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 mechanical compression full (eg. Lucas) or partial decompression (eg. US version) (I) compared with manual CPR (C), improve any outcomes (eg. ROSC, survival) (O)?

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

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).

No Cochrane database for systematic reviews searches performed.
Finally, the reviewers checked the paper and excluded papers which evaluated other forms of mechanical CPR than the Lucas device.

State inclusion and exclusion criteria
Included: Original animal and human studies
Excluded: Review articles, case report, letters, and editorials.

Number of articles/sources meeting criteria for further review:
9 studies met criteria for further review.
Of these none were LOE 1 (RCTs), two LOE 2 (non-randomised, concurrent controls), no LOE 3 (retrospective controls), five LOE 4 (no controls), and three LOE 5 (not directly related; all animal studies).
# Summary of evidence

## Evidence Supporting Clinical Question

<table>
<thead>
<tr>
<th>Level of Evidence</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tr>
<td>Fair</td>
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<td>Poor</td>
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<td>Larsen AI, 2007, C/E</td>
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**A = Return of spontaneous circulation**  
**C = Survival to hospital discharge**  
**B = Survival of event**  
**D = Intact neurological survival**  
**E = Other endpoint**  
**Italics = Animal studies**
### Evidence Neutral to Clinical question

<table>
<thead>
<tr>
<th>Good</th>
<th>Axelsson C, 2006, D</th>
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<td>Steen S, 2005, B/C</td>
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<td>Axelsson C, 2007, D</td>
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<td>Raessler KL, 1988, E</td>
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<td>Smekal D, 2009, E</td>
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<td>Olasveengen TM, 2008, D</td>
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**Level of evidence**

A = Return of spontaneous circulation  
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### Evidence Opposing Clinical Question

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**Level of evidence**

A = Return of spontaneous circulation  
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*Italics = Animal studies*
Some human and experimental studies were reported in the last few years. Animal and manikin studies showed that automatic mechanical chest compressions with LUCAS resulted in improvement of quality of CPR, cardiac output, cerebral blood flow and short term neurologic outcome. Some studies showed that the LUCAS device could be used safely. One small case series study (13 patients in cardiac arrest or severe hypotension and bradycardia with cardiac catheterization cases) [Larsen AI, 2007, 454] and one experimental study (14 anaesthetized pigs induced VF) [Rubertsson S, 2005, 357] added evidence supporting mechanical chest compressions with LUCAS. One case series study with 100 OHCA consecutive cases (42 VF, 58 asystole) treated with LUCAS and a concurrent controls study showed that LUCAS can be used safely [Steen S, 2005, 25; Smekal D, 2009, 1104] and a retrospective observational study showed better quality CPR with mechanical chest compressions than manual CPR [Olasveengen TM, 2008, 185]. However, descriptive non-randomized controlled trial with 328 OHCA [Axelsson C, 2006, 47; Axelsson C, 2007, 460] showed no difference in survival outcomes between mechanical CPR with LUCAS and manual CPR. Although it is not a study of mechanical compression with the LUCAS device, a multicenter randomized trial of patients with OHCA showed worse neurological outcomes in those with an automated load-distributing band device than manual CPR [Hallstrom A, 2006, 2620]. The authors of this study speculated that delay to deploy the device or deliver shocks in mechanical CPR group was one of the potential explanations for the worse outcomes in the intervention group. Improvements in implementation strategies or new concept to use the mechanical CPR device earlier to minimize the time to the initiation of mechanical chest compressions would be needed to make the best use of the advantage of mechanical CPR. The current recommendations of class IIb is still valid. Ongoing multicenter, randomized trial would give us further insight if mechanical chest compressions with LUCAS are more effective than manual CPR or not.

Acknowledgements:

We greatly appreciate Graham Nichol for commenting on this review.
Citation List


Level 4, Fair, Neutral

Part of the prospective cohort study, i.e. patients with a witnessed, non-traumatic, OHCA were distributed (cluster) to mechanical (LUCAS) or manual chest compression. Only 59% of the patients fulfilled the inclusion criteria for the trial and had no exclusion criteria and 9.7% of these survived to discharge. 10% of patients fulfilled the inclusion criteria but were excluded, and 20.4% survived to discharge. 31% of patients did not fulfill the inclusion criteria and 2.5% survived. Among those available, the majority of survivors had a rapid ROSC before the application of the intervention (LUCAS).


Level 2, Good, Neutral

In this descriptive, non-randomized, controlled trial, LUCAS device was exchanged between the four ALS units for approximate 6-month periods. 159 were allocated to the mechanical CPR group (the device was used only in 66% of cases) and 169 to the manual CPR group. No difference in survival outcomes were noted between the groups.


Level 4, Poor, Supportive

13 patients with cardiac arrest or severe hypotension and bradycardia who were treated with LUCAS device in the catheterisation laboratory were reported. The mean systolic and diastolic blood pressure obtained was 81+/−23 and 34+/−21mmHg, respectively, and angiography and eventually percutaneous coronary intervention was possible in all cases during ongoing automatic chest compression.


Level 4, Poor, Neutral

In this retrospective, observational study, the quality of CPR during transport after OHCA were evaluated in 36 of 66 patients receiving manual CPR and 7 of 9 receiving mechanical CPR. Chest compressions and ventilations were detected from impedance changes in routinely collected ECG signals, and hands-off ratio calculated as time without chest compressions divided by total CPR time. Quality was significantly better with mechanical than manual CPR. The fraction of time without chest compressions increased during transport of out-of-hospital cardiac arrest patients.

Level 5 (animal), Fair, Neutral

Experimental study in dogs randomized to five different chest compression methods after 3 minutes of induced VF. No difference was found between dogs treated with either mechanical chest compressions or manual chest compressions in coronary perfusion pressure. There was no difference in 24 hr survival.


Level 5 (animal), Good, Supportive

14 pigs were randomized into LUCAS CPR or manual external compressions after 8-minute non-treated VF. Chest compressions with the LUCAS device resulted in higher cerebral blood flow and cardiac output than standard manual external chest compressions. Restoration of spontaneous circulation was achieved in two animals, one from each group.


Level 2, poor, Neutral

This concurrent controls study compared the variety and incidence of internal injuries after chest compressions between mechanical compression with LUCAS device and manual chest compression CPR. 85 patients underwent autopsy after unsuccessful resuscitation attempts with manual or mechanical chest compressions. The incidences of injuries including sternal fracture, multiple rib fractures, and bleeding were similar between the groups and these injuries were not considered to have contributed to the patient's death. The authors concluded that mechanical chest compressions with the LUCAS device appear to be associated with the same variety and incidence of injuries as manual chest compressions.


Level 4, Fair, Neutral

The first 100 consecutive cases treated with LUCAS due to out-of-hospital cardiac arrest (58% asystole, 42% ventricular fibrillation (VF)) was reported. It was shown that LUCAS can be used safely. In this report patients with a witnessed cardiac arrest receiving LUCAS-CPR within 15 min from the ambulance call had a 30-day survival of 25% in VF and 5% in asystole, but if the interval was more than 15 min, there were no 30-day survivors.


Level 5 (animal), Good, Supportive

Experimental study in pigs comparing mechanical chest compressions with the LUCAS device to standard external chest compressions. After 90 seconds of untreated VF, the animals were randomized into treatment with either method. End-tidal CO2, cardiac output, coronary perfusion pressure and carotid artery blood flow were significantly
higher in the group with the LUCAS device. The proportion of those who achieved ROSC was 83% in those with LUCAS-CPR, which was significantly higher than manual CPR (0% ROSC). In normothermic fibrillating pigs, the ROSC rate was 100% after 15 min and 38% after 60 min of LUCAS-CPR (no drug treatment). Experience of the first 20 patients with LUCAS was also reported.