Ministry of Health, Kuwait

ECMO Committee

(Policy No 7)

Kuwait ECMO Centre Training and Education Program

POLICY 2020

Policy owner: ECMO Committee. MOH	**Applies to:** All Staff in MOH and Private Hospitals in Kuwait
Section Location: Departments of Anaesthesia, Adult Intensive Care and Pain Management in all MOH and Private Hospitals in Kuwait.	**Effective date:** 01-03-2020 **Revision date**: 01-03-2022
Approved by: Head of ECMO Committee, ECMO Committee Members	
Final Approval by: MOH Undersecretary	

Purpose:

- These guidelines aim to outline the structure of training for new ECMO centres fulfilling the ELSO guidelines as well as to maintain the training of all members of the ECMO team in the ECMO Centre ensuring quality of care for ECMO patients.

Policy Statement:

- These guidelines do not cover the essential requirements for an ECMO centre establishment which are covered separately in ECMO Policy No 3 (ECMO Centres Policy 2017)

Definitions:

- **ECMO team:**
  The ECMO team is composed of a number of members including ECMO consultant, ECMO Nurse, ECMO SR/registrar, Perfusionist as well as other members such as physiotherapists, dieticians and clinical pharmacist (for full team members and their roles, please refer to ECMO Policy No 4, VV-ECMO General Management Policy 2018).

- **ECMO Specialist:**
  The ECMO team member who is trained to manage the ECMO system (ECMO machine) as well as clinically managing the patient on ECMO under the supervision of the ECMO physician. This include **ECMO nurses and perfusionists**.

- **ECMO Physician:**
  This is the **ICU ECMO consultant** who is the most responsible physician in charge of the patient in the ICU and who has fulfilled the ECMO training requirement as outlines below.

- **ECMO Senior Registrar/Registrar**
  This is the **ICU senior registrar or registrar** who has fulfilled the ECMO training requirement as outlined below and who is providing the medical management of the ECMO patient under the supervision of the ECMO physician

Introduction

The ELSO have released the guidelines for training and continuing education of ECMO specialists (Version 1.5. February 2010) aiming to standardize the training of staff in the ECMO centres in order to ensure a set standard and a high quality of care delivered to patients. This policy have been developed in order to ensure this standard is met and maintained taking into account the local and individual needs for the ECMO centres in Kuwait.

All members of the ECMO team have to have the following baseline training and education in order to be eligible to be trained and join the ECMO team:

1- **ECMO consultant (ECMO Physician) and ECMO SR/registrar** : Bachelor Degree in Medicine and Surgery followed by a postgraduate degree/training in anaesthesia, ICU, medicine or surgery as well as clinical experience in ICU for a minimum of 2 years.
2- **ECMO nurse/ Perfusionist (ECMO specialist)**: Bachelor/Diploma Degree of nursing as well as ICU experience of a minimum of 3 years. Or a Bachelor's Degree in perfusion science

Developing an ECMO centre requires 2 phases of training:

A- Phase 1 training:
Initial training for establishing the ECMO team and centre requirement

B- Phase 2 training:
Marinating training to ensure the quality of skills and knowledge of the staff is maintained as well as providing the facility to train new members of staff joining the ECMO team

The details of each of these phases are described below as well the competency form required for each component.

A- Phase 1 training: Initial training for establishing the ECMO team and centre requirement (Total hours 24 hours):

The initial training of the ECMO team members which includes doctors, nurses, perfusionists and physiotherapists training together as one team requires a minimum of 24 hours in training which involves the following domains:

1- Theoretical training (6 hours)*
This involves the following topics:

- Introduction to ECMO and history
- ECMO equipment and circuit components
- ECMO physiology (VV and VA)
- Indications (VV and VA)
- Contraindications (VV and VA)
- Cannulation and decannulation
- Starting ECMO and ECMO management
- Nursing care for ECMO patients
- Physiotherapy and mobilization for ECMO patients
- Nutrition of ECMO patients
- Trouble shooting and complications
- Anticoagulation on ECMO
- Transfer on ECMO

2- Cannulation training (4 hours)
This involves training on the cannulating manikin which should fulfill the competency sheet (see Appendix I, cannulation competency form)

3- Practical/ hands on training (7 hours)

This involves the following sessions/ water drills and stations:

- **The ECMO system** (machine component and circuit/ circuit priming) – see Appendix II, ECMO system competency form)
- Oxygenator failure and Wet joint station - see Appendix III competency form
- Air in the circuit Appendix IV competency form
- Power failure Appendix V competency form
- Routine management and circuit check Appendix VI competency form
- Mobilization on ECMO Appendix VII competency form*

4- Simulation Training (putting it all together – 7 hours) Appendix VIII

This involves simulation scenarios which concentrate on technical skills as well as human factors needed to ensure good communication between the team members. The simulation scenarios include the following followed by a debrief session (see appendix VIII for competency checklist):

- Clot in the circuit (oxygenator failure)– identification and changing the circuit
- Air in the circuit (loose joint/ cvc air entrapment)
- Hypoxia secondary to hypovolemia (VV ECMO)
- Harlequin syndrome and differential hypoxia (adding a venous limb and connecting it to the VA circuit)

*Note: only these sessions are mandatory for physiotherapists

B- Phase 2 training: Marinating training to ensure the quality of skills and knowledge of the staff is maintained as well as providing the facility to train new members of staff joining the ECMO team

- This training aims to maintain the skills of the ECMO team especially at times when there are no ECMO patients in the unit as well as ensuring maintaining the skills for dealing with uncommon but catastrophic emergencies. It involved covering competencies in appendix III, IV, V, and VI on a 3 monthly basis as well as competencies in Appendix II for circuit primers.
- New members of the ECMO team will have to undergo all the training components in phase one training
- Attendance at regular morbidity and mortality meetings (minimum once/year) to discuss the cases have to be maintained as well as immediate discussion of any critical incidents that may occur for any of the ECMO patients (within one week of the incident)
- Attendance of an annual ECMO meeting

APPENDIX I

Cannulation Competency Form

- Identifies different types of cannulas (single lumen, double lumen, single and multihole)
- Identifies the suitable sizes of cannulas for VV and VA
- Recognizes access and return sites for VV and VA and for double lumen cannula
- Performs under full aseptic technique (cap, mask, sterile gloves and gowns, full body drape covering the whole patient)
- Recognizes open versus percutaneous cannulation techniques
- Identifies cannulation methods (seldinger technique and serial dilatation)
- Performs percutaneous cannulation with serial dilatation
- Ensures the guide wire is supported and checked regularly during dilatation to avoid movement
- Uses Image guidance (USS, ECHO and fluoroscopy)
- Demonstrated correct placement of the clamps once the cannula is inserted
- Demonstrates correct aspiration and flushing of the cannula with heparnized saline
- Demonstrates correct wet joint connection
- Demonstrates correct connection of the circuit (art-art and venous to venous)

Appendix II

The ECMO system competency form

This is done on a complete primed circuit with the ECMO console connected to the patient manikin in the simulation room.

Candidate should identify the following:

1- Identifies Circuit component

- Cannulas
- Circuit tubings
- Oxygenator
- Console
- Hand crank/ back up pump
- Heater/cooler and water pipes
- Gas blender
- Safety devices (SvO2 probe, Hb and Hct sensor, flow and bubble sensor, pressure probes)
- Extras (3 x 50mls syringes, 4 clamps, backup O2 cylinder, light source)

2- Identifies console components

- The touch display monitor with different parameters
- V = ECMO flow
- Rpm = revolutions per min (revs)
- P art (P3)= return line pressure
- P ven (P1) = access line pressure
- P int (P2) = pre-oxygenator pressure
- Δ P (P2-P3) = pressure difference between pre-oxygenator pressure and return line pressure

3- Identifies oxygenator components

- Access tubing
- Return tubings
- Oxygenator
- Pre-membrane tubing and sampling line
- Post-membrane tubing and sampling line
- Pressure sensors
- Pressure monitor cable
- Venous sat/Hb probe
- Gas line connector
- Water pipe connector for the heater/cooler

4- Performs Circuit priming

This is done on an unprimed training kit as follows:

- Attach oxygenator to console and priming bag to plate
- Clamp the inlet and outlet to bag
- Attach pigtails and ensure yellow cap is not attached and make sure you don't lose it.
- Attach 1.5 L saline to prime the bag (add 2500iu heparin after checking with the ECMO consultant if heparin is needed, otherwise don't add)
- Attach the pressure sensor connector to the oxygenator
- Power up the Cardiohelp machine
- Enable priming mode (S and Sx simultaneously)
- Zero all 3 pressures (Pint, Part, Pven)
- Place the priming tray on top of the console
- Open white clamps and allow fluid to run freely
- Turn pump to 3000 rpm for 3 minutes
- Return flow to zero
- Turn pump to 4000 rpm for 1 minute
- Prime pigtails and bleed the oxygenator from front
- Stop the pump
- Attach venous bubble sensor and arterial flow sensor (probe/bubble sensor)
- Clamp near flow probe/bubble sensor either side zero flow
- Close white clamps, remove priming bag, using clip attachment and reattach to each other. Don't circulate the primed circuit again
- Replace the yellow cap to the oxygenator
- Be ready to hand the tubings to the ECMO consultant in a sterile manner
- Start recording time at 5 minute interval
- Keep the clamps on the access and return lines near the oxygenator
- Start ECMO flow with sweep gas flow at a rate of 1:1 till you reach the maximum flow tolerated without overcoming the set pressure parameters and after consulting with the ECMO consultant
- **Interventions and alarm limits set:**

- Alarm **50mmHg** above measured pressure
- Intervention at **300mmHg**
- Pven should be **-120mmHg soft alarm** and **-150mmHg intervention**
- Set arterial and venous bubble alarm to active but with no intervention

Appendix III

Oxygenator failure and circuit change (Wet joint station) competency form

- Identify features of impeding oxygenator failure
- Manage oxygenator failure promptly and identify the need to change the circuit
- Call for help (ECMO team: ECMO consultant and ECMO specialist)
- Ensure adequate material and equipment present (new console with a primed circuit)
- Allocating roles and determine the team leader (2 ECMO physicians, ECMO nurse and perfusionist)
- Maximize ventilation and haemodynamic support
- Ensure aseptic technique
- Have 2 clamps and 2 x 50 mls syringes and 2 sterile scissors ready
- Connect the correct ends to each other (venous to venous and arterial to arterial)
- Connects the wet joint in adequate time

See Appendix VIII scenario 1 for more details of the oxygenator failure scenario

Appendix IV

Air in the circuit competency form

- **Identify causes of air in the circuit**

- Via central line or peripheral cannula
- Pigtail or stopcock fracture
- Ruptured circuit e.g. with alcohol
- Accidental decannulation
- Access insufficiency (cavitation)
- Super high partial pressure of oxygen causing foam inside the oxygenator
- Condensation
- Tracheostomy or central line insertion
- Dialysis through ECMO circuit

- **Identify effects of air in the circuit**

- Massive air embolus into the pump head resulting stopping the pump
- Hypoxia and cardiac arrest
- Air embolus into systemic circulation

- **Recognize air in the circuit and manage promptly by identifying the cause**
- **Clamp the return line**
- **Call for help (ECMO team: ECMO consultant and ECMO Specialist)**
- **Switch off the pump**
- **Assign team roles on arrival (ventilation, console, patient, and de-airing)**
- **Maximize ventilatory support (FiO2 1.0 and increase TV) and haemodynamic support**
- **Position patient to left lateral and head down if suspecting air in the circuit**
- **Maximize inotropic support to maintain BP**
- **Consider aspiration of air from the right heart through central line**
- **Remove the yellow luer cap from the oxygenator and keep it**
- **Start removing the air (attach a 50 mls luer lock syringe to pre-membrane pigtail to remove the air X3)**
- **Remove the clamp from the return line**
- **Restart the pump to 1000 revs then increase to full flow**
- **Reset bubble alarm**
- **Leave yellow cap off for around 1 hour**

Appendix V

Power failure competency form

- **Identify causes of pump failure**

- Pump head disengagement
- Electromechanical failure (failure of the pump drive unit in the console/ motor failure)
- Electrical failure (AC power not connected or battery fully discharged)

- **Identify effects of pump failure**

- Hypoxia
- Haemodynamic collapse
- both leading to cardiac arrest

- **Recognize pump failure and manage promptly by identifying the cause**
- **Call for help (ECMO team: ECMO consultant and ECMO Specialist)**
- **Maximize ventilatory support (FiO2 1.0 and increase TV) and haemodynamic support**
- **Assign team roles on arrival (ventilation, console, patient, hand crank)**
- **Clamp the return line and turn off the RPM**
- **Open safety bar by pressing both release mechanisms and lift the safety bar up**
- **Re-engage the pump if disengagement and re-establish the flow after removing the clamp**
- **If no pump disengagement, Remove pressure monitor cable**
- **Remove venous sats/Hb probe by pressing down the round bottom on the probe and pull the probe out**
- **Remove water pipes from the heater/cooler if needed (clamp lines and switch off heater/cooler)**
- **Remove the pump head if power failure and (turn clockwise to remove)**
- **Place the pump head on the hand crank (top of oxygenator placed first then clip underneath)**
- **Remove the clamp and start hand crank till you see the flashing green light**
- **Replace the console (set to zero revs)**
- **Clamp the return line and stop kranking**
- **Remove the pump head from the hand krank (unclip bottom first)**
- **Reattach the pump head into the new console after clamping the return (turn anticlockwise to clip into place)**
- **Restart the pump at 1000 revs**
- **Remove the clamp from the return**
- **Increase to full flow**
- **Attach pressure monitoring probe**
- **Attach venous sats/Hb probe**
- **Attach flow probe**
- **Reset alarm limits and turn on interventions**
- **Reconnect water pipes if removes and switch on heater/cooler**

Appendix VI

Routine management and circuit check competency form

- Use the ECMO monitoring form for VV and VA ECMO and the Circuit Safety Checklist Form

Appendix VII

Mobilization on ECMO competency form

- Ensure all team members are present (ECMO physician, ECMO nurse, perfusionist)
- Ensuring adequate functioning equipment are available with back up
- Ensure allocating roles and determining the team leader
- Ensure communication with the team
- Manages challenges during mobilization

Appendix VIII

Simulation Scenarios and Competency checklists

The following are simulation scenarios with their competency checklist:

- Clot in the circuit (oxygenator failure)– Identification
- Clot in the circuit (oxygenator failure)– Changing the circuit
- Air in the circuit (loose joint/ CVC air entrapment)
- Hypoxia secondary to hypovolemia (VV ECMO)
- Harlequin syndrome and differential hypoxia (adding a venous limb and connecting it to the VA circuit)

1- Oxygenator failure (clot in the circuit)

Objectives:

- Identifying features of the impeding oxygenator failure:
- Worsening gas exchange
- Increase in the TMP >50mmHg or doubling of the trends from the baseline
- High PaCO2 despite high sweep gas flow
- Decrease post-0xy PaO2<300mmHg
- Decrease O2 transfer (calculated from pre and post oxy content on FiO2 1.0)

(Post oxygenator O2 content – Pre oxygenator O2 content) X flow X 10

O2 content = (Hb x SpO2 x 1.34) + (PO2 x 0.023)

- Understands that if left untreated this will lead to full membrane failure and cardiac arrest so should be identified early through the safety checks

Scenario:

55 yrs old man admitted with severe ARDS. Placed on VV ECMO (Day 14). You're just starting your shift and received a handover from the on call team.

Patient is sedated, breath sounds are equal, heart sounds are normal, abdomen soft, cap refill 3 seconds

CXR is normal

On noradrenaline 0.05mcg/kg/min, remifentanil 0.1mcg/kg/min

The initial parameters will be as follows:

patient parameters	**ECMO parameters**	**Blood results**
HR = 90 (increased to 120)	ECMO flow = 4l/min	Pre-oxy ABG (SpO2, PO2,Hb)
BP = 95/60	ECMO FiO2 = 1.0	Post-oxy ABG (SpO2,PO2,Hb) PaO2<300mmHg
SpO2 = 88(decreased to 80)	Sweep gas flow = 8l/m	Hb = 9.5
CVP = 5	P1 = - 50	fibrinogen
FiO2= 0.4	P2= 130	platlets
RR = 10	P3 = 70TMP = 60	APTT= 60 (APTTr 1.9)
PIP = 10	Colour blood in circuit tubing: no colour difference	PCO2 = 44 (6), bic 22, BE -2
PEEP = 10	Clots inside the oxygenator	PO2 = 47mmHg

State	**Inappropriate Action**	**Appropriate Action**	**Operator Triggers**
Initial			**P1** -50 **P2** 130 4.0 **Lpm**
Oxygen Failure	• Does not notice decreased sats • Does not increase FiO2 • Does not check connections • Does not call back up • Does not run pre/post membrane	• Turn ECMO FiO2 to 100% • Check all oxygen connections • Turn vent up to 100% • Call for back up • Draw pre and post membrane labs	**Inappropriate Action** **(Over 2 min**) Decreased SpO2 to 86% Decreased SvO2 to 53% Decreased HCT to 26% Increase HR to 102

	labs within 5 mins		
Check Membrane Labs	**Pre Membrane Labs** pH 7.31 pO2 60 pCO2 50 SaO2 55% HCO3 24.2 BE - 1	**Post Membrane Labs** pH 7.29 pO2 62 pCO2 48 SaO2 56% HCO3 24.2 BE - 1	
Resolve	Continues to delay action	• Call perfusion to change out the oxygenator • Verify code meds are available • Ask for labs and ACT • Turn Sweep down by 0.5 • Turn FiO2 back down to before change out	**Inappropriate Action** **(Over 1 min)** Decreased SpO2 to 70% Decreased SvO2 to 45% Decreased HR to 50 **Appropriate Action** **(Over 1 min)** Increased SpO2 to 98% Decreased SvO2 to 73% Decreased HR to 98 ACT still at 171

Oxygenator failure simulation scenario competency checklist

The candidate should ensure the following:

Identification

- Start doing the circuit check
- Identifies the high TMP
- Recognize there is a clot in the circuit and that the thrombus build up has lead to the decree gas exchange function of the membrane
- Review the patient's monitoring form and identify the rising trends in the transmembrane pressure
- Ask for pre-oxy and post-oxy gases/ABG to calculate the gas transfer
- Recognizes the drop in the patient SpO2 to 80%
- Ensure the ECMO FiO2 is set up to 100% and increase the sweep gas flow
- Ask for blood results (fibrinogen, platelets, plasma free HB)
- States there is a oxygenator failure secondary to a clot in the circuit
- Plan to change the circuit
- Call for help (ECMO team and cardiac arrest team)
- Increase ventilator settings to maximal ventilation (FiO2 1.0 and PIP 30)

Changing the Circuit

- Ensure all ECMO team members are present (2 ECMO physician, 2 ECMO specialists including the perfusionist)
- Ensure all cardiac arrest team members are present (This should include members for airway, chest compression, IV and defibrillator)
- Allocating roles on arrival of the team (ECMO team and cardiac arrest team)
- Ask perfusionist to prime a new circuit
- Maintain full aseptic conditions
- Ensure adequate supply (6 clamps, 2 sterile scissors, 2 3/8 inch connections, 4x priming 50mls syringes, heparinized saline for wet joint connection, new primed circuit ready)
- Team leader takes leadership and allocate roles with going through the steps to be done
- Gives clear orders with closed loop communication
- States clamps are on/ off ECMO
- Connects the correct ends together (art-art and venous-venous)
- States clamps are off/ back on ECMO
- If not done in the allocated time, patient will go into cardiac arrest and CPR should be started
- Ensures each team members performs their own task without being distracted by other team members roles

ECMO Committee

(Policy No 7)

Kuwait ECMO Centre Training and Education Program

POLICY 2020

Policy owner: ECMO Committee. MOH	**Applies to:** All Staff in MOH and private Hospitals in Kuwait
Section Location: Departments of Anaesthesia, Adult Intensive Care and Pain Management in all MOH and private Hospitals in Kuwait.	**Effective date:** 01-03-2020 **Revision date**: 01-03-2022
Approved by: Head of ECMO committee, ECMO committee members	
Final Approval by: MOH Undersecretary	

_____ _____

MOH Undersecretary Date: