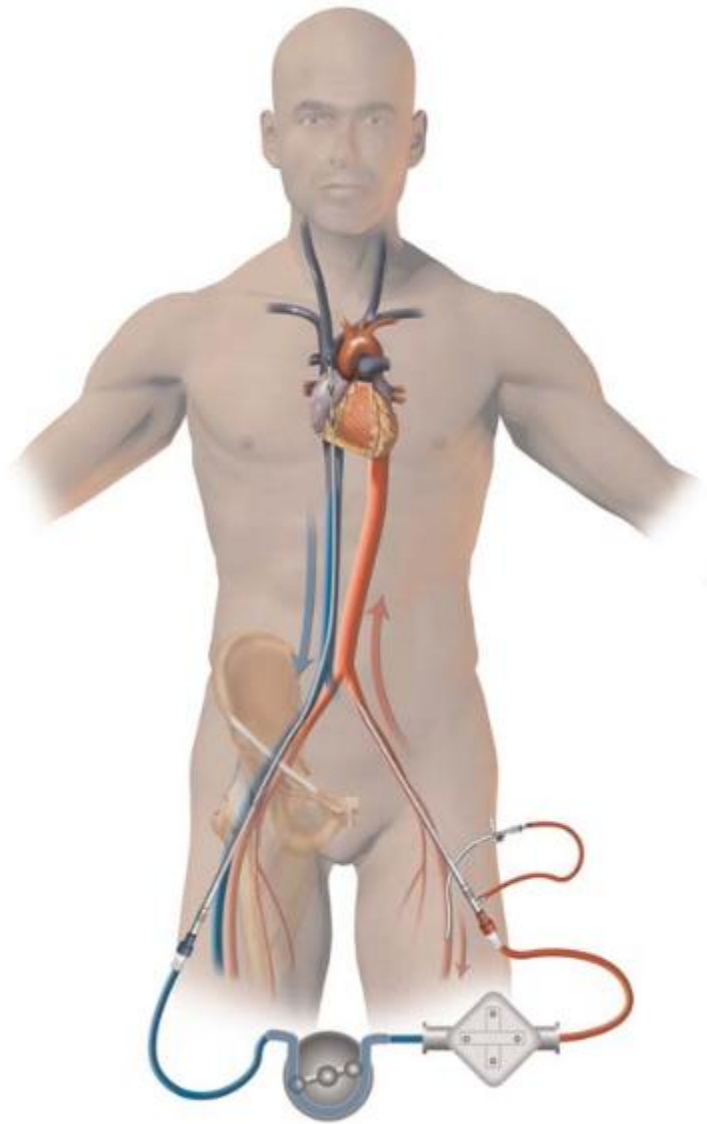


# Royal Infirmary of Edinburgh Extracorporeal Cardiopulmonary Resuscitation (E-CPR) Guidelines 2017



# E-CPR Checklist

For patients without return of spontaneous circulation for more than 15 minutes post arrest



If your patient can confidently tick all these boxes then please activate the E-CPR team by calling switchboard and activating the E-CPR team by group pager 07659176345

## EXTRA-CORPOREAL MEMBRANE OXYGENATION DURING CARDIOPULMONARY RESUSCITATION (E-CPR)

This Guideline is intended for Medical and Nursing staff of the General Intensive Care Unit (ICU), the Emergency department (ED) and the Cardiac Catheterisation Laboratory (Cath Lab) for patients in refractory cardiac arrest. These guidelines are based on the CHEER protocol from The Alfred hospital, Melbourne. Currently the literature consists of only case series of patients with varying success. Advanced invasive cardiac arrest care is still in its infancy and has yet to be proven in a randomised controlled trial. **Patient selection has been shown to be key** for the potential benefit of this therapy to be realised, especially for out of hospital cardiac arrests. The focus of E-CPR is **primarily for neurological protection** during treatment of reversible causes of cardiac arrest.

### DEFINITION

E-CPR is defined as the provision of an artificial circulation during cardiopulmonary resuscitation using a rapidly deployed, Extracorporeal Life Support (ECLS) system to allow for the potential of neurological and cardiac recovery. The primary goal is to minimise the time of “low flow” to the brain.

### INDICATIONS

Patients presenting in the ED, ICU or Cath Lab with cardiac arrest which is refractory to standard advanced cardiac life support treatment and **unequivocally** meets **ALL** the following criteria, will be deemed suitable for a trial of E-CPR.

1. The E-CPR team is available
2. The cardiac arrest was witnessed and ALS in progress
3. Chest compressions commenced within 5 minutes of witnessed arrest
4. There is no sustained ROSC despite full ALS after 15 minutes with continuous CPR & total CPR time is less than 45 minutes
5. The patient is between 16 years and 65 years
6. There are no known major comorbidities
7. No clear contraindication to systemic anticoagulation
8. Vascular access looks feasible- to be determined by ICU Consultant.

OR

- The patient is profoundly hypothermic (<32°C) due to accidental exposure

OR

- The arrest was due to a reversible non-cardiac cause (i.e. asthma, overdose of a vasoactive drug) **AND** the arrest was witnessed by a paramedic (“monitored arrest”)

## **E-CPR REQUIREMENTS**

In addition to the standard resuscitation, there are three key components of E-CPR, ALL of which MUST be provided concurrently and rapidly.

**1: Continuous External Chest Compressions-** External chest compressions using the Autopulse™ machine

**2: Therapeutic Hypothermia** - This is currently a niche role in the post Targeted Temperature Management era, but is part of the protocol from the CHEER trial and may change as new evidence arises.

**3: Rapid percutaneous cannulation-** Using small cannulae (15F arterial (15cm), 19F (38cm) venous) and connection to the pre-primed ECMO machine and aiming for at least 3L/minute flow.

**4:Ongoing management of the cardiac arrest without defibrillation as per ACLS guidelines**

## **ECMO-CPR EQUIPMENT**

When the E-CPR team is “Live” the following equipment will be kept in the procedure room of ward 118.

Fully stocked ECMO trolley

Sterile primed ECLS circuit (currently kept in Perfusion room in Cardiothoracic Theatres)

## **E-CPR ACTIVATION**

Currently there is insufficient evidence to fund a 24/7 E-CPR service and so at present only a limited service is available in RIE. For suitable out-of-hospital cardiac arrest patients, the ambulance service will pre-alert of the arrival of a cardiac arrest patient who will be transported to the ED.

1. The ED Consultant will determine whether the patient sounds suitable for E-CPR activation and activate the E-CPR team by phoning switchboard and asking for the E-CPR team to be group paged.
2. ICU Consultant on for E-CPR will coordinate the E-CPR team response.

## **E-CPR ROLES: these are the same wherever ECPR is commenced**

There are a minimum of 6 staff involved with each having a specific role. In the ED, each of the role tasks are designated as follows:

These roles are:

- Team Leader
- Cannulator
- Cannulator assistant
- Perfusionist
- Airway doctor
- Circulating nurse

### **“Team Leader”**

- Leads and coordinates the resuscitation
- On patient arrival, checks history and exclusion criteria with Cannulator
- Ensures that Autopulse is running and hand ventilation continues
- Ensures garments are removed and groin area clear
- After skin prep, ensures no further defibrillations
- Requests adrenaline 1mg IV each 4 minutes after rhythm and pulse check
- Ensures 5000 units of unfractionated heparin is given on request (3000 units if patient <50kg)
- Ensures antibiotic prophylaxis (Piperacillin/Tazobactam 4.5g IV) given on request
- Stops Autopulse on request from Cannulator during needle insertion if required
- Ensures sedation and NMB drugs (midazolam and rocuronium) if required are given on request
- Liaises with Cardiology

### **“Cannulator” is an ECLS trained ICM Consultant**

- Attends the procedure room in the ICU
- Proceeds to the site of the cardiac arrest with the E-CPR trolley
- Scrubs, dons sterile gown and gloves
- Opens CVC Pack on a trolley
- Applies ultrasound sleeve and gel to vascular probe
- Confirms patient suitable for trial of E-CPR
- Cleans and prepares groins with drape
- Images the femoral area and demonstrates the positions of the femoral artery and vein
- Requests pauses in chest compressions during needle and guide-wire insertion, if required
- Cannulates the femoral artery on right and femoral vein on left
- Requests 5000 units of heparin (3000 units if <50kg) and 4.5g Piperacillin /Tazobactam are given once cannulae are in situ

### **“Cannulator Assistant” is an ECLS Nurse or ICM Consultant**

- Brings the ECLS machine to the patient if perfusion unavailable
- Assists Cannulator to gown then set up the trolley with cannulation equipment
- Scrubs, gowns and gloves and assists Cannulator with draping, cannulation and circuit connection
- Starts heparin infusion within 60 minutes of ECLS starting

### **Perfusionist or ECLS Nurse (if perfusionist not present once cannulae sited)**

- Proceeds to the site of the arrest with a pre-primed ECMO circuit
- Prepares the ECMO circuit for use
- Hands on to cannulator assistant the Avalon dilators, Amplatz wires and cannulae when requested.
- When cannulae are inserted and connected, commences ECMO flow at 1500rpm and oxygen flow at 3L/min at 100% FIO<sub>2</sub>, then increases rpm to achieve 3L/min flow of blood.

### **“Airway Doctor” is an ED ST4 or above or Anaesthetic ST4 or above or Consultant**

- Supervises the move from the ambulance stretcher to the ED bed with CPR continuing and Autopulse placed ASAP (if not already in place)
- Continues hand ventilation with 100% oxygen using a bag/valve or C-circuit connected to the ETT
- Does NOT connect the patient to a ventilator until ECLS flow commences

### **“Circulating Nurse” is an ED Nurse**

- Assists the Airway Doctor with airway management if required
- Connects ETCO<sub>2</sub> and cardiac monitoring leads
- Prepares adrenaline for bolus administration
- Measures and announces time cycle to ensure rhythm check and adrenaline administration each 4 minutes
- Commences documentation
  1. Time of arrival
  2. Time of decision for E-CPR
  3. Time cannulation commences
  4. Time to ECLS support starts

## CARDIAC ARREST MANAGEMENT DURING CANNULATION:

The patient on Autopulse™ must not be connected to a mechanical ventilator but instead be ventilated gently by bag/ valve or C-circuit with 100% oxygen

During cannula insertion, all other procedures and therapies must be delayed, including arterial line placement/ CVC placement, defibrillation and chest X-ray.

**\*\*\*DO NOT DEFIBRILLATE DURING ECLS CANNULATION\*\*\***

### NOTES ON CANNULATION DURING CPR: Cannula insertion:

- The femoral vessels must be imaged with ultrasound
- The femoral artery and vein will be accessed with a needle followed by the Amplatz guide-wire.
- The guide wire must be imaged in the vein or artery respectively prior to dilation
- A small skin incision is required to facilitate rapid dilation
- Smaller ECLS cannulae (e.g 15F arterial, 19F multi-flow venous) are inserted since smaller cannulae are faster and easier to insert, and relatively low ECLS flows only (3L/minute) are required during therapeutic hypothermia
- No femoral artery back-flow cannula is required initially
- Patient arterial line monitoring can be delayed until after they arrive on the ICU or have undergone angiography

### Commence ECLS perfusion:

Once the cannulae are inserted, the ECMO circuit will be connected and flow will be commenced. The Autopulse™ will then be switched off.

Adequate therapeutic hypothermia (32-34°C) is **imperative** for neurological protection during and after prolonged cardiac arrest. If the temperature is still >34°C after commencement of ECMO, then use of surface cooling will commence and infusions of 4°C 0.9% sodium chloride are considered.

Once ECLS commences and adequate flow is reached, a large number of patients will develop a perfusing rhythm. Initially this will provide an inadequate cardiac output due to stunned myocardium and ECLS flows should not be weaned at this point. It is clearly very important to prevent stasis of blood in the heart and so every effort should be made to obtain a perfusing rhythm.

A number of scenarios can be predicted:

1. ECLS commences and a perfusing rhythm occurs - immediate ECG then manage as per likely underlying cause
2. ECLS commences but no perfusing rhythm obtained. If VF/VT after 5 minutes defibrillate another 3 times. If this fails give amiodarone, correct electrolyte/acid base abnormalities and try again after a period of time. Consider emergency PPCI. Start adrenaline by infusion if on echo LV ejection looks poor.

## **MAINTENANCE ON ECLS**

Once on ECLS, the subsequent patient management will depend on the clinical setting. Routine care should be as per 118 ECLS guidelines.

- For patients with presumed cardiac arrest of coronary artery lesion cause, transfer to the Cath Lab for coronary angiography and possible angioplasty will be required. The Cardiology Registrar on-call should be paged
- For patients with suspected massive pulmonary embolism, consideration should be given to surgical pulmonary embolectomy or interventional radiology for clot extraction. Thrombolysis in the context of established ECLS supportive therapy is probably unnecessary, and a waiting brief more appropriate.

## **TRANSFER TO THE CARDIAC CATHETERISATION LABORATORY**

If acute coronary occlusion is suspected, then the patient should be transferred to the Cath Lab as soon as possible. The ICU Consultant and ECLS nurse +/- perfusionist will normally undertake this task.

The Cardiologist will undertake coronary angiography using ideally the right brachial artery or right radial artery approach, but the femoral artery (contra-lateral side to ECLS arterial catheter) can be used if necessary.

In general, a coronary artery bare-metal stent(s) will be inserted and this will require administration of aspirin, clopidogrel and commencement of a heparin infusion.

At the conclusion of coronary angiography, the arterial sheath will be connected to a transducer and this will be used for arterial blood pressure monitoring and arterial blood gas analysis.

## **TRANSFER TO THE INTENSIVE CARE UNIT**

After coronary angiography and CT scanning of the brain and C-spine (if head strike), the patient will be transferred to the ICU. CT brain need not occur in the absence of head trauma but should occur in the event of a negative coronary angiogram to rule out intracranial bleed.

The subsequent treatment follows the usual practice of provision of ECMO and maintenance of therapeutic hypothermia in the ICU (see "Guideline for Therapeutic Hypothermia"). The patient who has had CPR for > 30 minutes and E-CPR must undergo therapeutic hypothermia for 24 hours followed by slow rewarming.

## **BACKFLOW CANNULA:**

A leg reperfusion cannula will be routinely placed to avoid limb threatening ischaemia. This should be done at a convenient time, but within 6 hours of ECLS cannula placement. The least invasive and preferred option is to site a retrograde 5F short sheath high flow cannula into the dorsalis pedis or posterior tibial artery percutaneously under ultrasound. If difficult it can be done with vascular surgery help at the bedside as a semi-open procedure. Alternative is



antegrade perfusion with cannulation of the superficial femoral artery, either by ultrasound or semi-open as above. Please see the ward 118 ECLS guidelines for more information.

## **PROGNOSTICATION:**

The assessment of neurological recovery after prolonged CPR is generally undertaken at 108 hours (i.e. 72 hours after cessation of sedation) and is based largely on the clinical neurological examination. In E-CPR patients, the assessment of prognosis will follow the standard ward 118 ICU OOHCA pathway.

Significant complications related to the technique of ECPR are most often a prelude to poor outcome. In this circumstance early recourse to a change in goals to palliative care will be pursued. In essence a technically flawless cannula insertion and avoidance of major bleeding requiring blood product support is associated with the best outcomes in this difficult group.

## **REFERENCES:**

1. Nagao K, Hayashi N, Kanmatsuse K, et al. Cardiopulmonary cerebral resuscitation using emergency cardiopulmonary bypass, coronary reperfusion therapy and mild hypothermia in patients with cardiac arrest outside the hospital. *J Am Coll Cardiol*. 2000;36:776-783
2. Chen YS, Lin JW, Yu HY, et al. Cardiopulmonary resuscitation with assisted extracorporeal life- support versus conventional cardiopulmonary resuscitation in adults with in-hospital cardiac arrest: An observational study and propensity analysis. *Lancet*. 2008;372:554-561
3. Kagawa E, Inoue I, Kawagoe T, et al. Assessment of outcomes and differences between in- and out-of-hospital cardiac arrest patients treated with cardiopulmonary resuscitation using extracorporeal life support. *Resuscitation*. 2010;81:968-973
4. Fagnoul D, Taccone FS, Belhaj A, Rondelet B, Argacha JF, Vincent JL, Backer DD. Extracorporeal life support associated with hypothermia and normoxemia in refractory cardiac arrest. *Resuscitation*. 2013; 84:1519-1524
5. Pellegrino V, Smith K, Walker T, Sheldrake J, Hockings L, Shaw J, Duffy SJ, Burrell A, Cameron P, Smit DV, Kaye DM, Refractory Cardiac Arrest Treated with Mechanical CPR, Hypothermia, ECMO and Early Reperfusion (the CHEER Trial), *Resuscitation* (2014)

## ECPR BOX Contents

To be placed in ECPR box from **bottom upwards** i.e the first item is placed into the box 1<sup>st</sup> and all the rest on top.

|   |
|---|
| Large tegaderm to cover insertion sites x4 <b><i>place into box 1st</i></b> |
| Hollister horizontal tubing securing devices X 4                            |
| Disposable suture instrument pack + 2.0 Mersilk suture                      |
| Avalon dilators X 1   |
| Amplatz wires X 2   |
| <b>ORANGE BAG</b>   |
| 500ml bag Saline  |
| 50ml catheter tipped syringes x2  |
| eCPR tray   |
| Ultrasound probe cover x 1  |
| Instillagel x 1   |
| ChloroPrep applicator 26mls   |
| Angiodrape x 1  |
| XL surgical gown x 2  |
| Sterile gloves 2 pairs each of 6, 6.5,7, 7.5, 8.0                           |
| CVC pack x1   |
| Masks, Hats, Eye Protection - x 3   |
| eCPR action cards   |

# E-CPR ACTION CARD

## TEAM LEADER – Emergency Department Consultant

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|   |  |
|---|--|
| Leads and co-ordinates ongoing resuscitation efforts  |  |
| Ensures ED equipment is available prior to patients arrival   | <ol style="list-style-type: none"> <li>1. End tidal CO<sub>2</sub> monitoring</li> <li>2. Cardiac monitoring</li> <li>3. Airway trolley</li> <li>4. Autopulse</li> <li>5. Spare batteries for Autopulse</li> <li>6. Ultrasound machine</li> <li>7. Defibrillator</li> </ol>        |
| Takes handover from 3RU paramedic   |  |
| Confirms with cannulator that patient meets criteria for trial of E-CPR   | <ol style="list-style-type: none"> <li>1. Adult age 16-65</li> <li>2. Witnessed cardiac arrest</li> <li>3. Early CPR –within 5 mins</li> <li>4. No known major co-morbidities</li> <li>5. ROSC not achieved after 15 mins ALS</li> <li>6. CPR time less than 45 minutes</li> </ol> |
| Ensures that Autopulse is running and hand ventilation occurs   |  |
| Ensures garments are removed  |  |
| Ensures no further defibrillations from point of decision to proceed to cannulation.                                      |  |
| Adrenaline 1mg IV every 4 mins after rhythm check and pulse check   |  |
| Ensures Piperacillin/Tazobactam 4.5g IV, heparin 5000u IV (3000u if <50kg), midazolam and rocuronium are given on request |  |
| V3.20151117   | Liaise with cardiology   |

# E-CPR ACTION CARD

## CANNULATOR – ECLS trained ICM Consultant

7

|  |  |
|--|--|
| <b>Prepares for patient arrival in ED</b>  | Hat, mask and eye protection<br>CVC pack opened on eCPR trolley<br>Performs hand hygiene<br>Dons surgical gown and sterile gloves<br>Takes on additional ECMO equipment from cannulation assistant   |
| <b>Confirms with Team Lead that patient is suitable for E-CPR</b><br><br><b>Takes decision to proceed to trial of E-CPR</b>      |  |
| Cleans groin and drapes patient with cannulation assistant   |  |
| US images femoral area to identify vessels   |  |
| <b>Begins cannulation procedure</b>  | <ol style="list-style-type: none"> <li>1. Places wires to RIGHT femoral artery then LEFT femoral vein (Seldinger technique)</li> <li>2. Sequentially dilates RIGHT femoral artery and cannulates with 15Fr return cannula</li> <li>3. Removes wire then introducer and then clamps cannula</li> <li>4. Sequentially dilates LEFT femoral vein and cannulates with 19Fr drainage cannula</li> <li>5. Removes wire then introducer and then clamps cannula</li> <li>6. Requests short pauses to Autopulse if required</li> <li>7. Performs wet connection with cannulator assistant</li> </ol> |
| Confirms ECMO CPR settings with perfusionist and undertakes unclamping sequence  |  |
| Confirms flow with perfusionist and requests RPM increase to achieve 3 l/min flow  |  |
| Confirms ECMO flow to team leader and requests discontinuation of Autopulse.<br><br>Secures cannulae                             |  |
| Requests heparin 5000u IV (3000u if <50kg), Piperacillin/Tazobactam 4.5g IV, midazolam and rocuronium are administered           |  |
| V3.20151117<br>Mandates ventilator settings and CO <sub>2</sub> targets (etCO <sub>2</sub> 2.5-3 or PaCO <sub>2</sub> 4.5-6 kPa) |  |

# E-CPR ACTION CARD

## CANNULATOR ASSISTANT – ECLS trained ICM Consultant or ECLS ICM Nurse

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|   |   |
|---|---|
| <p><b>Dons hat, mask and eye protection</b><br/><b>Gives CVP Pack to Cannulator</b></p> |   |
| <p><b>Assists cannulator in gowning and preparing E-CPR equipment</b></p>               | <p><b>Gloves for Cannulator</b><br/><b>Ties cannulators gown</b><br/><b>E-CPR tray</b><br/><b>Chloraprep 28ml</b><br/><b>Large Cannulation drape</b><br/><b>Instillagel</b><br/><b>US probe cover</b><br/><b>2 x 50ml catheter tip syringes</b><br/><b>500mls 0.9%NaCl</b><br/><b>Additional gown and gloves for self</b></p> |
| <p><b>Performs Hand hygiene, gown and gloves</b></p>                                    |   |
| <p><b>Assists cannulator with draping of patient</b></p>                                |   |
| <p><b>Takes Avalon dilators, Amplatz wires and E-CPR cannulas from perfusionist</b></p> |   |
| <p><b>Assists with cannulation procedure and circuit connection</b></p>                 |   |
| <p><b>Assists with securing E-CPR cannulas.</b></p>                                     |   |

# E-CPR ACTION CARD

## PERFUSIONIST

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|   |   |
|---|---|
| <b>Prepares ECMO circuit for use</b>  |   |
| <b>Passes to cannulator assistant the Avalon dilators, Amplatz wires and E-CPR cannulae when requested.</b> |   |
| <b>Passes on ECMO circuit once cannulas have been inserted.</b>   |   |
| <b>Confirms with cannulator that there is no air in the circuit</b>   |   |
| <b><u>Ensures ECMO parameters are appropriately set</u></b>   | <b>1. Sweep gas 3l/min</b><br><b>2. FIO<sub>2</sub> 50%</b><br><b>3. 1500 RPM</b> |
| <b>Monitors unclamping procedure with cannulator</b>  |   |
| <b>Confirms ECMO circuit flow and increases RPM to achieve 3l/min flow.</b>                                 |   |

# E-CPR ACTION CARD

**AIRWAY DOCTOR – ED SR / Anaesthetic Consultant or SR**

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**Supervises move from ambulance trolley to trauma mattress on ED trolley**

**Continues hand ventilation with 100% O<sub>2</sub> via C-Circuit**

**Places ETT if iGel in situ as directed by Team Leader**

**Does not connect the patient to a ventilator until ECLS flow commences**

**Once ECMO flow commences begin mechanical ventilation with settings as directed by cannulator**

**Aim to maintain etCO<sub>2</sub> (2.5-3kPa) or PaCO<sub>2</sub> (4.5-6kPa)  
Use sweep gas flow to manipulate CO<sub>2</sub>**

# E-CPR ACTION CARD

## AIRWAY NURSE (NURSE 1) – ED Nurse

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**Prepares etCO<sub>2</sub> and cardiac monitoring prior to patient arrival**

**Assists airway doctor with airway management**

**Connects etCO<sub>2</sub> and monitoring**

**Assists nurse 2 once definitive airway ensured**



# E-CPR ACTION CARD

## NURSE 2 – Emergency Department Nurse

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|   |   |
|---|---|
| <b>Prepares adrenaline mini-jets prior to patient arrival</b>                 |   |
| <b>Is responsible for Autopulse – pausing, restarting and battery changes</b> |   |
| <b>Administers adrenaline at direction of team leader</b>                     |   |
| <b>Prepares and administers other drugs as directed by team leader</b>        |   |
| <b>Commences documentation</b>  | <b>Time of arrival</b><br><b>Time of decision for E-CPR</b><br><b>Time cannulation commences</b><br><b>Time to ECMO support</b> |