Benefits of Using Extracorporeal Cardiopulmonary Resuscitation (ECPR) for Cardiac Arrest Patients

A systematic review

Ali Ballout, Perfusion Student, University Of Montreal

Vancouver , October 2017

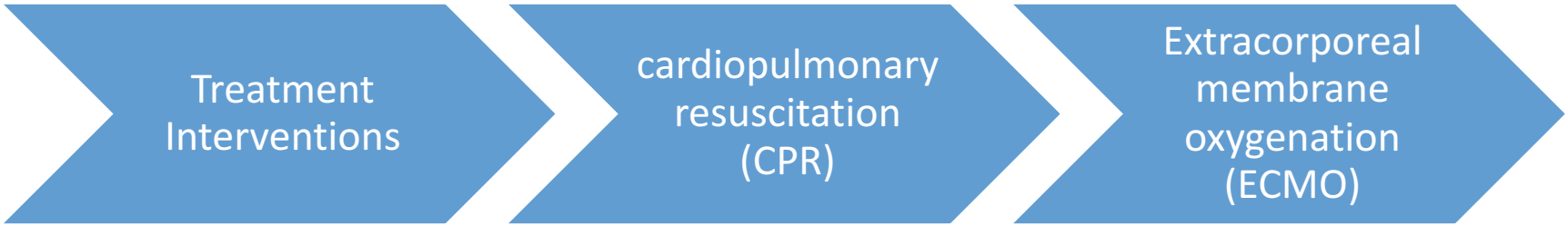
Plan

- Introduction
- Research Objective
- Methods
- Results and Discussion
- Conclusion

Refractory Cardiac Arrest

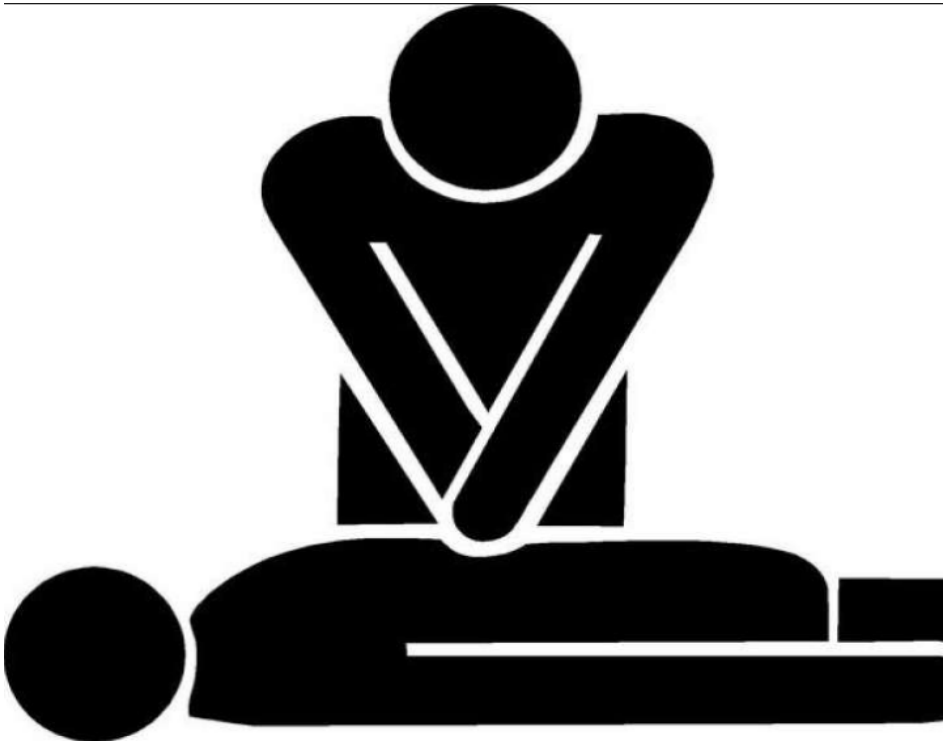
- Is a sudden loss of heart function and mechanical activity, that could occur instantly or after symptoms
- Refractory cardiac arrest : is the non-return of spontaneous cardiac rythm after 15 minutes of CPR.[1]

Refractory Cardiac Arrest



Refractory Cardiac Arrest

CPR



-Cardiopulmonary resuscitation (**CPR**) : is combining chest compressions with artificial ventilation in order to preserve intact brain function until further measures are taken.

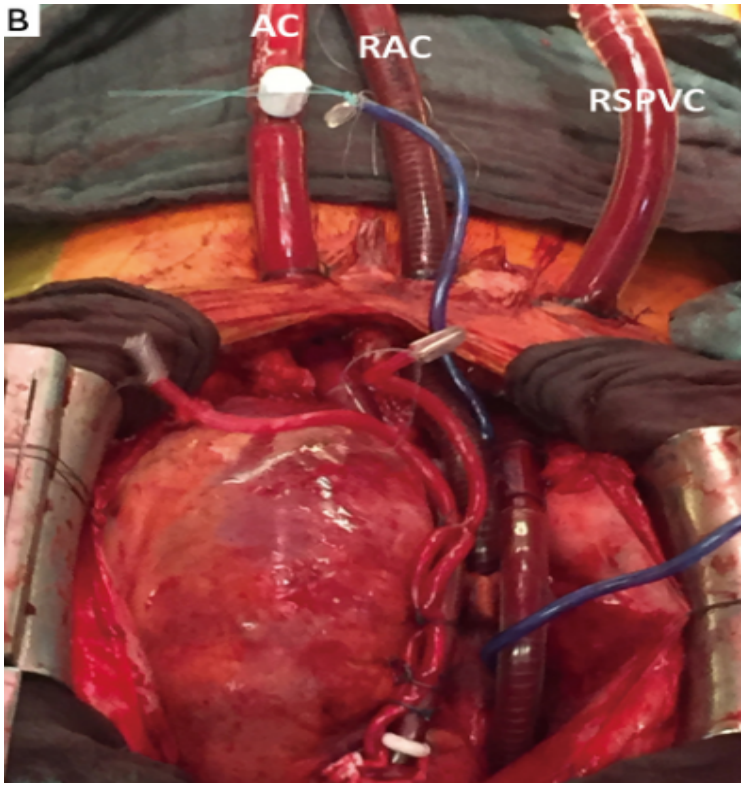
-long duration of CPR is accompanied by a decrease in return to spontaneous circulation (ROSC) [2,3].

Refractory Cardiac Arrest

-Extracorporeal cardiopulmonary resuscitation (ECPR) : is an extracorporeal technique that provides patients with prolonged cardiac
and respiratory support.

-ECPR results in significantly higher survival rate with minimal impairment [4,5].

ECPR



Banfi et al. JTD 2016

Refractory Cardiac Arrest

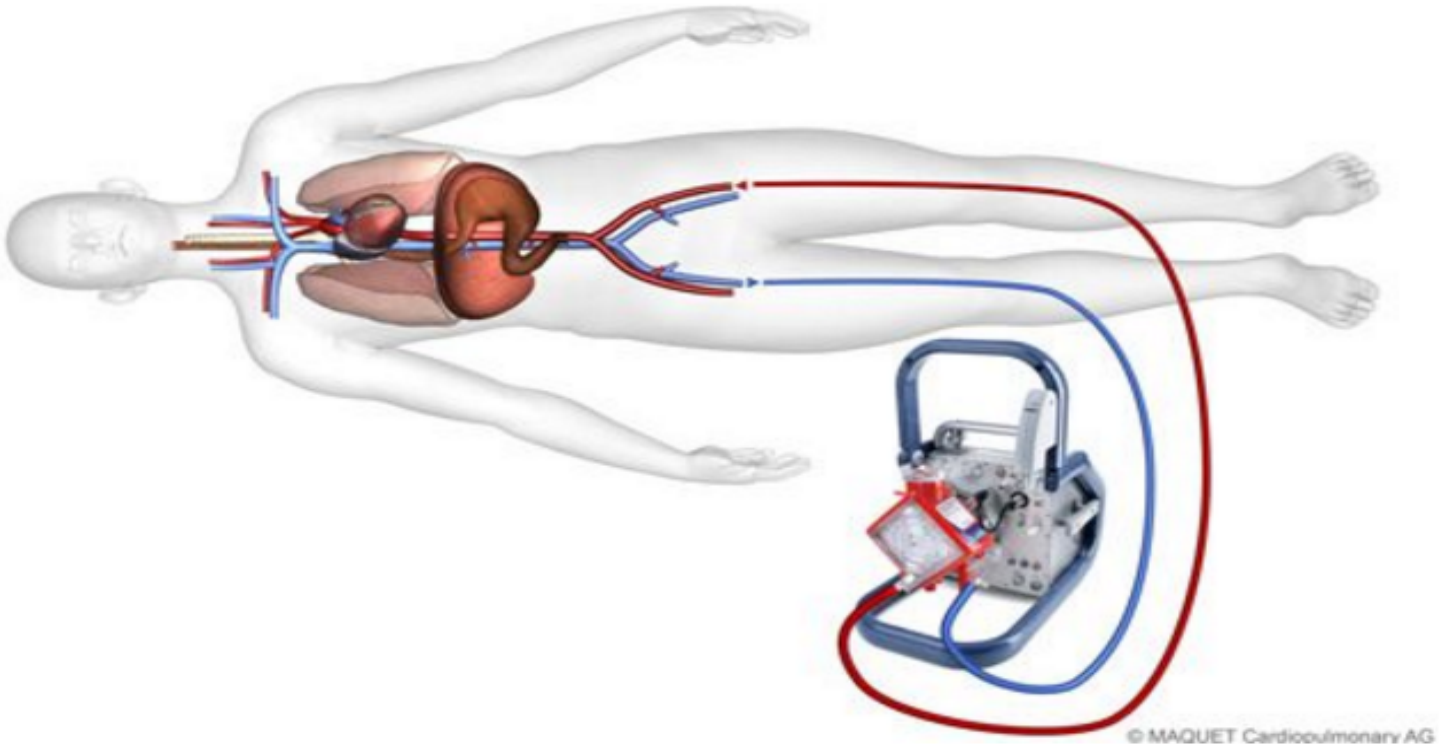
- Both in-hospital (15-20%) and out-hospital (10%) survival rate for cardiac arrest patients after doing conventional therapy (CPR) are low.[1,6]
- Traditional Prognostic Factors:
  - TIME (rapid recognition of cardiac arrest /time to ECMO)
  - Witnessed cardiac arrest
  - Age
  - In-hospital cardiac arrest
  - Initial Rhythm
  - Reversible cause

Extracorporeal Cardiopulmonary Resuscitation (ECPR)

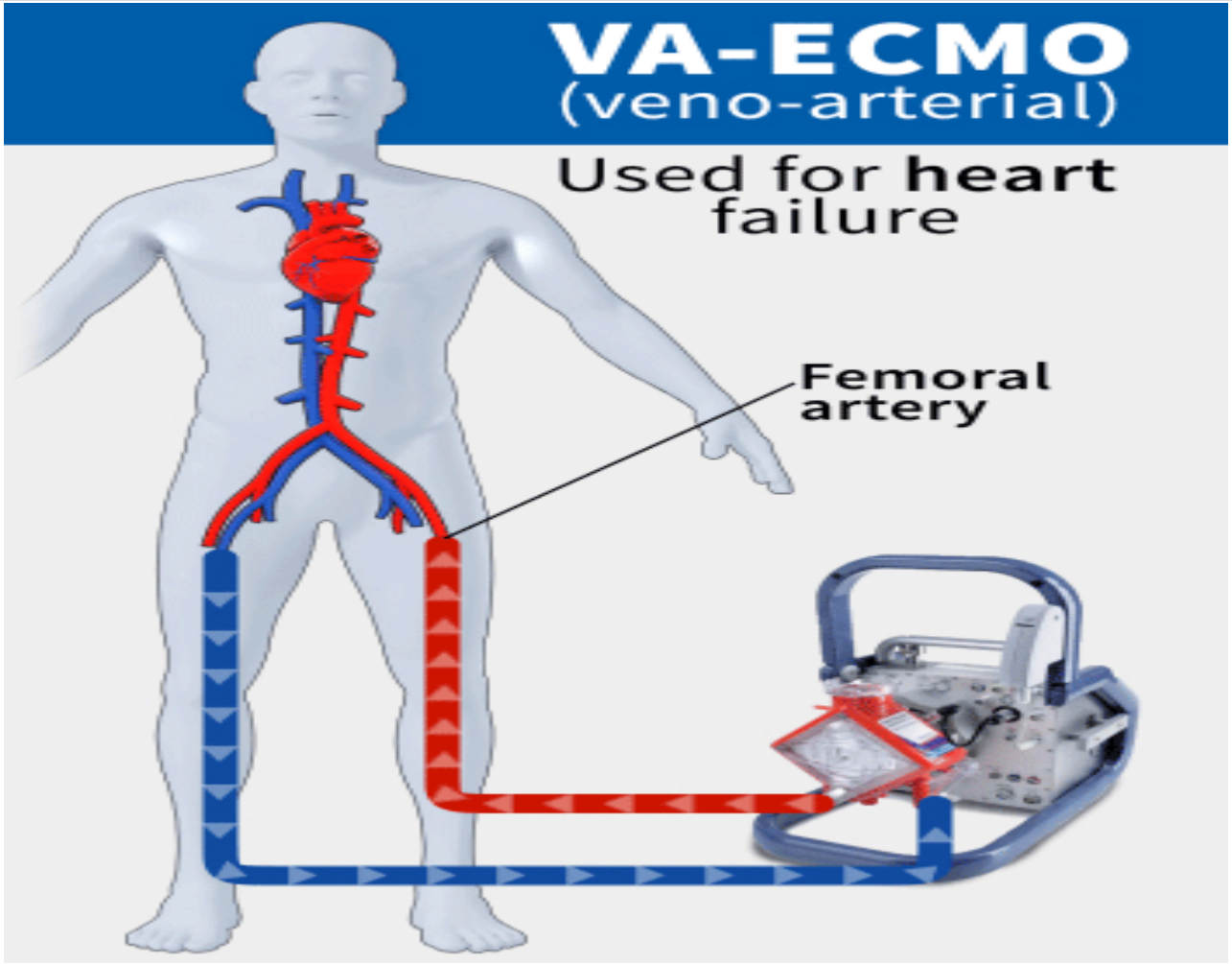
- Studies are showing that there is advantage of ECPR over CPR [7-12] :**significant advantage on survival**

- Extracorporeal membrane oxygenation (ECMO) can provide adequate perfusion to the brain and other vital organs, until return of spontaneous circulation (ROSC).

Extracorporeal Cardiopulmonary Resuscitation (ECPR)



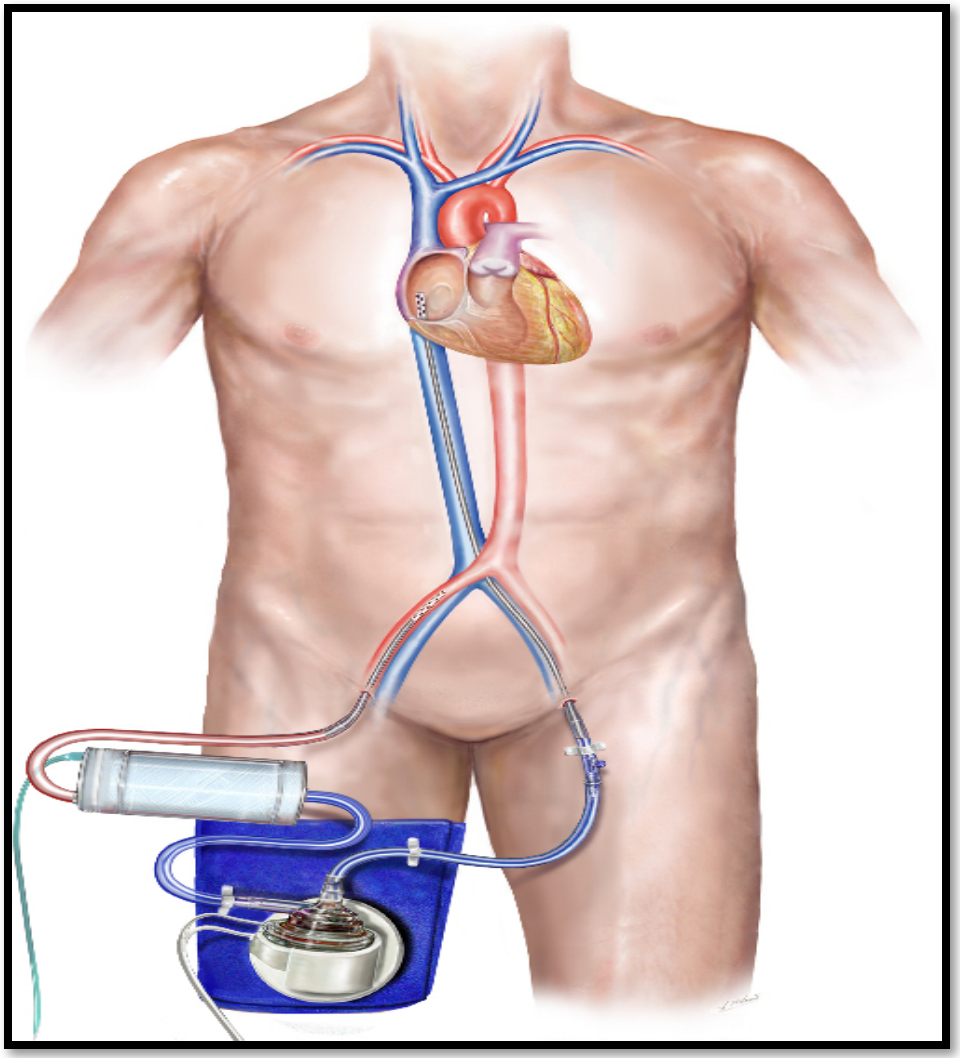
Extracorporeal Cardiopulmonary Resuscitation (ECPR)



www.smh.com.au

Extracorporeal Cardiopulmonary Resuscitation (ECPR)

Extracorporeal Cardiopulmonary Resuscitation (ECPR)



Extracorporeal Cardiopulmonary Resuscitation (ECPR)

In 2015, after several publications, the *American Heart Association guidelines* mentioned:

- There is insufficient evidence to recommend the routine use of ECPR for cardiac arrest patients.

- **ECPR could be considered if:**
  - Availability of ECMO program in the center
  - Cardiac arrest is brief
  - The cause of cardiac arrest is reversible

American Heart Association®

ECPR could be life-saving, thus we did this study to understand its effect after using conventional treatment in refractory cardiac arrest patients

My Project: PICO

Title	***Benefits of Using Extracorporeal Cardiopulmonary Resuscitation for Cardiac Arrest Patients – A systematic review***
Population	Adults (age>18 years), both genders
Intervention	Extracorporeal Cardiopulmonary Resuscitation (ECPR) post cardiac arrest (after CPR)
Outcomes	Primary outcome: Survival rate Secondary outcomes including Neurological status at hospital discharge, hemodialysis incidence bleeding, infection limb malperfusion and Hospital stay.

Objective

- Perform a systematic review to assess and evaluate how the use of ECPR in in-hospital refractory cardiac arrest, would achieve better survival and neurologic function.

Methods


SYSTEMATIC
REVIEW
GROUP
BIOMEDICAL
OCCUPATIONAL
SCIENCES
STUDY
INFLUENTIAL
HIGH
UNIVERSALLY
INCLUDE
REHABILITATION
SUMMARY
MEDICINE
RESULTS
REVIEW
SOCIOLOGY
QUALITATIVE
CRITERIA
METHODOLOGICAL
PUBLIC
RESEARCH
SYSTEMATIC
METHODOLOGY
LITERATURE
EXHAUSTIVE
QUESTION
REPORTING
APPLIED
FOUND
REVIEWERS
CONSULTED
DEVELOPING

Research Strategy

- Assisted by an experienced librarian

- Database searched: MEDLINE

Data collection and analysis

- Stage 1 :Screening the articles to exclude irrelevant articles after assessing abstract and title.
- Stage 2 :full text articles chosen are assessed for eligibility.
- Stage 3 :Data extraction and evaluation of full text articles that are included in the systematic review.

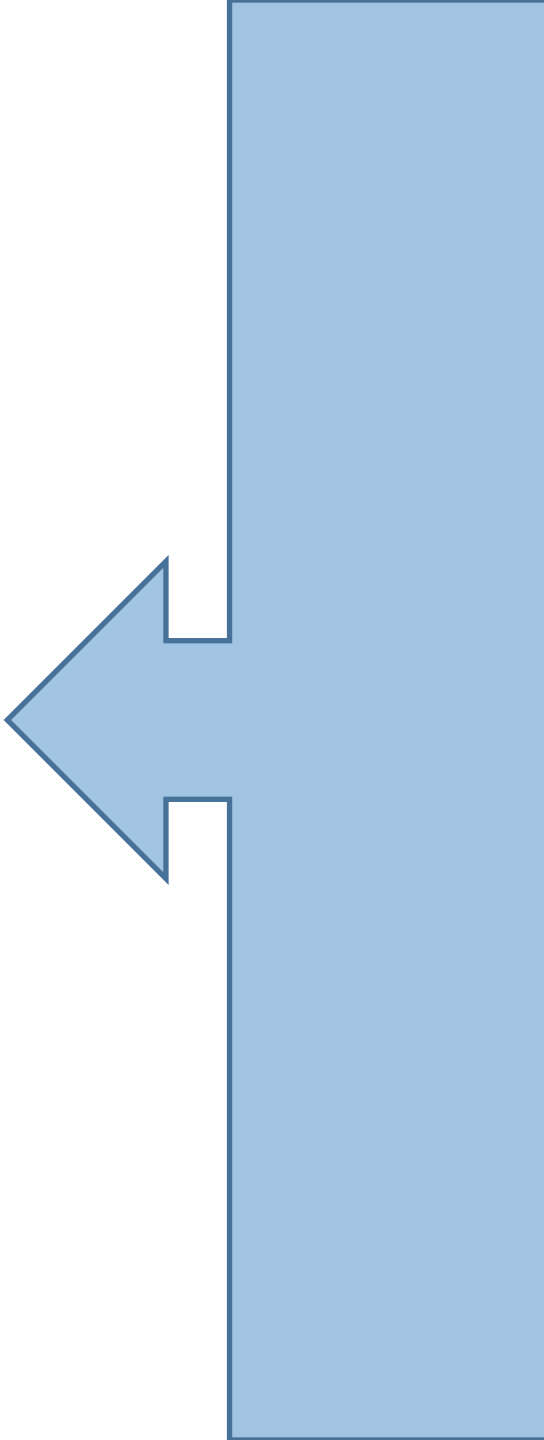
Inclusion /Exclusion Criteria

- **Inclusion Criteria**
- Articles published about Extracorporeal cardiopulmonary resuscitation post cardiac arrest
- Articles including the following outcomes: Survival rate, Hospital stay, hemodialysis incidence
- Articles employing patients who are refractory to CPR, thus used ECMO (indicated)

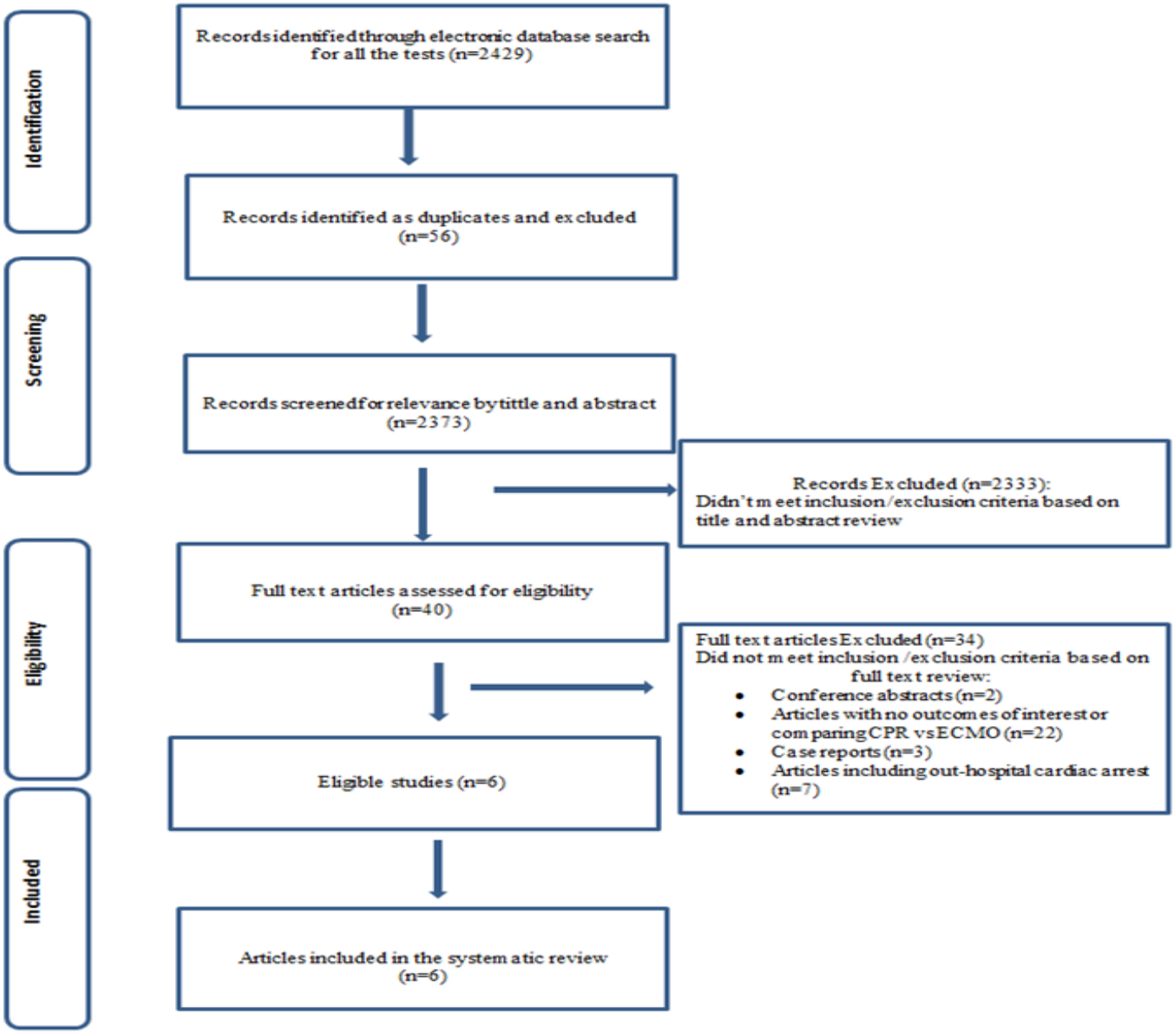
- **Exclusion Criteria**
- Conference abstracts
- Cases of age < 18 years
- Commentaries and review articles
- Articles about out-hospital cases
- Studies published in a language other than English

Outcomes

- Survival rate
- Mortality
- Hospital stay
- Weaning rate
- Complications
- ICU stay
- Neurologic function
- Lactate levels
- Successful de-cannulation
- Duration of mechanical ventilation



Results and Discussion



Results and Discussion

Outcomes	
Survival rate	-30-day **Survival rate**: varied between 25% and 47% **-Survival rate:** survival rate was higher for CPR lasting 60 min than for CPR lasting > 60 min (p=0.004) -**Overall survival:** associated to duration of ECMO (p=0.05)/ more favorable outcome in those patients when the duration of ECMO was less than two days (p < 0.001)
Hospital stay	**-Hospital stay:** varied between 17–45 days in survivors, and 2.8–10 days in non-survivors - 2 studies explained about this outcome
Duration of mechanical ventilation	**-One study :** duration varied between 5–14 days in survivors, 2–11 days in non-survivors
Neurologic function	Use of resuscitative ECMO was associated with neurologically favorable survival **(**CPC 1–2)

Results and Discussion

Outcomes	
Weaning rate	**Weaning rate**: varied between 37.5% and 66.7%
Complications	**Reported Complications such as** : -limb mal perfusion/ amputation (1-9%) **-**Bleeding up to 56% -refractory ventricular fibrillation -cerebral hemorrhage (one study reported 6%) **-**anoxic brain injury (one study reported 17%) -stroke (one study reported 17%) - bowel necrosis (one study reported 4.3 %) -ARF (22-36%) -Pneumonia (one study reported 9.1%)
Lactate levels:	**- Two studies: Lactate levels**: Median lactate levels were significantly higher among non-survivors during hours 6–48 of ECMO support **-Lactate levels**: improved after ECMO(preECMO:7.0+/- 5.4 vs post-ECMO:2.1+/- 1.5)

Results and Discussion

Article	Study	n	Results	Conclusion
(Bednarczyk, et al. 2014)	Single center retrospective observational study	32	**-**30-day **Survival rate**: 5 (50%) in the E-CS group, 10 (45.4%) in the E-CPR group, and 15 (47%) overall. **-Mortality:** Death on ECMO support occurred in 7 (21.9%) patients **-Hospital stay:** 29 (17–45) days in survivors, 7 (2.8–10) days in non-survivors **-ICU stay:**7.5 [3.3–14] days , ICU survival occurred in 16 (50%) of patients **-Duration of mechanical ventilation:** 9 (5–14) days in survivors, 5 (2–11) days in non-survivors **-Favorable Neurologic function:** All survivors had CPC 1–2 neurologic status(the 15 patients) **-Lactate levels**: Median lactate levels were significantly higher among non-survivors during hours 6–48 of ECMO support -**Successful de-cannulation:** 18 (56.3%)	Use of resuscitative ECMO was associated with neurologically favorable 30-day survival in 47% of patients with prolonged IHCA
(Chen,et al. 2003)	Observational Cohort	57	**-Survival rate:** 31.6% (18/57)→ survival rate was higher for CPR lasting 60 min than for CPR lasting > 60 min (p=0.004) -**Weaning rate**: 66.7% (38/57): 52.6% [n=20]) of those who were successfully weaned died later due to a severe neurologic deficit, persistent cardiac failure ,or multiple organ failure -After long-term follow up: **survival**: 88.9% /only 5.6% had a severe **neurologic deficit** -**Complications**: one patient had limb amputation	Prolonged CPR rescue by ECMO provides an acceptable survival rate and outcome in survivors.

Results and Discussion

Article	Study	n	Results	Conclusion
(Lazzeri, et al. 2013)	Single center retrospective observational study	16	**-Survival rate:** 4 patients (25%) **-Weaning rate**: 37.5% (6/16) among whom 2 patients died and 4 patients (25%) were discharged alive **-Favorable Neurologic function:** good neurological function:3/16 (18.8%) at six-month follow-up. When D/C: 2 patients showed good neurological function, 1 a moderate cerebral disability, 1 in a vegetative state -**Complications:** Bleeding in 9/16 (56.2%) of which 7 patients (43.7%) had RBC transfusion, refractory ventricular fibrillation occurred six days after VA-ECMO removal in 1 patient , cerebral hemorrhage occurred 36 h after VA-ECMO removal in 1 patient	VA-ECMO support was associated with a in-hospital survival rate of 25% and a good neurological function of 18.8% at six-month follow-up
(Peigh, et al. 2015)	Single center Observational Cohort	23	**-Survival to D/C:** 30% (7/23) **-Mortality:** 9 patients (39%) while on ECMO **-Hospital stay:** after E-CPR was 43+/- 28 days. **-Favorable Neurologic function:** 100% of those survived→ 7 with full neurologic recovery – no gross neurologic deficits during a follow-up visit 4 to 6 weeks after D/C from a rehabilitation facility. **-Lactate levels**:improved in 12 patients (preECMO:7.0+/- 5.4 vs post-ECMO:2.1+/- 1.5) **-Complications:** anoxic brain injury (4 patients), stroke (4 patients), and bowel necrosis (1 patients) → all died ARF in 5 patients	ECMO→ allowed good neurologic recovery, improved hospital outcomes for patients with in-hospital cardiac arrest→ should be considered

Results and Discussion

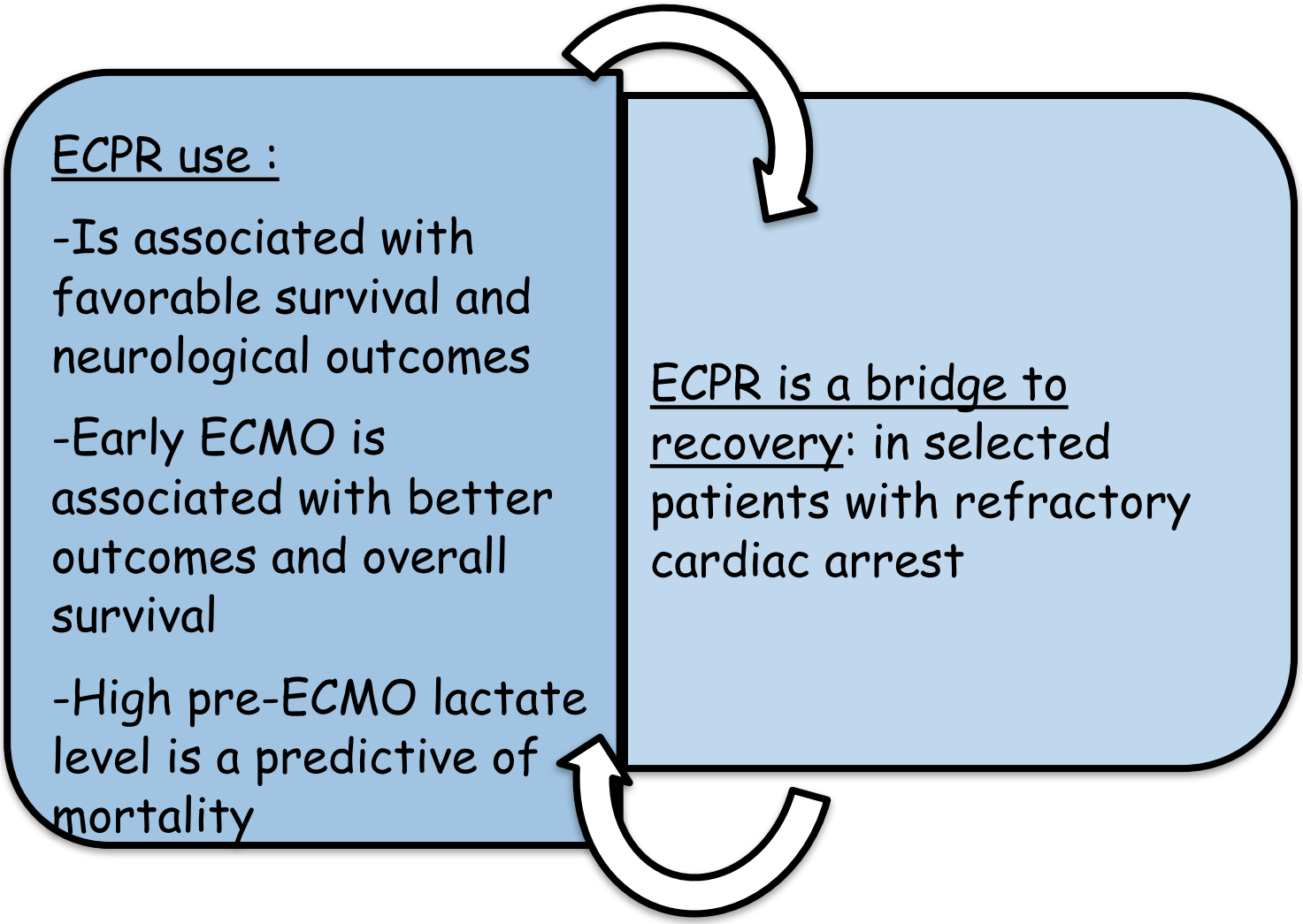
Article	Study	n	Results	Conclusion
(Lee, et al. 2012)	Prospective study	185	**-Survival to discharge:** 20.5% (38) -**Overall survival:** associated to duration of ECMO (p=0.05)/ more favorable outcome in those patients when the duration of ECMO was less than two days (p < 0.001) -**Survival rates**: at one, three, and five years were 20%, 18%, and 17%, respectively **-Weaned:** successful in 36.7% (68 patients) with 20.5% (38) discharged eventually	-Early ECMO application before catastrophic clinical deterioration and weaning as soon as possible may enhance overall survival. -Timely application of ECMO may improve tissue perfusion and inhibit the progression to multi-organ failure
(Liu, et al. 2011)	Retrospective chart review	10	-**Survival to D/C**: 36.3% (4) survived to discharge without neurological deficits or other post E-CPR complications -**30-day survival:** 36.3% (4) **-3-month survival**: 36.3% (4) **-cumulative survival rate of E-CPR** : 81.8% (at 24 hours), 54.5% (at three days), 45.6% (at 14 days), 36.4% (at one month), and 36.4% (at three months) -**Weaned**: successful in 63.6% (7 patients) -**Complications**: Acute renal failure 4 (36.4): 2 did hemodialysis , Mal perfusion of leg 1 (9.1), Bleeding or haematoma 1 (9.1) , Pneumonia 1 (9.1) , Sepsis 1 (9.1)	ECMO→ allowed good neurologic recovery, improved hospital outcomes

Discussion

- All included studies witnessed ECMO as an intervention associated with good survival rate and neurological function during follow-up .

- This was supported by other studies comparing between ECMO use and conventional treatment.

Conclusion


ECPR use :
-Is associated with favorable survival and neurological outcomes
-Early ECMO is associated with better outcomes and overall survival
-High pre-ECMO lactate level is a predictive of mortality
ECPR is a bridge to recovery: in selected patients with refractory cardiac arrest

References

1. Conrad SA and Rycus PT. Extracorporeal membrane oxygenation for refractory cardiac arrest. Ann Card Anaesth. 2017;1:S4-10.
2. Dowie R, Campbell H, Donohoe R, Clarke P. 'Event tree' analysis of out-of-hospital cardiac arrest data: confirming the importance of bystander CPR. Resuscitation. 2003;56(2):173-81.
3. Massetti M, Tasle M, Le Page O, Deredec R, Babatasi G, Buklas D, et al. Back from irreversibility: extracorporeal life support for prolonged cardiac arrest. The Annals of thoracic surgery. 2005;79(1):178-83; discussion 83-4.
4. Shin TG, Choi JH, Jo IJ, Sim MS, Song HG, Jeong YK, et al. Extracorporeal cardiopulmonary resuscitation in patients with inhospital cardiac arrest: A comparison with conventional cardiopulmonary resuscitation. Crit Care Med. 2011;39(1):1-7.
5. Cardarelli MG, Young AJ, Griffith B. Use of extracorporeal membrane oxygenation for adults in cardiac arrest (E-CPR): a meta-analysis of observational studies. ASAIO journal (American Society for Artificial Internal Organs : 1992). 2009;55(6):581-6.
6. Wang G, Chen X, Qiao L and al. Comparison of extracorporeal and conventional cardiopulmonary resuscitation : a meta-analysis of 2260 patients with cardiac arrest. World J Emerg Med. 2017;8(1) 5-11.
7. Shin TG, choi JH, Jo IJ and al. Extracorporeal cardiopulmonary resuscitation in patients with inhospital cardiac arrest: a comparison with conventional cardiopulmonary resuscitation. Crit Care Med. 2011;39(1):1-7.
8. Maekawa K, Tanmo K, Hase M and al. Extracorporeal cardiopulmonary resuscitation for patients with out-of-hospital cardiac arrest of cardiac origin: a propensity-matched study and predictor analysis. Crit Care Med. 2013;41(5):1186-96.
9. Chou TH, Fang CC, Yen ZS and al. An observational study of extracorporeal CPR for in-hospital cardiac arrest secondary to myocaridal infaction. Emerg Med J. 2014;31(6):441-7.
10. Kim SJ, Park JS, Hong YS and al. An optimal transition time to extracorporeal cardiopulmonary resuscitation for predicting good neurological outcome in patients with out-of-hospital cardiac arrest : a propensity-matched study. Crit Care. 2014;18(5)535.
11. Lee SH, Jung JS, Lee KH and al. Comparison of extracorporeal cardiopulmonary resuscitation with conventional cardiopulmonary resuscitation : is extracorporeal cardiopulmonary resuscitation more beneficial ? Korean J Thorac Cardiovasc Surg. 2015;48(5):318-27.
12. Goldberg ZD, Chan PS, Berg RA and al. Duration of resuscitation efforts and survival after in-hospital cardiac arrest: An observational study. Lancet. 2012;380:1473-81.

Thank You