Clinical question.

Does the use of mechanical circulatory support (MCS) improve outcome in adult patients with ROSC after cardiac arrest (prehospital or in-hospital) who have cardiovascular dysfunction?

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? : No

Search strategy (including electronic databases searched).

Search 1, PubMed:
"heart arrest" OR "cardiopulmonary resuscitation" AND "heart-lung machine"

NOT hypothermia NOT pediatric Limits: Clinical Trial, Meta-Analysis, Randomized Controlled Trial, Review, Controlled Clinical Trial, English, Japanese, Age > 18 years,

Search 2, PubMed:
"heart arrest" OR "cardiopulmonary resuscitation" AND "heart-lung machine"

Search 3, PubMed:
"heart arrest" OR "cardiopulmonary resuscitation" AND "extracorporeal membrane oxygenation".

Limits: Clinical Trial, Meta-Analysis, Randomized Controlled Trial, Review, Controlled Clinical Trial, English, Japanese, Adolescent: 13-18 years, Adult: 19-44 years, Middle Aged: 45-64 years, Middle Aged + Aged: 45+ years, Aged: 65+ years, 80 and over: 80+ years

Search 4, PubMed:
Search "cardiopulmonary resuscitation" AND "extracorporeal life-support"

NOT pediatric. Limits: English, Japanese

Search 5:
References of each article which is retrieved in search 4 were checked

Search 6, PubMed:
"post-arrest" AND "myocardial dysfunction"

Search 7, Cochrane:
"extracorporeal life-support"

Search 8, Cochrane:
"heart-lung machine"

Search 9, Cochrane:
"extracorporeal membrane oxygenation"

Search 10, PubMed: “cardiogenic shock” OR "heart failure” AND “Intra-Aortic balloon pumping”

Search 11, PubMed: “cardiogenic shock” OR "heart failure” AND “heart assist device”

Search 12, PubMed: “cardiogenic shock” OR "heart failure”) AND “Extracorporeal Membrane Oxygenation”

Search 13, PubMed: “cardiogenic shock” OR "heart failure” AND “cardiopulmonary bypass”

then hand search of relevant bibliographies


Search 15, Embase: “Heart Arrest” OR “cardiac arrest” AND (“Cardiovascular Diseases” OR “Cardiovascular dysfunction”) AND (mechanical circulatory support” OR “Assisted circulation”/exp OR “Heart-Assist Devices”/exp OR “Counterpulsation”/exp OR “Intra-Aortic Balloon Pumping”/exp)
Search 16. Cochrane: “Heart Arrest” OR “cardiac arrest” AND “mechanical circulatory support” OR “Assisted circulation” OR “Heart-Assist Devices” OR “Counterpulsation” OR “Intra-Aortic Balloon Pumping”

Search 17. AHA EndNote Master Library: “Heart Arrest” OR “cardiac arrest”) AND (“Cardiovascular Diseases” OR “Cardiovascular dysfunction”) AND (“mechanical circulatory support” OR “Assisted circulation” OR “Heart-Assist Devices” OR “Counterpulsation” OR “Intra-Aortic Balloon Pumping”

State inclusion and exclusion criteria.
The following were excluded:
Pediatric cases, infantile cases, neonatal cases, trauma cases, studies about mechanical circulatory support during cardiopulmonary resuscitation, single case reports, mechanical circulatory support for respiratory failure, and articles unrelated to the topic

Number of articles/sources meeting criteria for further review:
As listed above, search 1 to 9 were first performed. However, there are no acceptable articles directly answering the clinical question. The search was therefore expanded to the use of MCS in non arrest related disease states, as cardiogenic shock/severe heart failure.

Search 10: 1021 papers identified, one meta-analysis and 32 RCTs. One meta analysis and three RCTs are selected for further review.
Search 11: 2607 papers identified. There are four meta-analyses and 29 RCTs. Six RCTs are selected for further review.
Search 12: 357 papers identified, no adequate meta-analysis and RCTs. 51 review articles are found and four selected for further review.
Search 13: 1330 papers identified. No meta-analysis meeting the criteria for further review.
There are 28 RCTs, but no articles meeting criteria for further review.
Search 14-17: 572 papers identified.
Last search performed December 22, 2009
After exclusions and review of abstracts, 11 articles are selected for further review. No study directory addressed the subject; however, these results are discussed for use in the post-resuscitation settings.
## Summary of evidence

### Evidence Supporting Clinical Question

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<thead>
<tr>
<th>Level of evidence</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
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<tr>
<td>Good</td>
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<td>Greenberg, 2008 E</td>
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<td>Poor</td>
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<td>Smedira, 2001 E</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
- *Italicics* = Animal studies
### Evidence Neutral to Clinical question

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- Sjauw, 2009 E
- Larsen 2007 B, C
- Hovdenes 2007 B, D
- Sunde 2007 C, D

### 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 Opposing Clinical Question

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- Tennyson 2002 B, E

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

After extensive review of the literature it is obvious that mechanical support used in conjunction with cardiac arrest in nearly all studies have been used as an additional treatment during ongoing CPR. It has been instituted before ROSC and is therefore not evaluated in the context of this question.

In conclusion, there is currently no study which directly addresses the use of MCS in adult patients with ROSC after cardiac arrest (pre-hospital or in-hospital) who have cardiovascular dysfunction.

The following devices were considered as MCS devices and included in this WS: Intra aortic balloon pumping (IABP), extracorporeal membrane oxygenation (ECMO), left ventricular assist device (LVAD), percutaneous LVAD, and continuous aortic flow augmentation (CAFA). In one paper (Larsen 2007, 454, the use of LUCAS (a mechanical CPR device) was used in some patients after ROSC, and was therefore also considered as a MCS device and included.

All these devices are different, and act different, and are therefore summarized categorical:

1. **Intra aortic balloon counter pulsation (IABP)** seems to be the most frequently used. This support alone seems powerless to improve the hemodynamics, compare with other MCS. It lacks active cardiac support and requires certain residual level of left ventricular function.
   - Sjauw 2009, 459: Two meta-analyses comparing IABP therapy with no IABP therapy for the treatment of STEMI patients with or without cardiogenic shock. They found that IABP therapy is possibly beneficial for STEMI patient with cardiogenic shock when it is used as an adjunct to thrombolysis, however, not beneficial when it combined with PCI. In their conclusion, there is insufficient evidence endorsing the current recommendation for IABP therapy in STEMI with cardiogenic shock.
   - Hovdenes 2007, 137. Case series of 50 OHCA patients where 23 patients were treated with IABP in a non randomized fashion. Primary intervention studied was therapeutic hypothermia on survival and 6 month outcome Other interventions were also instituted like, levosimendan and different dosages of norepinehrine. Difficult to isolate the effect of IABP alone.
   - Sunde 2007, 29: Case series of OHCA patients with ROSC that during an intervention period received treatment according a specified protocol including therapeutic hypothermia, PCI and other measures. During this intervention period 8 patients were treated with IABP in a nonrandomized manner. Patients from the intervention period were compared with historical controls not treated with hypothermia. No patients during this control period were treated with IABP. Impossible to isolate effect of IABP alone.

2. **Extra Corporeal Membrane Oxygenation (ECMO)** can be provided via a venovenous cannulation setup that provides respiratory support or a venous-arterial cannulation setup that provides both respiratory and circulatory support.
   - Smedira 2001, 92, reports 202 cardiac failure case series receiving ECMO support. They emphasize that it is simple to use, applicable to victims of all size, and it can rapidly reverse ischemia and anoxia. They conclude that ECMO can salvage the patient who would otherwise die. During the recovery time of myocardial performance after the ROSC many patients died from the low cardiac output. Left ventricular assist devices are good to apply in such condition. They support or replace cardiac function and afford a chance to treat the cause of CA and/or a time to myocardial recover.

3. **Left Ventricular Assist Device (LVAD)**
   - Stevenson 2004, 975 evaluated whether LVAD would prolong survival compared with optimal medical management (OMM) in severe congestive heart failure. There was a major survival benefit seen with the LVAD compared with OMM. Their study suggests that the patients with heart failure who received intravenous inotropes can expect a doubling in survival rate to 50% at 1year with LVAD as provided.
- *Thiele 2005, 1276*, evaluated mortality in patient with CS complicating AMI and assess the hemodynamic effects of IABP in comparison to the TandemHeart percutaneous ventricular assist device (pVAD). Hemodynamically improvement achieved more effectively by TandemHeart pVAD when compared with IABP. Overall mortality is similar.

- *Burkhoff 2006, 469* also evaluated the TandemHeart pVAD and pointed out that TandemHeart pVAD improved hemodynamic parameters in patients presenting within 24 hours of the development of cardiogenic shock, even in patients already failing IABP. Although, overall 30 days survival was not improved.

- *Seyfarth 2008, 1584*, evaluated whether Impella LP2.5 pVAD provides superior hemodynamic support compare with IABP in patients with CS caused by AMI. They conclude that Impella 2.5 improves the hemodynamics rapidly, but the overall 30 days mortality was not. There are no trends in mortality benefit for the both TandemHeart and Impella 2.5 support despite the beneficial hemodynamic effect.


- *Greenberg 2008, 1241* assessed CAFA in their article published in 2008. The study confirmed that CAFA combined with intensive medical therapy demonstrated progressive improvement in hemodynamic parameters, CVP and PCWP, compared with intensive medical therapy alone. But this study did not demonstrate long-term survival benefit.

5. Lund University Cardiac Arrest device (LUCAS)

- *Larsen 2007, 454*. Case series of thirteen patients. Five patients had ROSC before LUCAS was applied but with signs of cardiogenic shock. No control group but standard treatment had failed. Three patients survived the PCI intervention but no one was discharged alive from the hospital.

In addition we included one animal study.

- *Tennyson 2002, 69*. A well designed animal study with control group using standard treatment with dobutamine used in clinical practice. Dobutamine post resuscitation resulted in better LV function than IABP during the study period of 6 hrs. Survival not studied.

It is natural that, these devices, LVAD, two percutaneous LVAD (TandemHeart and Impella), and CAFA, improve hemodynamic parameters, because they act directly as substitute for decompensated heart. On the other hand, it is also natural these instruments does not improve the mortality without definitive therapy. Though, MCS especially which supports the hemodynamics directly may restore the systemic perfusion rapidly and avoid further injury to the organs and they also afford a chance to treat the cause of shock or cardiopulmonary arrest.

Of course it depends on patient’s condition which support should be applied, because each devices have own function and forte, though, it also depends on each physician, because there need to attain proficiency in using such device efficiently.

Rescuers have no other resuscitative modality but MCS when the patients with profound shock refractory to medical support.

Acknowledgements:
Nil
Citation List

A randomized multicenter clinical study to evaluate the safety and efficacy of the TandemHeart percutaneous ventricular assist device versus conventional therapy with intraaortic balloon pumping for treatment of cardiogenic shock.

Comment: LOE 5 Fair. Supportive
Prospective randomized study. They compare pVAD with IABP and conclude that pVAD used in combination with standard pharmacologic therapy improves cardiac output, increase mean arterial pressure, and reduces pulmonary wedge pressure in patients presenting within 24 hours of developing cardiogenic shock.

Effects of continuous aortic flow augmentation in patients with exacerbation of heart failure inadequately responsive to medical therapy: results of the Multicenter Trial of the Orqis Medical Cancion System for the Enhanced Treatment of Heart Failure Unresponsive to Medical Therapy (MOMENTUM).

Comment: LOE 5. Good. Supportive
Greenberg et al. evaluate the continuous aortic flow augmentation (CAFA) in patients with heart failure exacerbation and persistent hemodynamic and clinical derangement despite intravenous diuretic and inotropic and/or vasodilator therapy. They conclude that CAFA may improve hemodynamic parameters such as cardiac index and pulmonary capillary wedge pressure in decompensated heart failure, but, however, 35 days alive out of hospital did not improved when compared with medical therapy alone.


Comment: Level 5. Poor. Neutral
Case series of 50 OHCA patients where 23 patients were treated with IABP in a non randomized fashion. Primary intervention studied was therapeutic hypothermia on survival and 6 month outcome Other interventions were also instituted like, levosimendan and different dosages of norepinehrine. Difficult to isolate the effect of IABP alone.


Case series of thirteen patients. Five patients had ROSC before LUCAS was applied but with signs of cardiogenic shock. No control group but standard treatment had failed. Three patients survived the PCI intervention but no one was discharged alive from the hospital.

A randomized clinical trial to evaluate the safety and efficacy of a percutaneous left ventricular assist device versus intra-aortic balloon pumping for treatment of cardiogenic shock caused by myocardial infarction.

Comment: LOE 5. Fair. Supportive
They compare pVAD, Impella2.5 with IABP. pVAD improve hemodynamic and metabolic parameters, but does not improve mortality at 30 days when compared with IABP.

A systematic review and meta-analysis of intra-aortic balloon pump therapy in ST-elevation myocardial infarction: should we change the guidelines?

Comment: LOE 5. Good. Neutral.
They attempt two meta-analyses of IABP for ST elevation myocardial infarction with and without cardiogenic shock. Contrary our expectation, IABP support for the STEMI patient with shock improves the survival outcome only when it combined with thrombolytic therapy.

Clinical experience with 202 adults receiving extracorporeal membrane oxygenation for cardiac failure: survival at five years.

Comment: LOE 5. Poor. Supportive.
Case series of patients with cardiac failure and unknown frequency of cardiac arrest where ECMO was used in bridging to transplantation.

Left ventricular assist device as destination for patients undergoing intravenous inotropic therapy: a subset analysis from REMATCH (Randomized Evaluation of Mechanical Assistance in Treatment of Chronic Heart Failure).

Comment: LOE. Fair. Supportive
They evaluate whether LVAD would prolong survival compared with medical management in severe congestive heart failure. There was a major survival benefit seen with the LVAD


Comment: Level 5. Poor. Neutral
Case series of OHCA patients with ROSC that during an intervention period received treatment according a specified protocol including therapeutic hypothermia, PCI and other measures. During this intervention period
8 patients were treated with IABP in a nonrandomized manner. Patients from the intervention period were compared with historical controls not treated with hypothermia. No patients during this control period were treated with IABP. Impossible to isolate effect of IABP alone.


Comment: Level 5. Fair. Negative. Well designed animal study with control group using standard treatment with dobutamine used in clinical practice. Dobutamine post resuscitation resulted in better LV function than IABP during the study period of 6 hrs. Survival not studied.


Comment: LOE. Fair. Supportive They compare percutaneous ventricular assist device; TandemHeart with IABP. TandemHeart improve hemodynamic and metabolic parameters, but does not improve mortality at 30 days when compared with IABP.