

E-CPR: myth and truth

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1. Introduction

Extracorporeal cardiopulmonary resuscitation (ECPR) has been described to the venoarterial extracorporeal membrane oxygenation (VA ECMO) in patients who remain in cardiac arrest (CA) despite conventional cardiopulmonary resuscitation (CPR), or when intermittent return of spontaneous circulation (ROSC) occurs, but repetitive CA reoccurs. Worldwide, neurologically favorable survival in patients resuscitated by emergency services for OHCA is only 2-11%, eventually 12-19% in patients with initially shockable rhythms and slightly better for IHCA of 22% . ECPR has been recognized in European Resuscitation Guidelines 2015 as a rescue therapy for those patients in whom initial advanced life support measures are unsuccessful or to facilitate specific interventions (eg, coronary angiography and PCI or pulmonary thrombectomy for massive pulmonary embolism). The American Heart Association (AHA) guidelines are more cautious regarding the recommendation for ECPR because of the ongoing paucity of available data. A recent meta-analysis compared ECPR to conventional CPR and showed a favorable effect on 3-6 month survival with good neurological outcome in ECPR subjects. However, the effect of ECPR on survival to discharge has not been clearly shown indicating the need for strict criteria for implementation of ECPR.

2. Organization of ECPR team and Facilities

The ECMO team consists of professionals from intensive care, cardiology, cardiac surgery, and other specializations collaborating

with specialized nurses and perfusionists. In-hospital coordination between the ECMO and CPR teams must include rules to activate the ECPR team in a 24/7 coverage model. ECMO team members must be well trained in cannulation, circuit management, and early post-resuscitation care. Supportive departments necessary for ECPR patients comprise: biochemistry with emergently available common laboratory tests (arterial blood gases, lactate, hemoglobin, glucose often available also bedside); radiology including vascular ultrasound, vascular embolizations, CT imaging used to adopt adjustments specific for ECMO patients;24 blood bank, pharmacy, coronary angiography and PCI service. Essential equipment readily available for use at the site of ECPR (or on the “ECPR trolley”) should consist of ECMO cannulation sets, ECMO cannulas (15 to 21 Fr for arterial and 19 to 29 Fr for venous access), 150 cm catheterization wires including stiff wires for adequate support, catheterization sheaths 5 to 8 Fr for vessel access establishment, eventually useful for distal perfusion, stopcocks, basic surgical instruments required for open access to femoral vessels and other routine material used for invasive procedures including sterile dressing, drapes and so on. A pre-assembled dry-primed or wet-primed ECLS machine should remain available 24/7, with regularly checked technical and battery status. The team should be trained to deploy the device for full use within 5-10 minutes from decision to proceed with ECPR.

3. Patients selection, Cannulation and Post-ECPR management

Patients who might be excellent candidates for ECPR consideration have a CA with initially shockable rhythm, a

witnessed arrest with immediate CPR with no sustained ROSC within 10-15 minutes of advanced life support by an emergency medical service/CPR team, and age less than 75 years. The optimal duration of refractory CA prior to ECPR remains unknown, but both for in-hospital cardiac arrest (IHCA) and out-of-hospital cardiac arrest (OHCA), maximal time of approximately 15 minutes of CPR seems to be reasonable. An age limit in ECPR also remains controversial. And indication for ECPR in older patients must be considered on a case by case basis.

Choosing cannula diameter size can prove difficult but important because changing them after cannulation is stressful and potentially dangerous. A smaller diameter cannula to prevent damage or tearing of the femoral or iliac artery can prevent this potentially fatal complication. Consequently, smaller cannula may not need a distal perfusion to prevent cannulated limb ischemia. For a targeted flow of 3.5-4 L/min an arterial cannula of 15-17 Fr. should be sufficient.

Small pupils are considered to be a favorable prognostic factor, similarly lactate values below 5 mmol/L, however, lactate values are usually higher in ECPR patients. Alternatively, some reports indicate brain near infrared spectroscopy (NIRS) can be a potentially valuable tool in assessing patients under CPR.

Patient receives full anticoagulation, unless contraindicated (suspicion of bleeding), usually with a bolus of unfractionated heparin of 75 100 IU/kg followed by continuous infusion to keep activated clotting time (ACT) close to 200 seconds, or an activated prothrombin time (APTT) at 50 70 seconds.

Titration to target peripheral saturation of 90-95% seems reasonable, bearing in mind that in a majority of ECPR patients pulse oximetry may be inaccurate. Thus brain tissue regional saturations by NIRS provide better in line control with target values around 60-70%. Beginning with inspired oxygen of 50-60% and later increases based on above monitoring appears reasonable. Blood flow is usually set to 4 L/min and eventually increased gradually.

Still, in certain subgroups of patients with witnessed cardiac arrest, shockable rhythms, high quality post cardiopulmonary resuscitation (CPR) care, including targeted temperature management, early coronary reperfusion, treatment of electrolyte disorders, seizures, and pneumonia, neurologically favorable

outcome as high as 25-30% can be reached. As the most common cause of CA was an acute coronary occlusion or chronic severe coronary artery disease, it is necessary to continue with coronary angiography following institution of ECLS. Other malignant rhythms or other causes of refractory CA should be identified as soon as possible. The causes of refractory CA differ from causes of usual CA and, unfortunately, may often be irreversible (aortic rupture, other severe bleeding, intracranial hemorrhage). If the cause is not established with pulmonary angiography or aortography, and other causes including pericardial tamponade have been excluded by bedside echocardiography, then CT scan of the brain and chest/abdominal exams should be performed. Initial examination should exclude severe electrolyte imbalances, assess organ functions, and allow thorough monitoring, mainly by means of lactate, blood gases, and hemoglobin levels.

4. IHCA versus OHCA

Multiple observational studies report encouraging results of ECPR in IHCA with neurologically favorable survival in up to 35% of cases. Patients were resuscitated in the ICU (61%), cath lab (16%), and emergency room (19%). Importantly, this study also demonstrated a declining chance of survival with prolonged duration of CPR. The probability of survival was approximately 50%, 30%, and 10% when CPR lasted 30, 60, or 90 minutes, respectively.

Use of ECPR in OHCA may appear even more attractive than in IHCA. OHCA patients are generally younger, previously healthy, and the cause of CA is usually of cardiac origin. On the other hand, pre-hospital logistics in the care for OHCA victims plays a major role in selecting suitable patients for ECPR. The favorable prognostic factors included witnessed arrests, shockable rhythms, and reversible causes of CA. Outcomes in studies varied substantially with neurologically favorable survival ranging from 4% to 29%, mainly around 15-25%. However, ECPR in OHCA remains challenging with many unresolved issues including optimal patient populations, variables associated with a favorable neurological outcome, cost benefit analysis of this resource demanding strategy and so on.

5. Weaning from ECMO and futility

Weaning follows a similar path of all VA ECMO; however, close neurological monitoring must occur. Patients after prolonged CPR may suffer irreversible cardiac damage and favorable neurological outcome may strengthen the efforts to proceed with more advanced mechanical circulatory support or heart transplantation. ECPR is associated with potential harm to patients and/or their relatives. Although recovery of the heart often occurs, a coma or vegetative state could result. It has earned the title of a “bridge to nowhere” in which the patient awakens, but has no cardiac function and is not a transplant or destination therapy candidate. ECPR can prolong the time to death in patients with unfavorable outcome.

6. Conclusion

Extracorporeal CPR does not yet represent the standard of care. Ongoing randomized studies have to elucidate whether ECPR is worth implementing into routine practice. Moreover, technological advances should enable improved end organ support. Miniaturization may enhance the use of wearable/implantable devices.

REFERENCES

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