Critical Review Form
Therapy

Perkins GD, Lall R, Quinn T, et al; PARAMEDIC trial collaborators. Mechanical versus manual chest compression for out-of-hospital cardiac arrest (PARAMEDIC): a pragmatic, cluster randomised controlled trial. Lancet. 2015 Mar 14;385(9972):947-55.

Objectives: **"to assess whether LUCAS-2 was better than manual CPR for the improvement of 30 day survival in adults receiving resuscitation for non-traumatic, out-of-hospital cardiac arrest." (p. 948)**

Methods: **This pragmatic, cluster randomized controlled trial was conducted using 91 ambulance stations, representing 25% of stations in four UK National Health Service (NHS) Ambulance Services, between April 15, 2010, and June 10, 2013. Ambulance vehicles were the unit of randomization. Individual patients were included in the study if a trial vehicle was the first ambulance service vehicle on scene, the patient was in cardiac arrest, resuscitation was attempted, and the patient was known or believed to be aged 18 years or older. Exclusion criteria were traumatic cardiac arrest and known or clinically apparent pregnancy.**

Patients were randomized in a 2:1 (control:LUCAS) ratio due to the limited number of LUCAS devices. For patients in the LUCAS group, manual CPR was initiated as the device was turned on. Manual compressions were paused as the back plate was inserted, restarted as the central arms were positioned and locked in place, at which time the suction cup was deployed and the device was activated. The LUCAS was then paused once ECG monitoring was established to allow for rhythm check. The LUCAS was then restarted. For patients in the control group, CPR was started on arrival and then paused once ECG monitoring was established to allow for rhythm check, after which compressions were restarted.

The primary outcome was survival at 30 days after the arrest. Secondary outcome included sustained ROSC until arrival at the receiving hospital, survival at 3 months, survival at 12 months, and survival with a favorable neurologic outcome (Cerebral Performance Category [CPC] score 1 or 2) at 3 months.

There were 418 emergency vehicles recruited and randomly assigned to LUCAS (147 clusters) and control (217 clusters) groups. Cardiac arrest was confirmed and resuscitation attempted in 4689 cases of which 218 cases were ineligible and excluded. Of the 4471 patients enrolled, 1652 were in the LUCAS group and 2819 were in the control group. Among patients in the LUCAS group, 985 (60%) received mechanical chest compressions.

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Guide	Comments
Are the results valid?	
Did experimental and control groups being the study with a similar prognosis?	
Were patients randomized?	Yes. Due to the limited number of LUCAS devices (143) patients were randomized in a ratio of 2 controls to 1 LUCAS device.
Was allocation concealed? Was it possible to subvert the randomization to ensure a patient would be "randomized" to a particular group?	Yes. "Individual ambulance vehicles (clusters) were assigned with a computer-generated randomisation sequence, which stratified by station and vehicle type (ambulance or RRV)." (pp. 948-949) This should be sufficient to maintain allocation concealment. Additionally, ambulance dispatch staff were not aware of group allocation and individual patients were assigned to groups based on first trial vehicle on scene.
Were patients analyzed in the groups to which they were randomized?	Yes. "The primary analysis was intention to treat." (p. 950)
Were patients in the treatment and control groups similar with respect to known prognostic factors?	Yes. Patients were similar with respect to age, gender, cause of cardiac arrest, location, witness status, use of bystander CPR, initial rhythm, use of intravenous medications, and airway intervention (intubation, LMA, not known). The authors do not report transport times.
Did experimental and control groups retain a similar prognosis after the study started?	
Were patients aware of group allocation?	No. Patients were in cardiac arrest and hence would not have been aware of anything.
Were clinicians aware of group allocation?	Yes. "Masking of ambulance clinicians was not possible, since they gave the intervention." (p. 949) It is very unlikely that performance bias would have influenced outcomes.
Were outcome assessors aware of group allocation?	Somewhat. The authors report that "those collecting the primary outcome were masked to treatment allocation." (p. 947) It is unclear if those assessing secondary outcomes were similarly masked.
Was follow-up complete?	Mostly yes. Mortality outcomes were available from the NHS Information Centre's central death registry, which captures all deaths occurring in the UK. CPC scores were available almost all patients in the study.
What are the results?	
How large was the treatment effect?	• For the primary outcome, 30-day survival was similar in the LUCAS-2 and control groups (6% vs. 7%, adjusted OR 0.86; 95% CI 0.64–1.15). • The proportion of patients achieving any ROSC (OR 1.02, 95% CI 0.89–1.16) and sustained ROSC transfer of care to the medical staff at the receiving hospital (OR 0.97, 95% CI 0.83–1.14) was similar in the two groups. • Survival at 3 months was similar to the primary outcome, indicating that little mortality occurs between 30 days and 3 months, with no difference between groups (OR 0.89, 95% CI 0.69–1.15). • The number of patients with a favorable neurological outcome at 3 months was lower in the LUCAS-2 group than in the control group (OR 0.77, 95% CI 0.59–1.02). • Both secondary statistical complier average causal effect (CACE) analyses had similar results to those of the intention-to-treat analysis.
How precise was the estimate of the treatment effect? (i.e. what 95% CIs were associated with the results?)	See above.

How can I apply the results to patient care?	
Were the study patients similar to my patient?	Likely yes. While this study was conducted in the UK, it seems likely that patients and care in cases of OHCA would be similar to those in the US. The CARES registry has reported similar rates of bystander CPR in the US. The authors do not report racial and ethnic information or medical comorbidities, but I suspect these would be similar to our population.
Were all clinically important outcomes considered?	Yes. The authors considered short-term outcomes (ROSC, survival to arrival at the receiving hospital) and long-term outcomes (3-month and 12-month survival) as well as functional outcomes.
Are the likely treatment benefits worth the potential harm and costs?	No. This study suggests there is no significant difference in short-term or long-term survival with the use of an automated chest compression device compared to manual compressions for out-of-hospital cardiac arrest, with lower rates of survival with a good functional neurologic outcome.

Limitations:

1. **Patients were randomized by ambulance vehicle rather than at the patient level, with no crossover to the other group. Such cluster randomized trials have the potential to introduce bias from differences in practice between paramedics and EMS services.**

2. **40% of patients assigned to the LUCAS group did not receive mechanical chest compressions as intended. While this may reflect a real-world scenario in this intention to treat analysis, it also limits our understanding of the effects of the LUCAS device on outcomes (intention to treat vs. per protocol analyses).**

3. **It was not possible to blind EMS providers or other clinicians to group allocation, and a limited attempt was made at blinding outcome assessors.**

Bottom Line:

This large, cluster randomized trial from the UK suggests there is no significant difference in short-term or long-term survival with the use of an automated chest compression device compared to manual compressions for out-of-hospital cardiac arrest, with lower rates of survival with a good functional neurologic outcome.