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

Worksheet author(s)
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Clinical question.
In adult cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P) – does the use of rapid deployment Extracorporeal Membrane Oxygenation (ECMO), Aortic Balloon Pump (IABP) or emergency cardiopulmonary bypass (CPB) (I), compared with standard treatment (C), increase survival to hospital discharge with favorable neurologic outcomes (O)?
This is an update of the previous CoSTR review which evaluated whether 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 correctable anatomic lesion (CAD, PE, etc.) or not.

Is this question addressing an intervention/therapy, prognosis or diagnosis: Intervention
State if this is a proposed new topic or revision of existing worksheet: Revision

Conflict of interest specific to this question
The authors have no conflict of interest relevant to this worksheet.

Search strategy (including electronic databases searched).

English literature
We searched the Cochrane Controlled Trials Register (CCTR), PUBMED, and Scopus. Each database was searched using the search strategy shown below.

CCTR
#1 Cardiac arrest in Title, Abstract or Keywords and cardiopulmonary bypass in Title, Abstract or Keywords, from 2003 to 2009 in The Cochrane Central Register of Controlled Trials; 46 articles
#2 Cardiac arrest in Title, Abstract or Keywords and extracorporeal in Title, Abstract or Keywords, from 2003 to 2009 in The Cochrane Central Register of Controlled Trials; 5 articles
#3 #1OR #2; 48 articles

PUBMED
#3. #1OR #2; 280 articles

Scopus
#1. TITLE-ABS-KEY("cardiac arrest" AND "cardiopulmonary bypass") AND DOCTYPE(ar) AND PUBYEAR AFT 2002 AND PUBYEAR BEF 2010 AND (LIMIT-TO(SUBJAREA, "MEDI") OR LIMIT-TO(SUBJAREA, "NURS") OR LIMIT-TO(SUBJAREA, "HEAL") OR LIMIT-TO(SUBJAREA, "MULT") OR LIMIT-TO(SUBJAREA, "MULT")); 203 articles
#2. (TITLE-ABS-KEY("cardiac arrest") AND TITLE-ABS-KEY(extracorporeal)) AND DOCTYPE(ar) AND PUBYEAR AFT 2002 AND PUBYEAR BEF 2010 AND (LIMIT-TO(SUBJAREA, "MEDI") OR LIMIT-TO(SUBJAREA, "NURS") OR LIMIT-TO(SUBJAREA, "MULT")); 137 articles
#3. #1OR #2; 307 articles

Searching other resources: We included the articles included in the previous review.

Japanese literature
We searched Igaku Chuo Zasshi (Japana Centra Revuo Medicina) to identify articles published in Japan using the following thesaurus keyword search:

#1. (“Artificial Cardiopulmonary System” OR “Percutaneous Artificial Cardiopulmonary System”) AND (“cardiac arrest” OR “cardiopulmonary arrest”) AND Publication Type(exclude conference proceedings); 14 articles
#2. (“Artificial Cardiopulmonary System” OR “Percutaneous Artificial Cardiopulmonary System”) AND “resuscitation” AND Publication Type(exclude conference proceedings); 20 articles
#3. “1 OR #2; 25 articles

State inclusion and exclusion criteria
Articles were included for review for the following: [1] Design: Interventional or observational studies, meta-analysis, or systematic review [2] Population: Human adult aged 14 or over, with cardiac arrest, [3] Intervention: Rapid deployment (ECMO) or Aortic Balloon Pump (IABP) or Emergency cardiopulmonary bypass (CPB), [4] Outcomes: Survival or favorable neurologic outcomes.
The following studies were excluded: [1] Design: Case report or Narrative review, [2] Population: Children aged 14 or under or animal studies, cardiac arrest that followed hypothermia, or studies conducted for same population (only most recent study is included), [3] Intervention: cardiopulmonary bypass for post surgical hypothermia [4] Language: other than Japanese or English

Number of articles/sources meeting criteria for further review:
24 studies met criteria for further review, including: 2 LOE 2 and 22 LOE 4.
# Summary of evidence

## Evidence Supporting Clinical Question

| Poor | 1 | 2 | 3 | 4 | 5 | Level of evidence |

A = Return of spontaneous circulation  
B = Survival of event  
C = Survival to hospital discharge  
D = Intact neurological survival  
E = Other endpoint  
*italics* = Animal studies
## Evidence Neutral to Clinical question

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<td>Chen 2008 D</td>
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<td>Fukumoto (J), 2001, B, C, D</td>
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### Level of evidence

- **A** = Return of spontaneous circulation
- **B** = Survival of event
- **C** = Survival to hospital discharge
- **D** = Intact neurological survival
- **E** = Other endpoint

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## Evidence Opposing Clinical Question

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### Level of evidence

- **A** = Return of spontaneous circulation
- **B** = Survival of event
- **C** = Survival to hospital discharge
- **D** = Intact neurological survival
- **E** = Other endpoint

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*Italics = Animal studies*
We identified nine articles written in English after previous ILCOR search. In addition to the nine new reports, four studies categorized as LOE-3 in the previous report, and ten studies written in Japanese published between 1991 and 9/30/2009 were included in the review. Thus total of 23 studies were eligible for review.

No LOE-1 study is identified. We classified studies as LOE-2 if subjects with and without CPB are selected from same cohort (i.e. both were selected patients with cardiopulmonary arrest in same time period). Two LOE-2 studies were identified. In the LOE-2 studies, we classified them into three groups based on four methodological quality indicators suggested by ILCOR (4 or 3: Good, 2 or 1: Fair, and 0: Poor). We defined LOE-3 studies as cohort studies with retrospective (historical) cohort data (i.e. individual treated in the past and used in a comparison group when researchers analyze the results of a clinical study that had no control group). There was no LOE-3 study in our analysis. We categorized studies as LOE-4 if there is no individual is included in the report, and made quasi-comparison with previously published studies. Four studies classified into LOE-3 with previous review criteria were categorized in the LOE-4. In addition, 18 newly published studies were classified as LOE-4. We further classified the LOE-4 studies into three groups based on three methodological quality indicators suggested by ILCOR (3 or 2: Good, 1: Fair, and 0: Poor).

Although LOE-2 studies can be clearly classified into either of three groups, supporting, neutral, or opposing to clinical questions based on statistical significance (we did not consider statistical power in this review), it is ambiguous how we can classify them in LOE-4 studies. We categorized LOE-4 studies as “supporting” if one of following conditions were satisfied: (1) authors indicated the usefulness based on comparison with previously published reports of standard treatment or (2) Return of spontaneous circulation /discharge survival rate and/or preferable neurological outcome is greater than 33% (we did not consider 95% confidence interval in this review).

Within all studies, eleven reports focused only on cardiac cause, and others included non-cardiac causes. Out-of-hospital arrest was included in sixteen studies. Eight studies focused only on in-hospital patients, and one study did not distinguish them. ECMO, emergency CPB, and IABP were evaluated in six, nineteen and one studies respectively. Regarding outcomes, nine studies evaluated neurological disabilities, such as Glasgow-Pittsburgh cerebral performance categories (CPC) and Glasgow Outcome Scale (GOS). Time of neurological evaluation varies from at discharge to after 68 months of event. Six studies reported rate of complications and two reported reintervention as outcomes (reported as E in Summary of Evidence table).

In the previous review reported in 2005, four LOE-3 studies indicates that extracorporeal techniques or invasive perfusion devices may improve outcome from cardiac arrest when compared with standard CPR in patients with cardiogenic shock (before cardiac arrest occurs) and witnessed cardiac arrest in patient with an underlying cardio circulatory disease amenable to immediate corrective intervention. (Chen, 2003, 197; Martin,1998, 743; Mooney,1991,450; Nagao, 2000, 776) Reviewers concluded that implementation may be difficult due to timing of events and presence of experienced staff.

We further identified two LOE 2 studies. Chen et al. conducted prospective control study matching with propensity score for 172 patients with in-hospital cardiopulmonary arrest to compare extracorporeal cardiopulmonary resuscitation (ECPR) and conventional cardiopulmonary resuscitation (Chen, 2008, 554). They demonstrated that the cumulative survival rate was 65.2% (at 24 h), 52.2% (3 days), 37.0% (14 days), 34.8% (30 days), 32.6% (6 months), and 19.6% (1 year; nine survivors) in the extracorporeal group and 41.3% (24 h), 34.8% (3 days), 23.9% (14 days), 17.4% (30 days), 15.2% (6 months), and 13.0% (1 year; six survivors) in the conventional CPR-M group. The hazard ratio of extracorporeal CPR over conventional CPR was 0.47 (95% CI 0.28–0.77, p=0.003) if the survival curves were trimmed at 30 days. Extracorporeal CPR still showed a survival benefit at the end of 1 year (hazard ratio 0.53, 95% CI 0.33–0.83, p=0.006). Neurological outcome showed no difference at 1 year (p=0.27). Tanno conducted retrospective cohort study that compares 66 patients undergone emergency cardiopulmonary bypass and 332 patients with conventional CPR after out-of-hospital cardiac arrest due to cardiac etiology (Tanno, 2008, 649). Although they showed that significantly higher survival rate at 3 months (22.7% vs 9.9%, P<0.05), there was no statistical different for preferable neurological outcome defined by CPC (10.6% vs 5.7 %, P=0.14).

Studies evaluating CPR indicated that (1) duration of CPR prior to intervention and (2) presence of witness were correlated with survival outcome. Studies evaluating ECMO indicated that (1) etiologic disease (myocarditis), (2) a shorter CPR duration, and (3) first documented rhythm of ventricular tachycardia or ventricular fibrillation were positively associated with the survival at discharge. Studies including IABP treatment did not clearly define for which patient populations IABP would be most beneficial.

In addition to above thirteen studies written in English, we identified ten studies written in Japanese. All of ten studies are classified as LOE 4 since no study included control subject. Regarding outcomes, two studies employed neurological evaluation (e.g Glasgow Outcome Scale: GOS). Other two studies used “social reintegration” as outcome, however, both studies did not clearly describe criteria of the “social reintegration”. Remaining six studies did not evaluate neurological outcomes. Three studies evaluated long-term prognosis (more than 3 months). Survival to hospital discharge of these ten studies in Japanese was reported between 9.5 - 54.5%.
Citation List


   LOE: 4
   QUALITY: fair
   DIRECTION OF SUPPORT: supporting C
   COMMENTS: no report of industry sponsorship


   LOE: 4
   QUALITY: good
   DIRECTION OF SUPPORT: supporting ABCD
   COMMENTS: no report of industry sponsorship


   LOE: 2
   QUALITY: good
   DIRECTION OF SUPPORT: supporting AC, neutral D
   COMMENTS: no report of industry sponsorship


   Abstract in Japanese
   LOE: 4
   QUALITY: good
   DIRECTION OF SUPPORT: supporting A, neutral BCD
   COMMENTS: no report of industry sponsorship


   Abstract in Japanese
   LOE: 4
   QUALITY: fair
   DIRECTION OF SUPPORT: supporting ABC, neutral E
   COMMENTS: no report of industry sponsorship


   Abstract in Japanese
   LOE: 4
   QUALITY: good
   DIRECTION OF SUPPORT: supporting ABC, neutral E
   COMMENTS: no report of industry sponsorship


LOE: 4
QUALITY: fair
DIRECTION OF SUPPORT: supporting C
COMMENTS: no report of industry sponsorship


LOE: 4
QUALITY: fair
DIRECTION OF SUPPORT: supporting A, neutral BC
COMMENTS: no report of industry sponsorship


LOE: 4
QUALITY: good
DIRECTION OF SUPPORT: supporting CD
COMMENTS: no report of industry sponsorship


LOE: 4
QUALITY: good
DIRECTION OF SUPPORT: supporting CD
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LOE: 4
QUALITY: fair
DIRECTION OF SUPPORT: supporting AC
COMMENTS: no report of industry sponsorship


Abstract in Japanese
LOE: 4
QUALITY: fair
DIRECTION OF SUPPORT: supporting AB, opposing C
COMMENTS: no report of industry sponsorship


LOE: 4  
QUALITY: fair  
DIRECTION OF SUPPORT: supporting ABCDE  
COMMENTS: no report of industry sponsorship


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COMMENTS: no report of industry sponsorship


LOE: 4  
QUALITY: fair  
DIRECTION OF SUPPORT: neutral A  
COMMENTS: no report of industry sponsorship


Abstract in Japanese  
LOE: 4  
QUALITY: fair  
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COMMENTS: no report of industry sponsorship


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COMMENTS: no report of industry sponsorship