for ACT – as instructed on trial off sheet	

Keep relatives / all team members informed accordingly throughout *NB: The maximum trial off period is two hours unless indicated by the Duty ECMO Consultant* Must ensure good / adequate flow through cannulae and observe gradient & flow across oxygenator	To reduce anxiety, ensure patient safety and make sure the patient is suitable to remove from ECMO support
Document the trial off on designated Trial Off Form & ECMO Chart	
If the trial off is unsuccessful, re-establish ECMO and remove the bridge from the circuit	

VA Trial Off Retrograde Flow

Please follow protocol as above prior to commencement of trial off.

1) Reverse flow probe.
2) Decrease revs per minute (RPM) – aim for flow of:
   - 100 – 150mls/minute (Chalice Neonatal Paragon Oxygenator)
   - 300 – 400mls/minute flow (Chalice Infant Paragon Oxygenator)
   - 500 – 600mls/minute flow (Chalice Maxi Paragon Oxygenator)
3) Adjust inotropes / ventilation as required as instructed by Duty ECMO Consultant.
4) Administer fluid / volume as required as prescribed.
5) Monitor arterial blood gases every 30 minutes during trial off period.
6) For prolonged trial off, refer to parameter / trial off sheet for guidance.

Title: Emergency Change-out Of CentriMag Motor

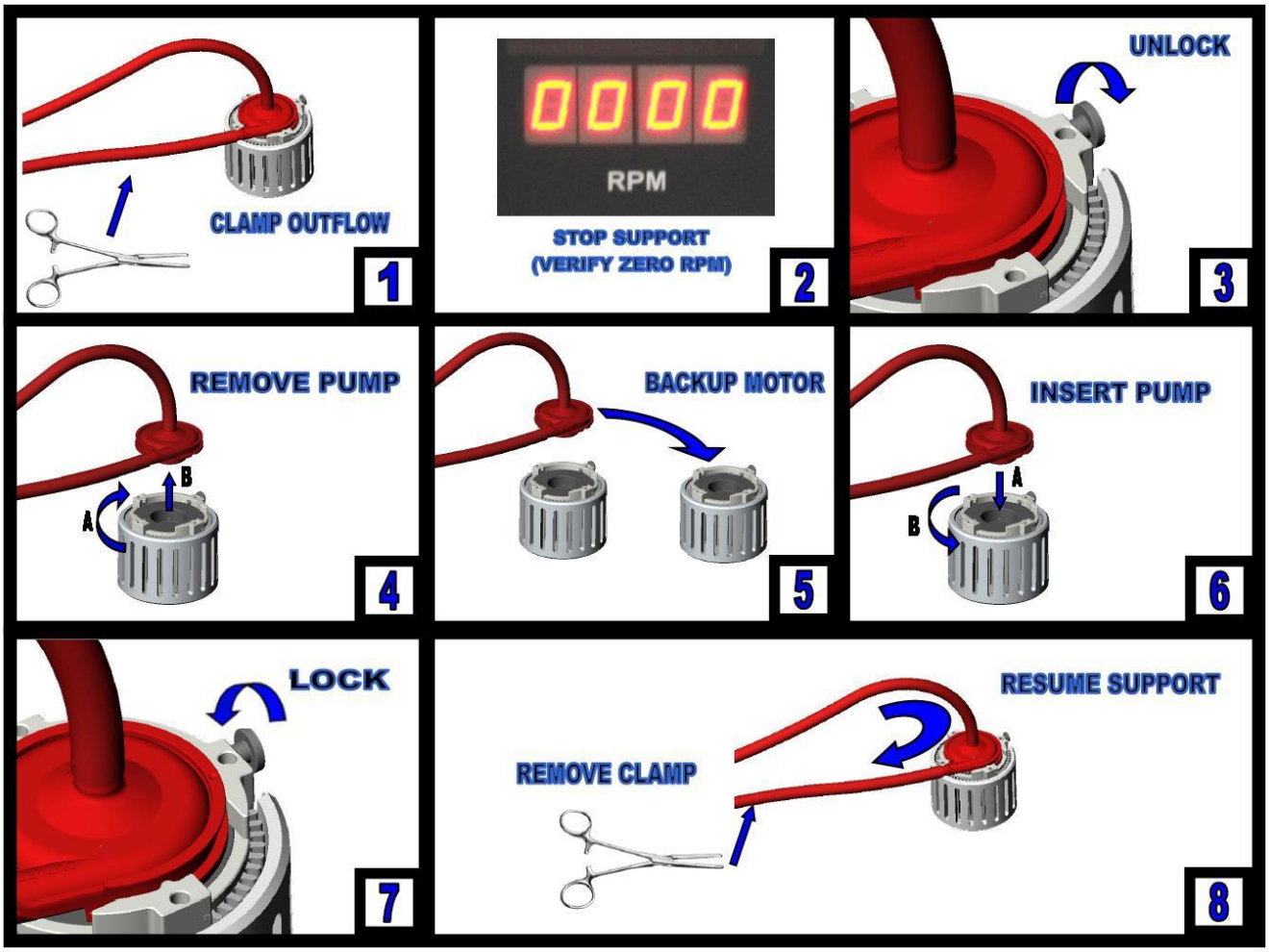
Description: In the event of failure, to change the motor drive
Personnel: ECMO Specialist Duty ECMO Co-ordinator
Emergency ECMO Call-out Team Perfusionist

Equipment: 1 x Clamp

ECMO Specialist Action:

Action:	**Rationale:**
Bleep 2222 (ECMO emergency)	
Clamp post pump head (between pump head & oxygenator)	
Stop support as per diagram	
Turn on second CentriMag console and select either **L** or **R** support	
• Transfer the disposable head to the second motor • Restart flow, increase RPM & remove clamp, as per previous support • The new motor drive will have to be held until Perfusion arrive unless help is at hand on the ICU • Apply flow probe from new console on to tubing • Disconnect pressure monitoring cables from old console to new console – calibrate as per ECMO protocol • Affected console & pump head to be removed by on-call Perfusionist for service & further investigation	RPM will be shown on new console, but flow & pressures will be shown on old console until Perfusion arrive

• New console & pump head to be replaced by on-call Perfusionist immediately • Full documentation of events to be recorded by ECMO Specialist, Perfusionist & ECMO Fellow in patient's / specialist's notes • Datix incident form to be completed by ECMO Specialist for further investigation • Relatives / family to be fully informed / supported by Duty ECMO Co-ordinator, ECMO Specialist, ECMO Fellow, Duty ECMO Consultant & Nurse	



Title: Decannulation Protocol

Description: To assist in the decannulation of an ECMO patient following a successful trial off

Personnel: Duty ECMO Consultant
Duty ECMO Co-ordinator
ECMO Specialist
CPICU Medical Team

Equipment: Theatre Tray & Surgical Disposables
Yellow Bin

ECMO Specialist Action:

Action:	**Rationale:**
Gather all supplies • If decannulating from VV ECMO, notify appropriate staff • If decannulating from VA ECMO or cut down site, the Theatre team may be required	To ensure an efficient procedure
Ensure venous access to the patient is secure & patent and the necessary drugs are transferred to the patient & running as per prescription Antibiotic therapy as prescribed Action: Intensivist / Duty ECMO Consultant	To ensure satisfactory patient status & safety
Ensure emergency drugs are drawn up and at hand for immediate use	To prevent complications or patient deterioration
Ensure ventilation is correct and re-intubation equipment is ready at hand for immediate use	To ensure patient safety

Assist Duty ECMO Surgeon with the procedure as required	For a quick, efficient & safe procedure
Monitor patient's status throughout the procedure & document accordingly	For patient safety
Dispose of the circuit, as per the ECMO Equipment Clean-up Procedure (page 49)	To maintain a clean & safe environment
Ensure all documentation is completed, signed & dated	For future records
Any concerns post-decannulation, contact the Duty ECMO Co-ordinator / Duty ECMO Consultant	To gain advice / further instructions and to make them aware of the patient's status
Seek medical advice regarding the necessity for administration of antibiotics	To reduce the risk of decannulation bacteraemia

Comments

VA Decannulation

If vessels are reconstructed, please seek medical advice with regards to Heparin infusion.

Recommendation

Heparin infusion at 10 units/kg/hr as a maintenance infusion, as prescribed.

Title: **Equipment Clean-up Procedure**

Description: To maintain the ECMO circuit components, day to day running of the circuit and decannulation & disposal of equipment

Personnel: ECMO Specialist
Duty ECMO Co-ordinator

Equipment: Hemochron Signature Elite ACT Machine
ECMO Cart & Equipment
Infusion Devices
Soap & Water
Emergency Cart

ECMO Specialist Action:

Action:	**Rationale:**
Ensure the ECMO cart is cleaned on a daily basis with water / detergent / Trigene as per infection prevention unit protocol (or as often as required) and documented on ECMO Specialist Evaluation Sheet stating the cart name	To maintain a clean & safe environment
Ensure all components are in good working order – inform the Duty ECMO Co-ordinator of any defects and complete Datix incident form	To ensure the circuit is functioning properly
In the event of decannulation, all disposable components should be put into the yellow bin (from the ECMO Storeroom) Place lid on the yellow bin & ensure it is securely sealed (dated / timed / location noted & signed) *ensure count clamps prior to sealing yellow bin*	To ensure safe disposal of the circuit

Clean all equipment & store in the ECMO Storeroom	To ensure safe disposal of the circuit
Ensure the ECMO cart is plugged into the mains electrical supply Ensure that the UHL clean & ready for use equipment label is attached to the cart, signed & dated	
Dispose of the emergency cart items to the allocated area	
Contact Blood Bank once patient has been decannulated & ensure they are aware the patient no longer requires any blood products	

Comments

If cart not found to be clean, must be returned to responsible ECMO Specialist for re-cleaning – in line with UHL Infection Control Policy

Datix incident form to be completed.

Education and Training

None

Supporting References

None

Key Words

Cannulation, Activated Clotting Time (ACT), Heparin, Trans-membrane Pressure Monitoring, Pigtail, Circuit Three-way Tap, Patient Bridge

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The Trust recognises the diversity of the local community it serves. Our aim therefore is to provide a safe environment free from discrimination and treat all individuals fairly with dignity and appropriately according to their needs.
As part of its development, this policy and its impact on equality have been reviewed and no detriment was identified.

CONTACT AND REVIEW DETAILS			
Guideline Lead (Name and Title) Gail Faulkner – ECMO Co-ordinator Chris Harvey - Director of Adult & Paediatric ECMO			**Executive Lead** Chief Nurse
Details of Changes made during review:			
Date	**Issue Number**	**Reviewed By**	**Description Of Changes (If Any)**
Sept – Oct 2023	**3**	GMF / CJH Children's Quality & Safety Board	**Minor amendments only**