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

Worksheet author(s)  
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Date Submitted for review:  
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Clinical question.

In adult cardiac arrest following open (including heart and lung transplantations) and closed heart surgery (P) does use of any specific interventions (I) as opposed to standard care (according to treatment algorithm) (C), improve outcome (O) (e.g. ROSC, survival)

Is this question addressing an intervention/therapy, prognosis or diagnosis? Intervention/Therapy

State if this is a proposed new topic or revision of existing worksheet: New Topic

Conflict of interest specific to this question

Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet? None

Search strategy (including electronic databases searched).

**PubMed:**
1. Cardiopulmonary resuscitation (MESH) 7452; Cardiac Surgical procedures (MESH) 126732; Combined: 388 (No limits) – Limits for humans, English, all adult 19+ = 154 + 8 reviews
2. Cardiopulmonary resuscitation (MESH) 7452; Heart valve Prosthesis (MESH) 6837: Combined 7 (no limits)
3. Cardiopulmonary resuscitation (MESH) 7452; Coronary Artery Bypass (MESH) 36632; Combined 40 (no limits)
4. Heart massage 2253; Heart Surgery 286942; Combined 2253 (no limits) – Limits for Humans, English, clinical trial, RCT, meta-analysis, adults 19+ = 27

**Cochrane database** – cardiopulmonary resuscitation and cardiac surgery – no additional articles

**Embase** – Cardiopulmonary resuscitation and cardiac surgery – 1 additional article

Alternative terms included: Thoracic Surgery

**State inclusion and exclusion criteria**

Inclusion – all post cardiac surgery patients for all procedures.
Excluded: Peri-operative cardiac arrests.

All paediatric studies

Three papers have been excluded from this review:

**Number of articles/sources meeting criteria for further review:**

From the two combined MESH searches (67 references), there were 14 relevant papers, 3 ’e-comments’, and 4 reviews. The worksheet question does not specify any one specific intervention but all the 20 papers refer to ‘chest compression’ and the relevant risks

I have dismissed the 3 ’e-comments’ as these are un-refereed submissions but have included them in the reference list for completeness.

For the reviews; I hand searched the quoted references. The reviews cover:

1. The use of amiodarone or lidocaine  8 papers, 4 wrong pt group and 2 other ILCOR worksheets (wrong pt group)
   - two relevant papers;
     a) dating back to 1984 – 18pt review of use of lidocaine & equivocal.
     b) dating back to 1987 – case report – neonate with amiodarone
2. Internal v external cardiac massage (16 papers, 12 wrong pt group and 1 ILCOR COS statement)
   3 papers – already included in 9 searched papers.
3. Delaying CPR until after attempting defibrillation or pacing (22 papers, 18 wrong pt group, 1 ILCOR COS, 1 ILCOR WS, I letter (1996)
   1 paper - included in original search

I have NOT included the reviews in my worksheet analysis

A further hand search revealed additional papers 6 papers.
Summary of evidence

**Evidence Supporting Clinical Question**

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**Level of evidence**

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

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<th>Beyersdorf 1992&lt;sup&gt;ABCE&lt;/sup&gt;</th>
<th>Feng 1995&lt;sup&gt;ABCD&lt;/sup&gt;</th>
<th>Wabba 1997&lt;sup&gt;E&lt;/sup&gt;</th>
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<td>Poor</td>
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<td>Kaiser 1990&lt;sup&gt;C&lt;/sup&gt;</td>
<td>Bohrer 1989&lt;sup&gt;E&lt;/sup&gt;</td>
<td>Ricci 2000&lt;sup&gt;E&lt;/sup&gt;</td>
<td>Steinhoff 2001&lt;sup&gt;E&lt;/sup&gt;</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  
*Italic* = Animal studies

### Evidence Opposing Clinical Question

| Good | | | | | |
|------|------|------|------|------| |
| Fair | | | | | |
| Poor | | | | | |
| 1 | 2 | 3 | 4 | 5 | |

**Level of evidence**

A = Return of spontaneous circulation  
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REVIEWER'S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:
The Worksheet PICO question is extremely wide covering 'any specific interventions' in the post cardiac surgical patient. As such I have used uninhibited search criteria. The number of relevant publications dealing with the PICO criteria is small and there is very little direct quality information (LOE 4 or 5). Unfortunately many of these papers are more than 10 years old and therefore may not reflect modern techniques of cardiothoracic surgery or recent changes in resuscitation guidelines.

One good paper (LOE 4) [El-Banayosy, 1998, 390] has shown that the incidence of cardiopulmonary resuscitation after cardiac surgery was low, at 2.3%.

The recurring question raised in these papers was the need for emergency re-opening of the chest following cardiac arrest. Two fair papers (LOE 2) [Mackay 2004, 66; Raman, 189, 129], four good papers (LOE 4) [Anthi, 1998, 15, Fairman, 1981, 386; Mackay, 2002, 421; Ngaage, 2009, 64] two fair papers (LOE 4) [Birdi, 2000, 743; Karhunen 2006, 143;] and one poor paper (LOE 4) [Rousou, 1994, 280] support the failing management of post cardiac surgery cardiac arrest with re-sternotomy with a time limit of either 10 minutes (LOE 4) [Mackay, 2002, 421] or 5 minutes (LOE 5) [Pottle 2002, 269]. One fair paper (LOE 4) [Mackay, 2002, 421] also concluded that emergency re-sternotomy performed on these patients outside CICU had uniformly poor results.

The question then arises as to when to perform the re-sternotomy. Three poor case reports (LOE 5) [Bohrer, 1989, 352; Ricci, 2000, 586; Steinhoff, 2001, 159] describe damage to the heart possibly due to external chest compressions prior to open chest management. However, there is no evidence for delaying resuscitation or for withholding chest compressions until an emergency re-sternotomy has been performed.

There is evidence from one poor quality level 4 study [Kriaras, 1996, 10] that infection risk is not significant in appropriately-conducted resternotomy outside of the operating theatre.

Acknowledgements: Drs J Dunning & W Ross – worksheet co-authors

Citation List

Anthi A, Tzelepis GE, Alivizatos P, Michalis A, Palatianos GM, Geroulanos S.
Unexpected cardiac arrest after cardiac surgery: incidence, predisposing causes, and outcome of open chest cardiopulmonary resuscitation.

Level of Evidence: 4
Quality: Good
Direction: Supporting
Retrospective study of 29 (0.7%) pts undergoing CPR following cardiac surgery. ROSC was achieved in 13 (45%) closed chest massage and 14 (55%) open chest massage. 2 open chest massage died. 20pts alive at one year (No groups stated). Authors claim that this is evidence for open chest massage but there was no results presented that demonstrated superiority of one technique over the other. Equivocal results.

Beyersdorf F, Kirsh M, Buckberg GD, Allen BS, Bonchek LI, Arom KV.
Warm glutamate/aspartate-enriched blood cardioplegic solution for perioperative sudden death
Level of Evidence: 4
Quality: Good
Direction: Neutral

Small post-op study of the effect of a cardioplegia solution on peri-operative arrested hearts. All treated with resternotomy and returned to thetare for CPB. 75% survived to hospital discharge.


Level of Evidence: 4
Quality: Fair
Direction: Supportive

A retrospective review of 5.5 years of emergency ‘crash back onto CPB’ in post cardiac surgery patients. It provides some support improved survival in those who had complications post surgery who underwent emergency thoracotomy and CPB. It does not distinguish those who had undergone cardiac arrest from those who had other indications for emergency CPB.


Level of Evidence: 5
Quality: Poor
Direction: Neutral.

Three cases of patients who had a short period of CPR after VF arrests following Cardiac surgery. All 3 patients were successfully returned sinus rhythm but the short period of external cardiac massage resulted in exsanguinating haemorrhage due to either tearing of the right atrial suture or rupture of the proximal anastamosis of the vein graft. This provides evidence for the danger of External CPR shortly after Cardiac Surgery.

Old Paper


Level of Evidence: 4
Quality: Good
Direction: Supporting
Retrospective study of 4968 adult consecutive patients following heart surgery. Incidence of CPR low at 2.3%; 79 of the 113 (70%) survived to discharge. 24 patients required open chest massage for unsuccessful closed CPR – 13 (45%) survived.

Fairman RM, Edmunds LH Jr. 
Emergency thoracotomy in the surgical intensive care unit after open cardiac operation. 

Level of Evidence: 4  
Quality: Good  
Direction: Supporting

Retrospective case study supporting open thoracotomy for circulatory collapse (?)cardiac arrest) following cardiac surgery. Old paper – 1981. Small number of patients.

Feng WC, Bert AA, Browning RA, Singh AK. 
Open cardiac massage and periresuscitative cardiopulmonary bypass for cardiac arrest following cardiac surgery 

Level of Evidence: 4  
Quality: Good  
Direction: Neutral

Small retrospective review (n=3) – all underwent resternotomy and CPB without long-term neuro injury.

Reoperation in the intensive care unit 

Level of Evidence: 4  
Quality: Poor  
Direction: Neutral

Retrospective cohort study (n=110) of resternotomy in the ICU. 3.9% re-exploration for bleeding. Postoperative death not related to resternotomy
Karhunen JP, Sihvo EIT, Suojaranta-Ylinen RT, Ramo OJ, Salminen US.
Predictive Factors of Hemodynamic Collapse After Coronary Artery Bypass Grafting: A Case-Control Study

**Level of Evidence:** 4  
**Quality:** Fair  
**Direction:** Supporting

Retrospective case study - 76 pts requiring resternotomy for cardiac arrest following CABG (attempted match pairing with no cardiac arrest) 75% arrests in first 5 hrs post op with 46% mortality; 5yr survival 49%.

Antimicrobial protection in cardiac surgery patients undergoing open chest CPR.

**Level of Evidence:** 4  
**Quality:** Poor  
**Direction:** Supporting

Small retrospective study looking at post resternotomy wound infection.

Koshal A, Murphy J, Keon WJ
Pros and cons of urgent exploratory sternotomy after open cardiac surgery
*Can J Surg.* 1986 May;29(3):186-9

**Level of Evidence:** 4  
**Quality:** Poor  
**Direction:** Neutral

Only Group 1 relevant – sternotomy did not lead to a significant difference in morbidity. Old paper (23 yrs). Retrospective chart analysis

Mackay JH, Powell SJ, Osgathorp J, Rozario CJ.
Six-year prospective audit of chest reopening after cardiac arrest

**Level of Evidence:** 4  
**Quality:** Good  
**Direction:** Supporting
Prospective audit supporting chest reopening post cardiac surgery patients within 10 minutes of arrest.

Mackay JH, Powell SJ, Charman SC, Rozario C.
Resuscitation after cardiac surgery: Are we ageist?

**Level of Evidence:** 2
**Quality:** Fair
**Direction:** Supporting
Non-randomised consecutive case study supporting resternotomy. Severity of illness determined level of resuscitation.

Ngaage DL, Cowen ME.
Survival of Cardiorespiratory Arrest After Coronary Artery Bypass Grafting or Aortic Valve Surgery

**Level of Evidence:** 4
**Quality:** Good
**Direction:** Supporting
Retrospective 9yr cohort study – VF & VT most common mechanisms, and MI commonest cause. Poor outcomes despite aggressive resuscitation.

Pottle A, Bullock I, Thomas J, Scott L.
Survival to discharge following open chest cardiac compression (OCCC). A 4-year retrospective audit in a cardiothoracic specialist centre--Royal Brompton and Harefield NHS Trust, United Kingdom.
Resuscitation. 2002 Mar;52(3):269-72

**Level of Evidence:** 5
**Quality:** Good
**Direction:** Neutral

4 year retrospective audit – 72 pts ; 38 adults; Survival rates as chart only & difficult to interpret (5/18 CABG, 3/14 valve, 4/31 congenital- survival to discharge) . Authors recommended resternotomy after 5 minutes unsuccessful resuscitation.

Raman J, Saldanha RF, Branch JM, Esmore DS, Spratt PM, Farnsworth AE, Harrison GA, Chang VP, Shanahan MX.
Open cardiac compression in the postoperative cardiac intensive care unit
Anaesth Intensive Care. 1989 May;17(2):129-35

**Level of Evidence:** 2  
**Quality:** Fair  
**Direction:** Supporting

Retrospective analysis, small cohort supporting open chest compression. Very old study – 1989

Ricci M, Karamanoukian HL, D’Ancona G, Jajkowski MR, Bergsland J, Salerno TA.  
Avulsion of an H graft during closed-chest cardiopulmonary resuscitation after minimally invasive coronary artery bypass graft surgery.  

**Level of Evidence:** 4  
**Quality:** Poor  
**Direction:** Neutral

Case report of single case of graft avulsion after cardiac surgery following CPR. However the report does not make clear whether the cause of the cardiac arrest (severe hypotension) was caused by 'graft problems' or whether the CPR caused the avulsion. Pt died.

Emergency cardiopulmonary bypass in the cardiac surgical unit can be a lifesaving measure in postoperative cardiac arrest.  
Circulation 1994; 90, II 280-284.

**Level of Evidence:** 4  
**Quality:** Poor  
**Direction:** Supportive

A retrospective study demonstrating that emergency resternotomy and cardiopulmonary bypass in CICU can enhance survival from post cardiac surgical cardiac arrest

Steinhoff JP, Pattavina C, Renzi R.  
Puncture wound during CPR from sternotomy wires: case report and discussion of periresuscitation infection risks.  
Heart Lung. 2001 Mar-Apr;30(2):159-60.

**Level of Evidence:** 5  
**Quality:** Poor  
**Direction:** Neutral
**Peri-arrest risk from chest compression on previous sternotomy**

Wahba A, Götz W, Birnbaum DE
Outcome of cardiopulmonary resuscitation following open heart surgery.

**Level of Evidence:** 4  
**Quality:** Good  
**Direction:** Neutral

Retrospective study with 1.4% requiring CPR. Significant correlation between CPR and death. 29 pts had re-sternotomy with a 50% long term survival rate.