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Review

ECPR in a tertiary care hospital: Presentation of challenges on the basis of a real case

Andreas Bloch [a, *], Nadja Schai [a], Jan-Oliver Friess [b], Tobias Michael Merz [a], Gabor Erdoes [b]

[a] Department of Intensive Care Medicine, Inselspital, Bern University Hospital, University of Bern, Switzerland
[b] Department of Anesthesiology and Pain Medicine, Inselspital, Bern University Hospital, University of Bern, Switzerland

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ABSTRACT

Extracorporeal cardiopulmonary resuscitation is a rescue intervention for refractory cardiac arrest. Based on a case description this article summarizes the indications, contraindications, the current literature and guidelines related to this topic. Further, challenges during a patient's course are described and potential problems are addressed.

Contents

* Corresponding author. Department of Intensive Care Medicine, Inselspital, University Hospital Bern, CH-3010, Bern, Switzerland.
E-mail addresses: andreas.bloch@insel.ch (A. Bloch), nadja.schai@insel.ch (N. Schai), jan-oliver.friess@insel.ch (J.-O. Friess), tobias.merz@insel.ch (T.M. Merz), gabor.erdoes@insel.ch (G. Erdoes).

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Abbreviations

ALS	Advanced Life Support
BLS	Basic Life Support
CPR	Cardiopulmonary Resuscitation
ECMO	Extracorporeal Membrane Oxygenation
ECPR	Extracorporeal Cardiopulmonary Resuscitation
ED	Emergency Department
EMS	Emergency Medical Services
ICU	Intensive Care Unit
MAP	Mean Arterial Pressure
NIRS	Near-Infrared Spectroscopy
OR	Operating Room
ROSC	Return Of Spontaneous Circulation
TEE	Transesophageal Echocardiography
VA ECMO	Veno-Arterial ECMO
Vfib	Ventricular fibrillation
VT	Ventricular tachycardia

1. Introduction

1.1. Introduction – case report (first part)

A previously healthy 38 year old man collapses after complaining of severe chest pain lasting several hours. His wife starts to perform basic life support (BLS) as instructed over the phone by the emergency medical services (EMS). Nine minutes after the collapse, the EMS team applies the first defibrillation after diagnosing ventricular fibrillation (Vfib). Despite 20 min of ongoing advanced life support (ALS) efforts, including endotracheal intubation, the cumulative application of 4 mg of adrenaline and 5 defibrillations, the patient remains in Vfib. The EMS team decides to transfer the patient to the nearby tertiary care hospital for the evaluation of extracorporeal cardiopulmonary resuscitation (ECPR) under ongoing cardiopulmonary resuscitation (CPR) using an automated compression device.

1.2. Introduction – literature, indications and contraindications

Almost all cardiac arrest patients who do not respond to standard CPR measures die [1,2]. Veno-arterial extracorporeal membrane oxygenation (VA ECMO) provides both respiratory and hemodynamic support and can be established during CPR [3,4]. This gives the treating team the option to address and to potentially reverse the cause of cardiac arrest while the blood flow to the vital organs is maintained by the mechanical circulatory support, hopefully achieving the return of spontaneous circulation (ROSC). This approach is called extracorporeal cardiopulmonary resuscitation (ECPR).

Because of the very poor prognosis of refractory cardiac arrest, there is growing interest in ECPR. Recent prospective observational studies, as well as retrospective cohorts, case series and case studies report higher survival rates and better neurological outcome of patients supported by ECPR compared to conventional cardiopulmonary resuscitation (CPR) [5–10]. In a meta-analysis including 2260 cardiac arrest patients, ECPR showed a highly significant benefit regarding both survival and long-term neurological outcome when compared to conventional CPR [11]. Another systematic review reports a survival rate of 22% among 833 ECPR cases, with a favorable neurological outcome in 13% [4].

Current resuscitation guidelines consider ECPR as an adjunct therapy – further strategies in the setting of refractory cardiac arrest include intra-arrest anti-arrhythmic drugs, double-sequential defibrillation and coronary angiography under mechanical CPR [12,13].

High quality studies on outcomes of ECPR versus conventional resuscitation are lacking and clinical benefit and cost-effectiveness of this therapy are not yet established. Therefore, only patients with a reasonably high likelihood of a favorable outcome should be offered ECPR over conventional CPR. Indications include a potentially reversible cause of cardiac arrest, (i.e. acute coronary syndrome, hypothermia, drug overdose), and Vfib or ventricular tachycardia as the first documented rhythm [14,15]. Patients with relevant chronic health conditions, or advanced organ dysfunctions should be excluded from ECPR [14], as well as patients after prolonged and unsuccessful BLS and CPR efforts [16–18].

ECPR is a technically and organizationally challenging treatment modality. It follows that patients can only benefit if the provider team is well prepared and if the necessary treatment pathways are established [19].

However, once these requirements are in place, it is possible to achieve positive results. This is highlighted in a recent study by Yannopoulos et al. who report a strategy for treatment of refractory out-of-hospital cardiac arrest consisting of early transfer to a tertiary hospital for ECPR and subsequent coronary angiography. This approach resulted in an increase of survival of nearly 40% compared to the observational period before implementation of ECPR [20].

2. Technical issues

2.1. Technical issues – case report (second part)

On arrival at the hospital the patient is in ongoing Vfib despite further defibrillations. The admitting interdisciplinary team decides to initiate VA ECMO based on the hospital protocol for refractory Vfib. A 19 French cannula is inserted into the right femoral artery, followed by cannulation of the right femoral vein using 25 French cannula with the tip reaching to the vena cava superior. ECPR is started using a primed ECMO circuit.

2.2. Technical issues - ECPR preparation and communication

Before the arrival of a patient for ECPR the triage facility must be informed by the EMS team. Information provided should include the patient's age and relevant co-morbidities, initial cardiac rhythm, downtime, concomitant injuries (i.e. pneumothorax, cardiac tamponade), on-site measures (airway management, usage of mechanical compression device, vascular access) and expected time of arrival at the hospital. It is the responsibility of the in-house emergency physician to forward all necessary information to a predefined multidisciplinary treatment team, which then performs the initial assessment of the patient immediately upon arrival at the hospital. This team should include a cardiologist, a cardiac surgeon, an intensive care specialist, an anesthesiologist, and a perfusionist. The multidisciplinary team should meet at a specified location for the patient handover and for the decision whether to include the patient into the ECPR pathway. By this stage, the decision about where to potentially institute ECPR must already have been made. In our pathway, patients are either taken directly to the cardiac catheterization laboratory or - if a catheterization laboratory is unavailable - to the intensive care unit (Fig. 1) under ongoing mechanical CPR either using a mechanical compression device in case it is already installed or using the classical manual method.

2.3. Technical issues - material

The decision for ECPR should be made within a short period of

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