WORKSHEET for Evidence-Based Review of Science for Emergency Cardiac Care

Worksheet author(s)
Michael Czekajlo, MD, PhD

Date Submitted for review:

Clinical question.
In adult cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P) – does the use of rapid deployment ECMO, Aortic Balloon Pump or emergency cardiopulmonary bypass (I), compared with standard treatment (C), increase survival to hospital discharge with favorable neurologic outcomes (O)?

Is this question addressing an intervention/therapy, prognosis or diagnosis? Question addresses intervention using mechanical assist devices; specifically intraortic balloon pump and ECMO/emergency cardiopulmonary bypass.

State if this is a proposed new topic or revision of existing worksheet: In the previous guidelines Falcucci and Chirumamilla addressed a similar question and concluded “Invasive perfusion devices improve outcome from cardiac arrest when compared with standard CPR in cardiac arrest patients with an underlying cardiocirculatory disease amenable to immediate corrective intervention. (surgically correctible anatomic lesion (CAD, PE, etc.))”

Conflict of interest specific to this question
Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet? No conflict of interest.

Search strategy (including electronic databases search)
- medline, Cochrane and embase
- reviewed citations from 2005 worksheet by Falcucci and Chirumamilla
- Textbook of Critical Care Medicine
- Reviewed citations in bibliographies of all articles included.

State inclusion and exclusion criteria
Search words used: adult, cardiac arrest and cardiopulmonary bypass; adult, cardiac arrest and ECMO adult, cardiac arrest, ECPR; adult, cardiac arrest and intra-aortic balloon pump. ECMO resulted in 4161 aarticles and Extracorporeal membrane oxygenation 4005; when adult ECMO searched there were 1108 results; Adult ECMO & cardiac arrest resulted in 58 articles of which 13 were included for further review.

A search of Extracorporeal Life Support and cardiac arrest resulted in 67 articles with significant overlap with the search of Adult ECMO & cardiac arrest. The final 13 articles included for further review are represented by this search.

Only peer reviewed journals with full articles and no abstract only articles were included. Human studies and one animal study was included that was a citation for the 2005 guidelines. No other relevant animal studies found. Hypothermia arrest and case reports were excluded.

ECMO is a form of cardiopulmonary bypass and for the purpose of the searches most of the articles entitled cardiopulmonary bypass were an ECMO circuit. The difference between ECMO and Cardiopulmonary bypass done in the OR is the type of tubing and the use of cardioplegia in the OR.

Number of articles/sources meeting criteria for further review:
20 articles from the literature search; incorporation of articles from 2005 guidelines; hand search of citations in reviewed articles.
# Summary of evidence

## Evidence Supporting Clinical Question

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<th>Good</th>
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<tr>
<td>Tanno 2008 649 CDE Chen 2008 554 CD</td>
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<td>Chen 2006 950 CE</td>
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<td>Chen 2003 197BCD</td>
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<td>Schwartz 2003 758AE</td>
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<td>Smedira 2001 92 BCE</td>
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<td>Wilms 1997 65BE</td>
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### Level of evidence

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<td>E = Other endpoint</td>
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<tr>
<td>B = Survival of event</td>
<td>D = Intact neurological survival</td>
<td>Italics = Animal studies</td>
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### Evidence Neutral to Clinical question

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### Evidence Opposing Clinical Question

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REVIEWER’S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:

The use of mechanical assist devices such as IABP and ECMO/CPB as adjunctive therapy to stabilize hemodynamics and improve oxygenation and perfusion in adult patients with cardiogenic shock and/or cardiac arrest is of significant benefit when used appropriately.

ECMO and CPB were independently researched in the data bases but had considerable overlap so for the purpose of this analysis will be addressed as equivalent therapies since there is not much technical difference between the 2 procedures in regards to post cardiac arrest patients. No randomized controlled trials for the use of IABP or ECMO exist. IABP is standard of care in cardiac surgery units to help support the left ventricle pre and post bypass and in cases of cardiogenic shock to help reduce afterload and provide time for reperfusion and revascularization such as in acute myocardial infarction in the Emergency Department or the Cardiac Cath lab. It is doubtful that a randomized controlled study using ECMO could be done since it is recognized and currently used as rescue therapy and bridge therapy to LVAD and transplantation.

ECMO has been available for over 40 years. Most of the literature reports its benefit in the pediatric/neonatal population for respiratory failure and congenital cardiac anomalies. More recently data has been published using ECMO as rescue therapy for adult patients in cardiogenic shock and cardiac arrest.

Even though the epidemiology of cardiac arrest victims has traditionally been different the data suggests a benefit whether the arrest was out of hospital or inhospital.

There is less data available for ECMO in out of hospital cardiac arrest. In Tanno’s (Tanno 2008 649) study of 66 out of hospital cardiac arrest patients 3 month survival was 22.7% and 10.6% had a CPC of 1. However, the CPB group was more likely to have had a witnessed arrest, receive bystander CPR and was younger with a mean age of 52 compared to 70 in the standard treatment group. One year data was not available to compare to other Prehospital Utstein data to compare the benefit of ECMO in this population.

Chen (Chen 2008 2529) in his final analysis had a small subgroup of 7 patients who had out of hospital cardiac arrest who received ECMO. Three of these patients survived to be weaned off of ECMO with a CPC and a fourth suffered neurological injury and was in a persistive vegetative state.

Data from in-hospital cardiac arrests showed survival to discharge rated of at least 30% and 1 year survival in Chen’s (Chen 2008 554) study being 15.3% with a CPC of 1 or 2. The difficulty in comparing the ECMO studies include the different initiation times of ECMO; different protocols and lack of consistency in reporting outcomes. However, all reports consistently reported survival with ECMO inversely proportional with CPR times.

Smedira (Smedira 2001 92) in his retrospective review of 202 adults treated with ECMO reported a 30 day survival of 38% and 5 year survival of 24%. In the discussion the authors suggested that the lack of concomitant use of IABP may have contributed to poor outcomes. This also raises the question as to whether the use of hypothermia which is now widely accepted as beneficial adjunctive therapy and optimization of the quality of ACLS which were not addressed in most of the studies needs to be addressed before or in conjunction with the use of ECMO.

Chen (Chen 2008 554) had raised the issue of the quality of CPR perhaps not being equal in the ECPR vs traditional CPR group. Although some level of selection bias can not be ruled out the data suggests that
aggressive therapy needs to be provided to younger patients with better baseline conditions and reversible pathology.

Since it may be difficult to immediately know whether the underlying pathology is reversible IABP and ECMO provide a therapeutic bridge to allow time to diagnose the underlying pathology and potentially correct surgically. In 2 of the studies biochemical markers including AST, creatinine and lactate trends have the potential to be prognostic. Worsening end organ and multiorgan failure were a major reason for mortality.

Although the studies in the adult population have been small and many questions are left unanswered there is sufficient evidence to recommend the use of IABP and ECMO to adult cardiac arrest victims as a therapeutic bridge to allow myocardial recovery or for a destination therapy. At the very least these therapies will allow time to determine whether recovery is possible or further therapy would be futile.

Acknowledgements:

Citation List

1) Bartlett RH, Roloff DW, Custer JR, Younger JG, Hirschl RB. Extracorporeal life support: the University of Michigan experience. JAMA. 2000 Feb 16;283(7):904-8

4 Fair BC


5 Good

- IABP data that also included out of hospital cardiac arrest
- Etiology of arrest correlates with mortality
- Renal failure associated with poor prognosis


2 Fair CD

- survival to discharge at 1 year better with ECMO
- would hypothermia have improved survival?
ECPR group had more arrests in ICU compared to conventional group
CPR > 10 min before ECMO
- CPC 1-2 at 1 yr 15.3% with ECMO and 8.9% with conventional tx

3Fair CD

- Successful weaning rate 58.5%
- -survival to discharge 34%
- 7 OOHCA who got ECMO; 3 were weaned with CPC of 4 and 1 d/c’d in vegetative state
- Risk factors: long CPR, etiology of aCS, organ dysfunction at 24h


4Good CE

- Higher lactate and multi organ failure associated with higher mortality
- Everyone had IABP
- - SOFA score for prediction?
- -Risk factor for mortality: longer CPR, etiology ACS, increasing organ dysfunction at 24h
- -probability of survival decreased with increased CPR duration


4Good BCD

- CPR for > 10 min without ROSC before ECMO
- ECMO duration 96.1 min +/- 87.9 min
- Daily Echo
- No ECMO weaning until 72 hrs
- Biochemical data for weaning and survival
- Multiorgan failure major reason for mortality


4Good CD

- support sECMO for etiology that is correctable surgically


4Good ABE
Data on 187 pt’s from 17 centers
- Witnessed arrest
- Correctable underlying etiology
- 21% survival at 30 days
- 30% weaned off bypass
- - ? IABP/hypothermia/quality of ACLS?
- - Raises question as to whether eCMO should be limited to centers that have capability to provide all resuscitative services to not dilute experience of staff.


3Fair A

- Mean survival 47.8 min
- - no long term survivors
- - Would they have done better if they received IABP and hypothermia?
- - ? patient selection


4Good CD

- Mean age of this group was young, 42
- 11 of 18 bridged to either LVAD or transplant
- Survival 8 at 18 months
- Raises question about regional centers that can perform ECMO as well as VAD and transplant


4Good CD

- CPR up to 180 min survived at 1 year
- Delay in getting eCMO, avg CPR 120 min
- Hypothermia first 24 hrs
- ECMO adjusted to MAP< UOP and lactate
- Even high lactate of 39 and 20 pre-ecmo survived
- Dobutamine for LV decompression, heparin and hypothermia used
- ARDS vent protocol

3Fair ACE

- 7 pt’s got CPB and survived
- correctable underlying etiology had improved survival
- survival to d/c was 64%


3Fair ABCD

- IABP and hypothermia used
- Did combination of IABP and hypothermias improve survival?
- high ROSC rates
- Quality of prehospital care?


5 Good

- Confirms what we already know and practice that IABP supports LV


4Good AE

- Cardiogenic shock pt’s did better than cardiopulmonary arrest
- ECMO good when cause reversible
- Complication rate = 39%
- Major complication = 18%
- Bleeding is an issue. If used as bridge to transplant should leukocyte reduced PRBC be used?

4Good BCE

- Follow up 7.5 yrs
- 5 yr survival of 24%
- Renal failure associated with poor outcome
- Multiorgan failure associated with poor outcome; suggests ECMO could be used as bridge and if underlying cause not correctable and/or worsening organ function by 3-5 days withdraw of care to be considered?


4Good CE

- IABP used in 6 pt’s
- Survival to d/c 41% (9)
- 9 pt’s without neuro deficit


2Good CDE

- Use of CPB for arrest pt’s associates with reduced mortality but did not increase good neurological outcome. 10.6% CPC of 1
- CPB group age + 52; standard group – 70 y/o
- CPB group more likely to receive bystander CPR
- CPB more likely to have witnessed arrest and VF


4Fair BE

- ECMO provides time to correct underlying cause
- CPR > 30 min had worse survival
- Study done before hypothermia became standard