Mechanical CPR: Who? When? How?

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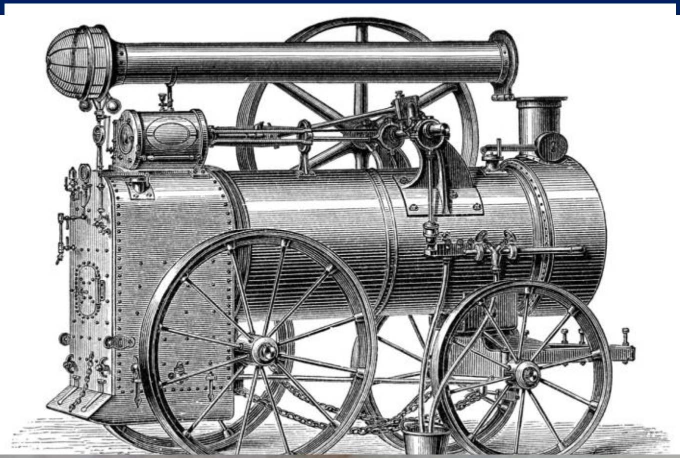
Conflicts of interest

Research support:

Stryker, Zoll, Nonin, Massimo, Zoll, Advanced CPR solution

History of technology



Invention of steam engine: 1731

History of CPR

Manual CPR: 1961

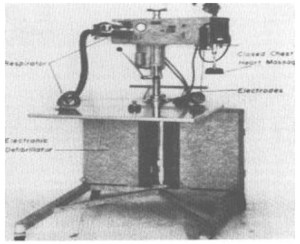


Fig. 5. Beck–Rand electricity powered.

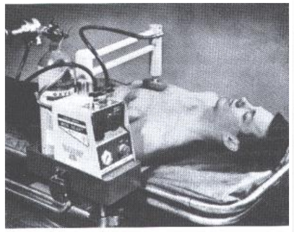
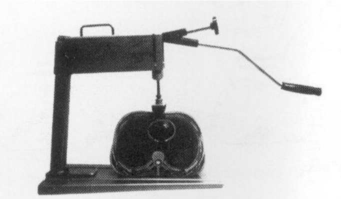


Fig. 4. Iron Heart gas powered.



Bowen Pulsator

Fig. 10. Bowen Pulsator.

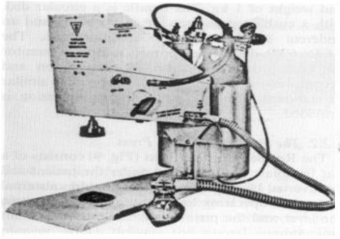
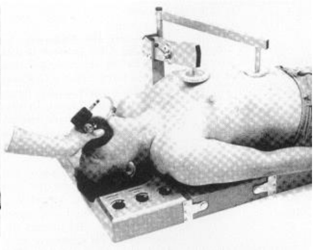
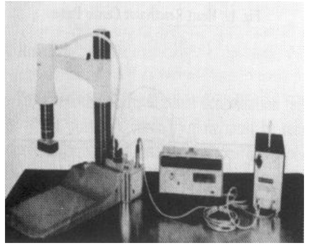
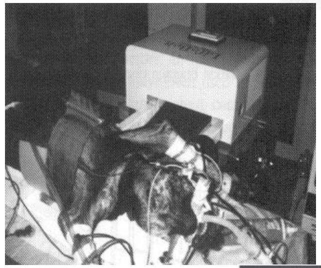
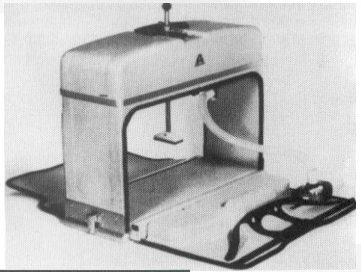


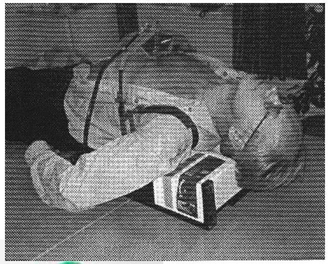
Fig. 13. HLR Tamband gas powered.











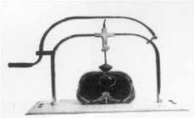


Fig. 9. Rentsch Cardiac Press.

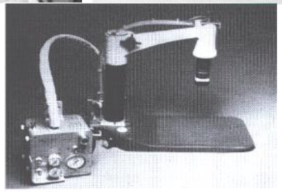


Fig. 1. Thumper gas powered.

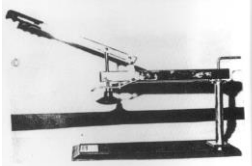
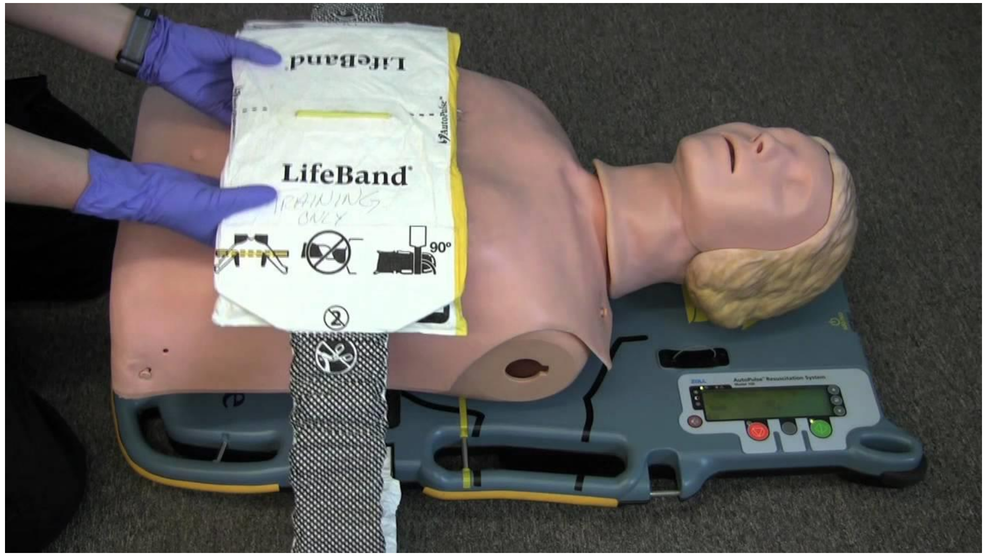


Fig. 11. Hepco Cardiac Massager.

Two main designs

Piston-based devices

Load-band devices



RCT with mechanical CPR

Mechanical versus manual chest compression for out-of-hospital cardiac arrest (PARAMEDIC): a pragmatic, cluster randomised controlled trial

Gavin D Perkins, Ranjit Lall, Tom Quinn, Charles D Deakin, Matthew W Cooke, Jessica Horton, Sarah E Lamb, Anne-Marie Slowther, Malcolm Woollard, Andy Carson, Mike Smyth, Richard Whitfield, Amanda Williams, Helen Pocock, John J M Black, John Wright, Kyee Han, Simon Gates, PARAMEDIC trial collaborators*

Lancet. 2015;385:947–55

ELSEVIER

Resuscitation

Volume 85, Issue 6, June 2014, Pages 741-748

Clinical Paper

Manual vs. integrated automatic load-distributing band CPR with equal survival after out of hospital cardiac arrest. The randomized CIRC trial ☆ ☆☆

Lars Wik [a], Jan-Aage Olsen [a, b], David Persse [c], Fritz Sterz [d], Michael Lozano Jr. [e, f], Marc A. Brouwer [g], Mark Westfall [h, i], Chris M. Souders [c], Reinhard Malzer [j], Pierre M. van Grunsven [k], David T. Travis [e], Anne Whitehead [l], Ulrich R. Herken [m], E. Brooke Lerner [n]

Original Investigation

Mechanical Chest Compressions and Simultaneous Defibrillation vs Conventional Cardiopulmonary Resuscitation in Out-of-Hospital Cardiac Arrest

The LINC Randomized Trial

Sten Rubertsson, MD, PhD; Erik Lindgren, MD; David Smekal, MD, PhD; Ollie Östlund, PhD; Johan Silfverstolpe, MD; Robert A. Lichtveld, MD, PhD; Rene Boomars, MPA; Björn Ahlstedt, MD; Gunnar Skoog, MD; Robert Kastberg, MD; David Halliwell, RN; Martyn Box, RN; Johan Herlitz, MD, PhD; Rolf Karlsten, MD, PhD

JAMA. 2014;311:53–61

Resuscitation 82 (2011) 702–706

Contents lists available at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

ELSEVIER

Clinical paper

A pilot study of mechanical chest compressions with the LUCAS^{TM} device in cardiopulmonary resuscitation☆

David Smekal [a,*], Jakob Johansson [a,b], Tibor Huzevka [a], Sten Rubertsson [a]

[a] Department of Surgical Sciences - Anaesthesiology & Intensive Care, Uppsala University, SE-751 85 Uppsala, Sweden
[b] Centre of Emergency Medicine, SE-751 85 Uppsala, Sweden

Clinical Paper

Manual vs. integrated automatic load-distributing band CPR with equal survival after out of hospital cardiac arrest. The randomized CIRC trial ☆ ☆☆

Lars Wik [a], Jan-Aage Olsen [a, b], David Persse [c], Fritz Sterz [d], Michael Lozano Jr. [e, f], Marc A. Brouwer [g], Mark Westfall [h, i], Chris M. Souders [c], Reinhard Malzer [j], Pierre M. van Grunsven [k], David T. Travis [e], Anne Whitehead [l], Ulrich R. Herken [m], E. Brooke Lerner [n]

Resuscitation 2014

4231 patients

Mechanical CPR | **Manual CPR**

Survival at 30D

9,4%

Odd Ratio
1.06 (95% CI 0.83, 1.37)

11%

Original Investigation

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The LINC Randomized Trial

Sten Rubertsson, MD, PhD; Erik Lindgren, MD; David Smekal, MD, PhD; Ollie Östlund, PhD; Johan Silfverstolpe, MD; Robert A. Lichtveld, MD, PhD; Rene Boomars, MPA; Björn Ahlstedt, MD; Gunnar Skoog, MD; Robert Kastberg, MD; David Halliwell, RN; Martyn Box, RN; Johan Herlitz, MD, PhD; Rolf Karlsten, MD, PhD

2589 patients

Mechanical CPR

Manual CPR

Survival at 4h

23,6%

Différence entre traitement
– 0.05 (95% CI – 3.3, 3.2)

23,7%

Mechanical versus manual chest compression for out-of-hospital cardiac arrest (PARAMEDIC): a pragmatic, cluster randomised controlled trial

Gavin D Perkins, Ranjit Lall, Tom Quinn, Charles D Deakin, Matthew W Cooke, Jessica Horton, Sarah E Lamb, Anne-Marie Slowther, Malcolm Woollard, Andy Carson, Mike Smyth, Richard Whitfield, Amanda Williams, Helen Pocock, John J M Black, John Wright, Kyee Han, Simon Gates, PARAMEDIC trial collaborators*

4470 patients

Mechanical CPR

Manual CPR

Survival at 30 D

6%

N=104/1652

Odds Ratio
0.86 (95% CI 0.64, 1.15)

7%

N=193/2819

In hospital cardiac arrest

RESUSCITATION 198 (2024) 110142

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Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

EUROPEAN RESUSCITATION COUNCIL

Clinical paper

The association between mechanical CPR and outcomes from in-hospital cardiac arrest: An observational cohort study

Check for updates

Conor Crowley[a,b,c,*], *Justin Salciccioli*[b,d], *Wei Wang*[d,e], *Tomoyoshi Tamura*[f],

2232 patients with mechanical CPR
108 911 with manual CPR

Survival to discharge:
11,8% mechanical CPR
16,9% Manual CPR
P<0,001

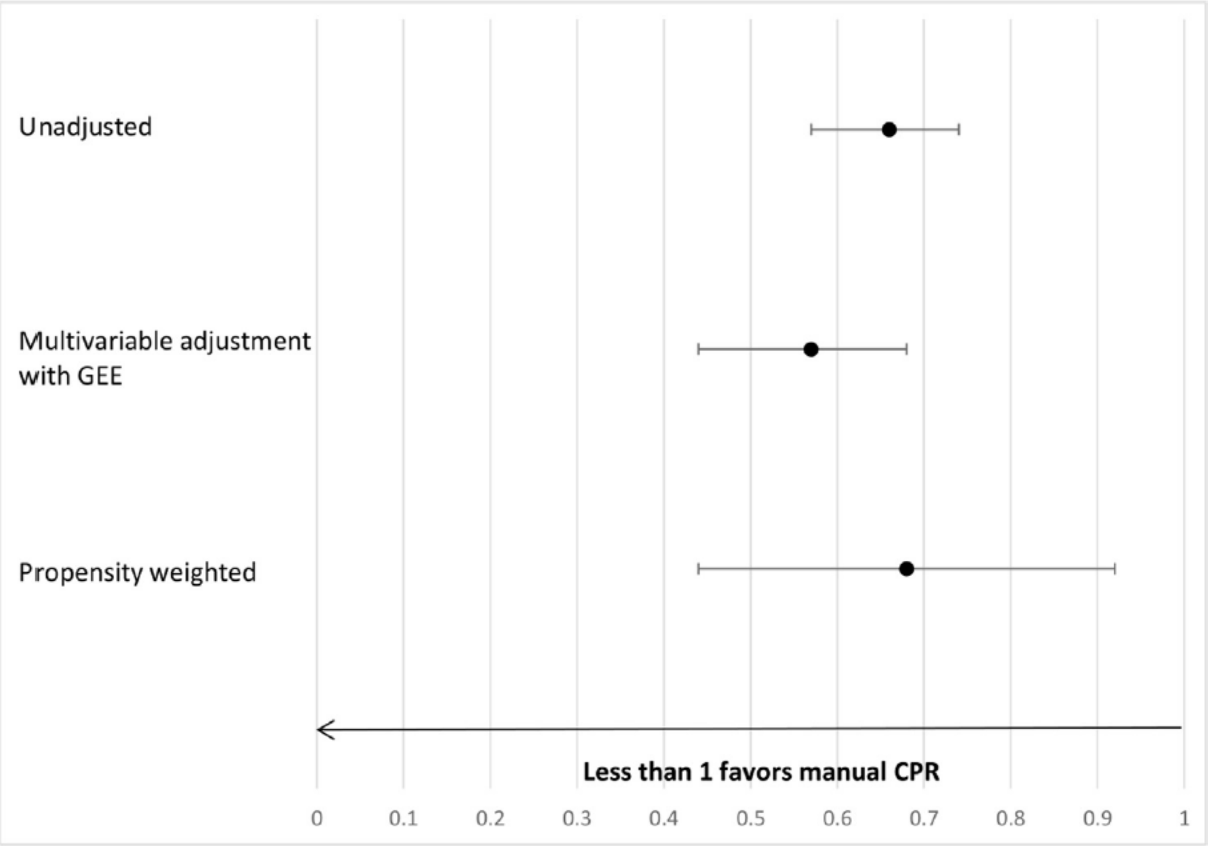


Fig. 3 – Forest plot of ORs for survival to discharge of mechanical vs manual CPR.

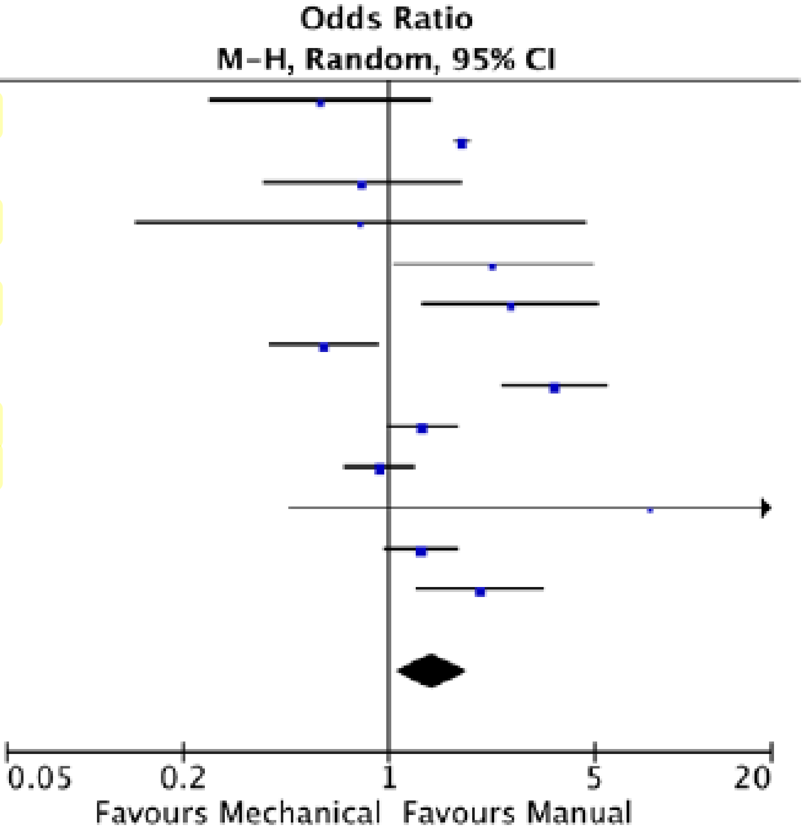
Meta-analysis

Survival with good neurologic outcome

Study or Subgroup	Manual Events	Manual Total	Mechanical Events	Mechanical Total	Weight	Odds Ratio M-H, Random, 95% CI
Axelsson 2006	9	169	14	159	5.5%	0.58 [0.24, 1.39]
Buckler 2016	5967	63056	984	17625	12.2%	1.77 [1.65, 1.90]
Chen 2021	12	273	15	279	6.1%	0.81 [0.37, 1.76]
Gao 2016	2	15	5	31	2.0%	0.80 [0.14, 4.70]
Gonzales 2019	21	176	10	176	6.1%	2.25 [1.03, 4.93]
Hallstrom 2006	28	373	12	394	6.9%	2.58 [1.29, 5.16]
Mistraletti 2023	72	1061	33	305	9.4%	0.60 [0.39, 0.93]
Newberry 2018	129	1020	29	763	9.6%	3.66 [2.42, 5.55]
Perkins 2015	168	2819	77	1652	10.9%	1.30 [0.98, 1.71]
Rubertsson 2014	100	1289	108	1300	10.9%	0.93 [0.70, 1.23]
Tantarattanapong 2022	19	193	0	34	0.9%	7.71 [0.45, 130.76]
Wik 2014	112	2132	87	2099	10.9%	1.28 [0.96, 1.71]
Zeiner 2015	92	655	21	283	8.7%	2.04 [1.24, 3.35]
Total (95% CI)		**73231**		**25100**	**100.0%**	**1.41 [1.07, 1.84]**
Total events	6731		1395			

Heterogeneity: $Tau^2 = 0.16$; $Chi^2 = 74.25$, df = 12 ($P < 0.00001$); $I^2 = 84\%$

Test for overall effect: Z = 2.46 (P = 0.01)



Medicine (Baltimore). 2024 Feb 23;103(8):e37294.

Why it's not working - Quality of CPR

Clinical Paper

Manual vs. integrated automatic load-distributing band CPR with equal survival after out of hospital cardiac arrest. The randomized CIRC trial ☆ ☆☆

Lars Wik [a], Jan-Aage Olsen [a, b], David Persse [c], Fritz Sterz [d], Michael Lozano Jr. [e, f], Marc A. Brouwer [g], Mark Westfall [h, i], Chris M. Souders [c], Reinhard Malzer [j], Pierre M. van Grunsven [k], David T. Travis [e], Anne Whitehead [l], Ulrich R. Herken [m], E. Brooke Lerner [n]

CCF in manual CPR group = 79%

Original Investigation

Mechanical Chest Compressions and Simultaneous Defibrillation vs Conventional Cardiopulmonary Resuscitation in Out-of-Hospital Cardiac Arrest
The LINC Randomized Trial

Sten Rubertsson, MD, PhD; Erik Lindgren, MD; David Smekal, MD, PhD; Ollie Östlund, PhD; Johan Silfverstolpe, MD; Robert A. Lichtveld, MD, PhD; Rene Boomars, MPA; Björn Ahlstedt, MD; Gunnar Skoog, MD; Robert Kastberg, MD; David Halliwell, RN; Martyn Box, RN; Johan Herlitz, MD, PhD; Rolf Karlsten, MD, PhD

CCF in manual CPR group = 78%

Why it's not working – too long

A training question?

Table 1
CPR quality metrics for the years (2012) and (2013).

2012 and 2013 LUCAS and CPR Process			
	2012 ($n = 61$)	2013 ($n = 71$)	p Value
Chest compression interruption prior to first mechanical compression (s)	21 (15, 31)	7 (4, 12)	<0.001
Longest chest compression interruption during resuscitation attempt (s)	25 (20, 35)	13 (10, 20)	<0.001
Proportion of cases in which longest interruption was for mechanical CPR device application	74%	31%	<0.001
Compression fraction	0.90 (0.88, 0.93)	0.95 (0.93, 0.96)	<0.001
Interruption for mechanical CPR device application as proportion of total "hands off" time	18% (12%, 32%)	10% (6%, 18%)	<0.001

Continuous variables presented as median (25th, 75th percentile).

M. Levy et al. / Resuscitation 92 (2015) 32–37

LUCAS Minimizes Hands-Off Time

Cumulative Interruption Time: 00:00 Manual CPR Interruptions: 0

RESUSCITATION 169 (2021) 124–135

Available online at ScienceDirect

Resuscitation

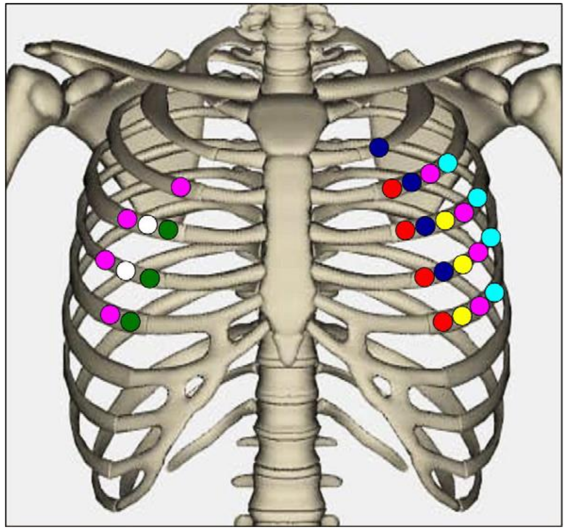
journal homepage: www.elsevier.com/locate/resuscitation

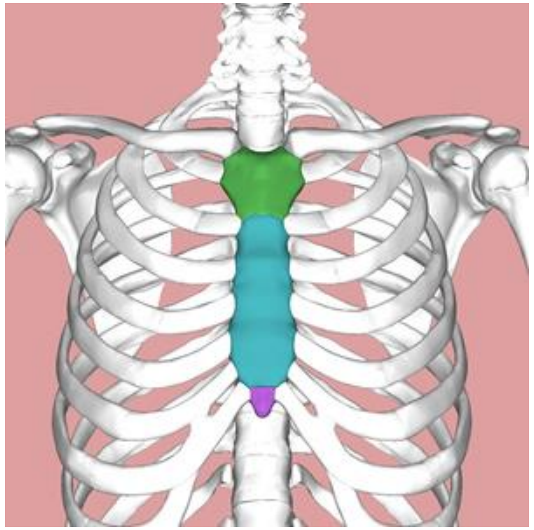
Why it’s not working – too traumatic

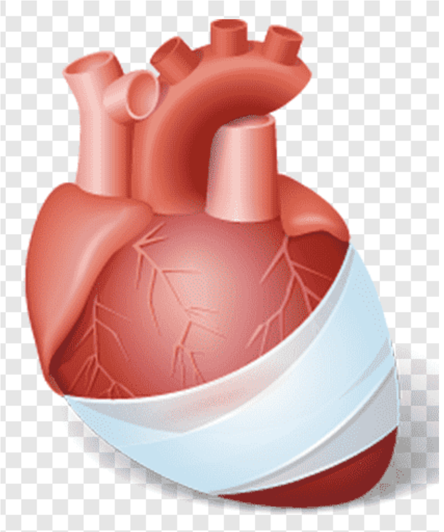
Review

Safety of mechanical and manual chest compressions in cardiac arrest patients: A systematic review and meta-analysis

Yanxia Gao[a,1], *Tongwen Sun*[b,1], *Ding Yuan*[a], *Huoyan Liang*[b], *Youdong Wan*[c],








Are there still some
patients who can benefit?

Mechanical versus manual chest compression CPR under ground ambulance transport conditions

Acute Cardiac Care, March 2013; 15(1): 1–6

Julia Fox[1], René Fiechter[2], Peter Gerstl[2,3], Alfons Url[1], Heinz Wagner[3], Thomas F. Lüscher[4], Urs Eriksson[2,3] & Christophe A. Wyss[4]

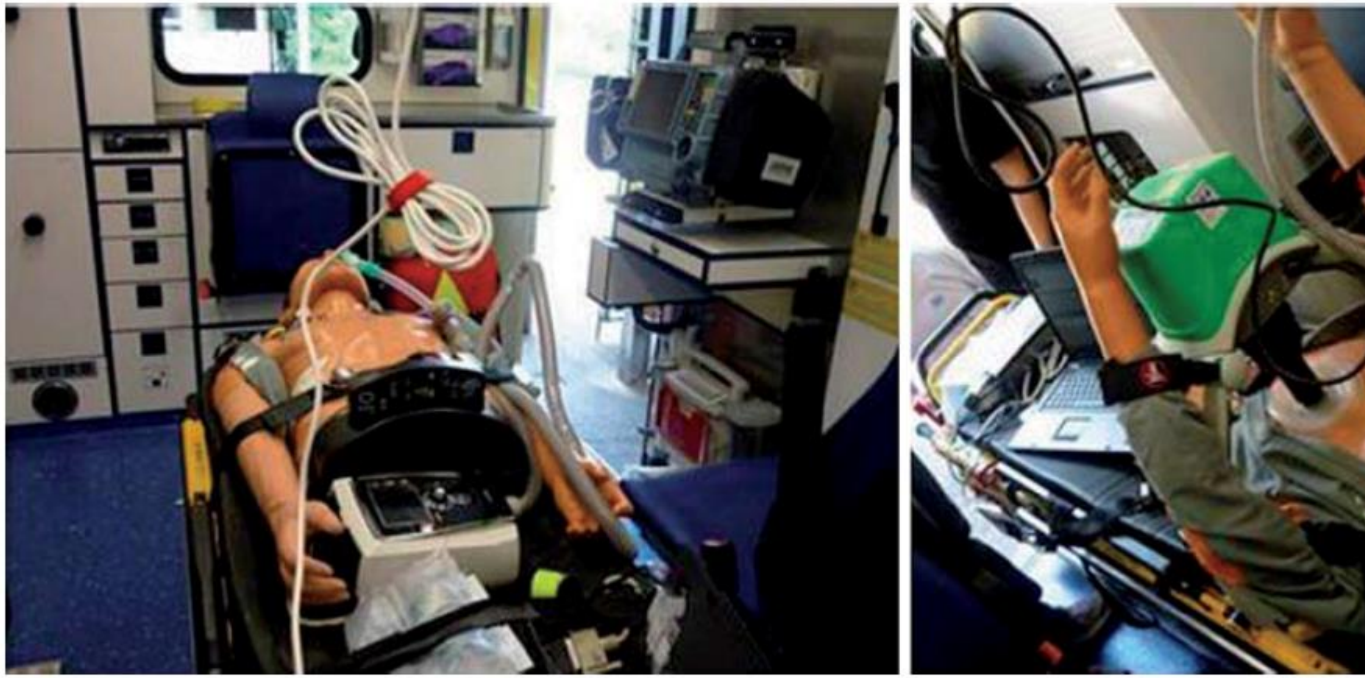
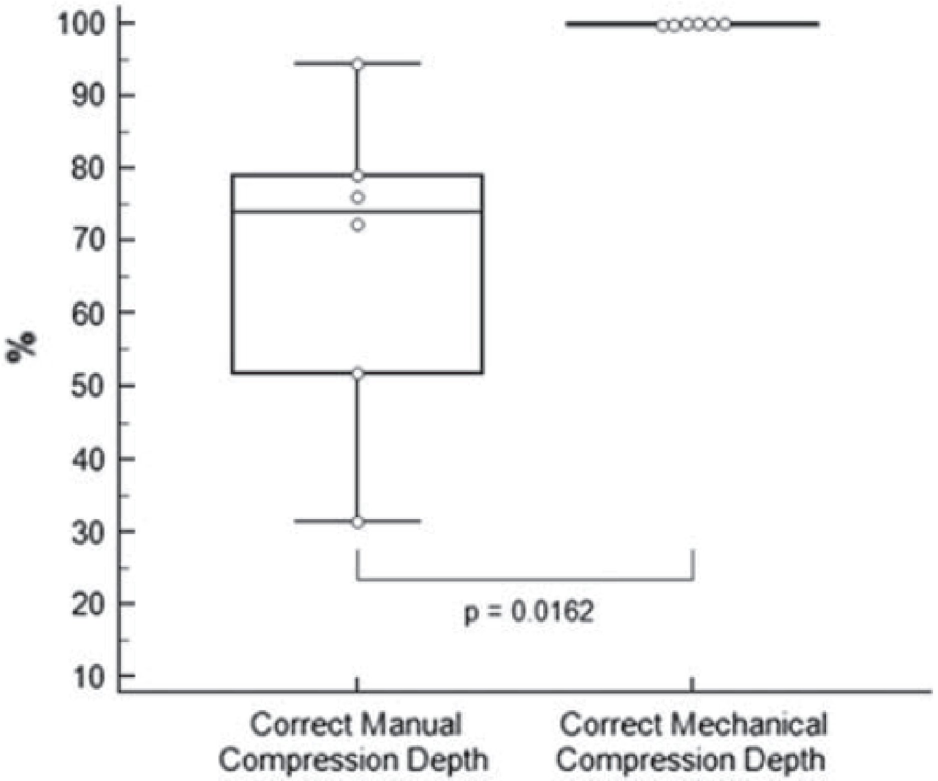
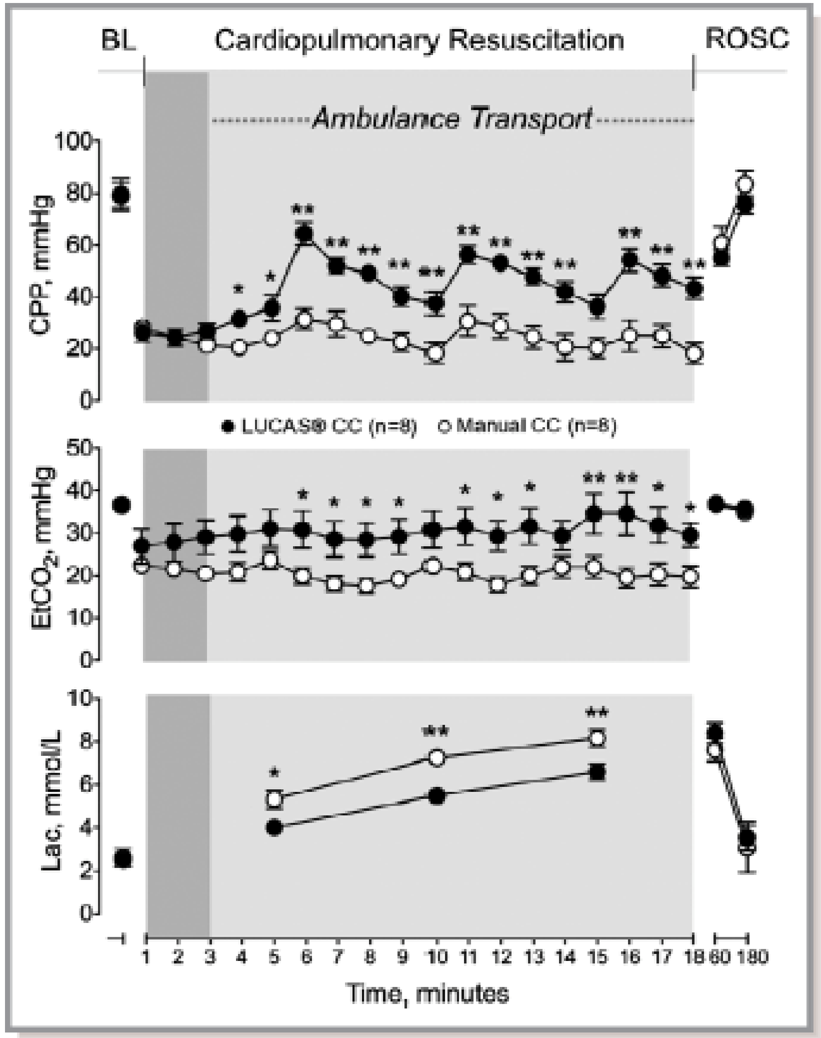


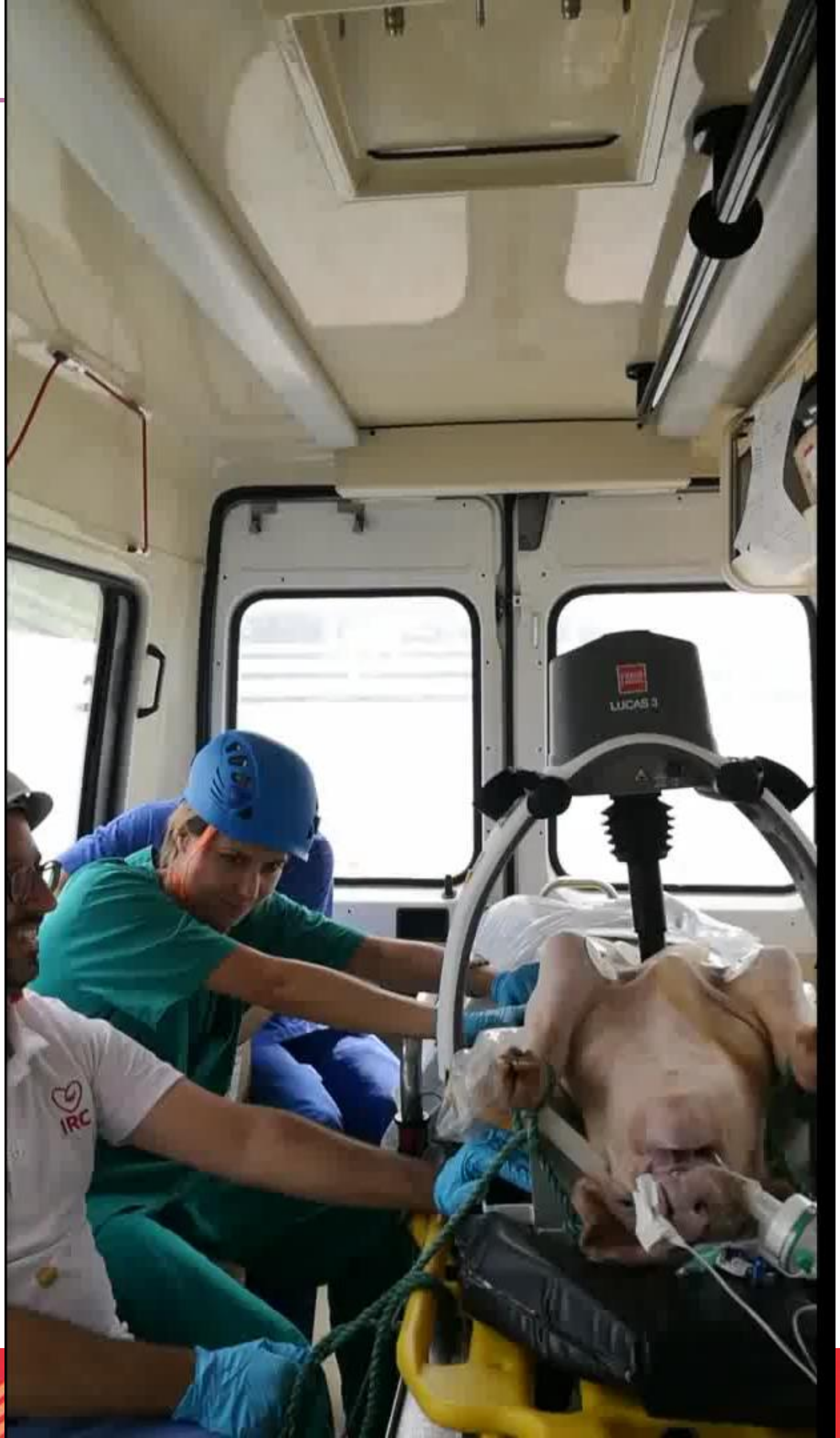
Figure 1. LUCAS™2 performing mechanical CPR during ambulance transport.



LUCAS Versus Manual Chest Compression During Ambulance Transport: A Hemodynamic Study in a Porcine Model of Cardiac Arrest

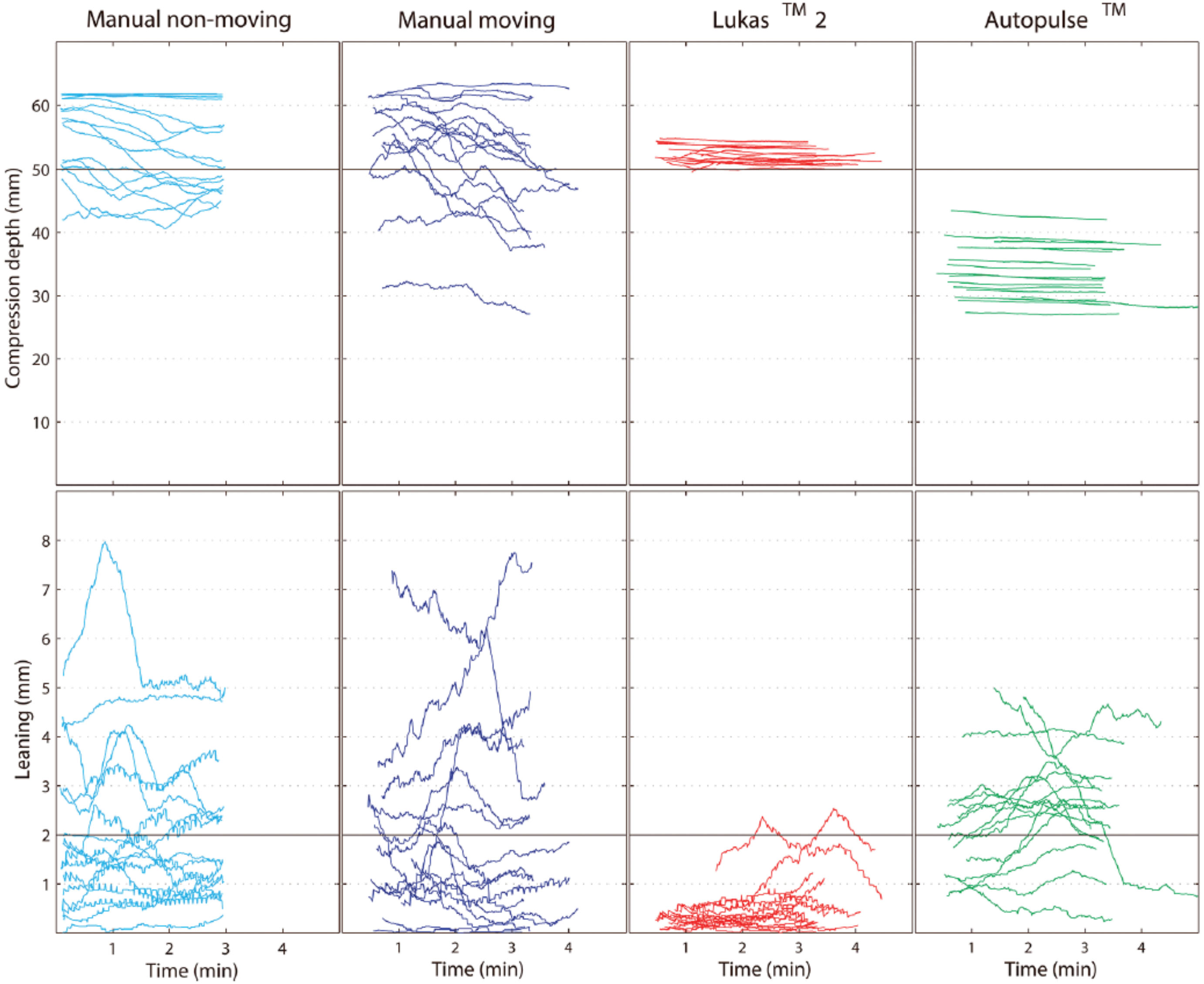
Aurora Magliocca, MD; Davide Olivari, MBiol; Daria De Giorgio, MBiol; Davide Zani, MVet; Martina Manfredi, MVet;
Antonio Boccardo, MVet; Alberto Cucino, MD; Giulia Sala, MVet; Giovanni Babini, MD; Laura Ruggeri, MD; Deborah Novelli, MBiol;
Markus B Skrifvars, MD, PhD; Bjarne Madsen Hardig, RN, PhD; Davide Pravettoni, MVet; Lidia Staszewsky, MD; Roberto Latini, MD;
Angelo Belloli, MVet; Giuseppe Ristagno, MD, PhD





Mountain rescue cardiopulmonary resuscitation: a comparison between manual and mechanical chest compressions during manikin cardio resuscitation

Oyvind Thomassen,[1] Sven Christjar Skaiaa,[2,3] Jorg Assmuss,[4] Øyvind Øster
Jon Kenneth Heltne,[1,5] Lars Wik,[6,7] Guttorm Brattebo[1,8]



For which patients:
We should (must) do it

Neurologic Recovery From Profound Accidental Hypothermia After 5 Hours of Cardiopulmonary Resuscitation

Yvonnick Boue, MD[1,2,3]; Julien Lavolaine, MD[1]; Pierre Bouzat, MD, PhD[1,2,3]; Sophie Matraxia, MD[4]; Olivier Chavanon, MD, PhD[5]; Jean-François Payen, MD, PhD[1,2,3]

Crit Care Med. 2014;42:e167-70.

RESUSCITATION 179 (2022) 183–188

Available online at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

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EUROPEAN RESUSCITATION COUNCIL

du graphique

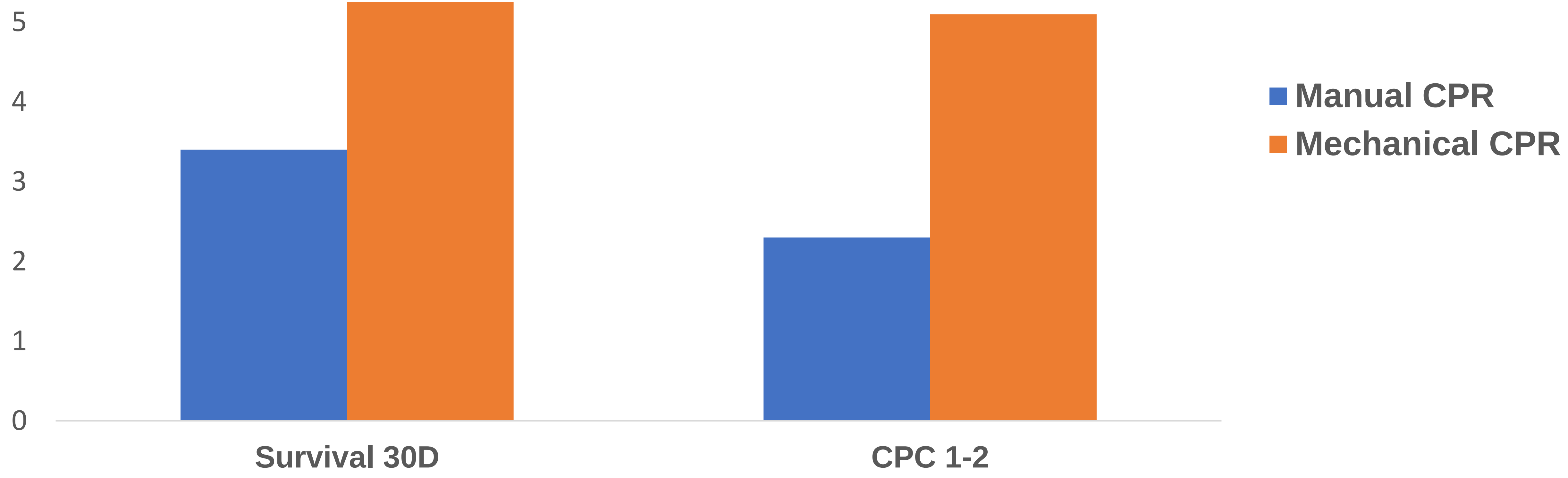
For prolonged CPR

Clinical paper

Mechanical chest compression devices under special circumstances

Holger Gässler[a,*], *Lara Kurka*[b], *Stefan Rauch*[b], *Stephan Seewald*[c], *Martin Kulla*[a], *Matthias Fischer*[b]

3920 patients with CPR > 45min



Lancet. 2020;396:1807-1816

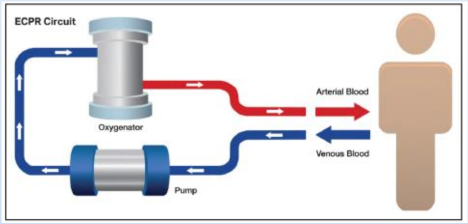
Advanced reperfusion strategies for patients with out-of-hospital cardiac arrest and refractory ventricular fibrillation (ARREST): a phase 2, single centre, open-label, randomised controlled trial

Demetris Yannopoulos, Jason Bartos, Ganesh Raveendran, Emily Walser, John Connett, Thomas A Murray, Gary Collins, Lin Zhang, Rajat Kalra, Marinos Kosmopoulos, Ranjit John, Andrew Shaffer, R J Frascone, Keith Wesley, Marc Conterato, Michelle Biros, Jakub Tolar, Tom P Aufderheide

Mechanical CPR was an inclusion criteria

Survival to discharge
Primary outcome

ECPR



standard CPR

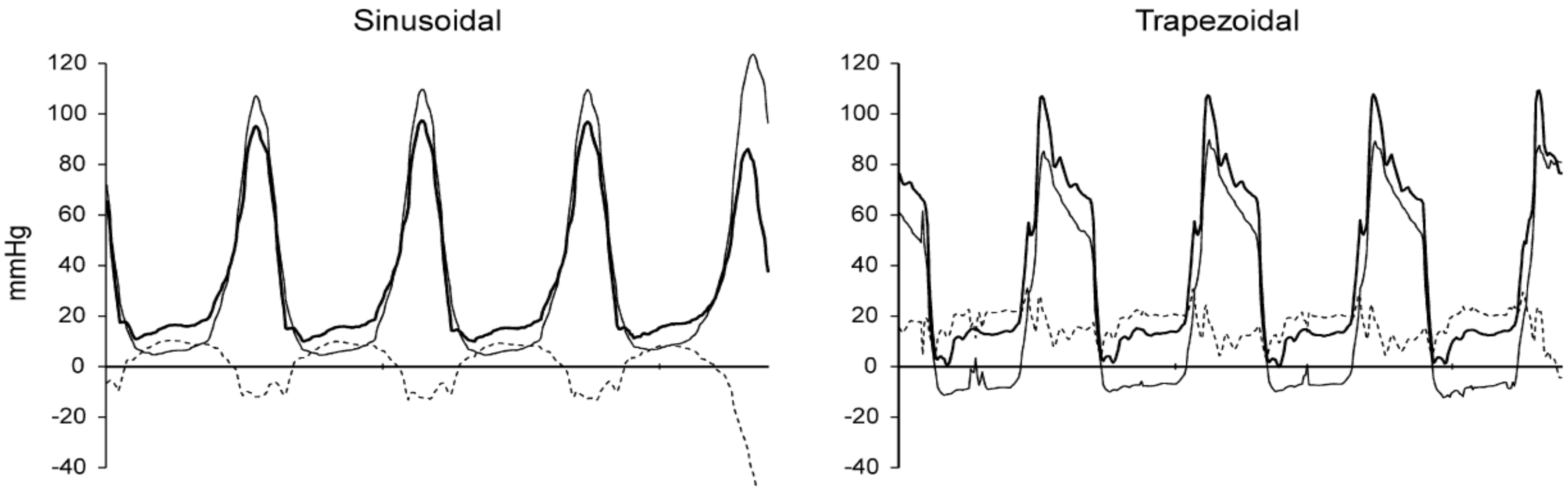
43%
(6/15 patients)

risk difference 36%, 3·7–59·2; 0·9861 posterior probability of ECMO superiority

7%
(1/15 patients)

Change in wave form to improve hemodynamic

J. Kramer-Johansen et al. / Resuscitation 82 (2011) 213–218



	Trapezoid	Sinusoid	P value
SAP (mmHg)	79 (66,86)	62 (58,70)	0.007
Carotid blood flow (ml/min)	52 (20,66)	37 (21,41)	0.04
Cortical cerebral microcirculation (% of baseline)	52 (20,66)	26 (17,43)	0.005

Maybe some improvement to come…

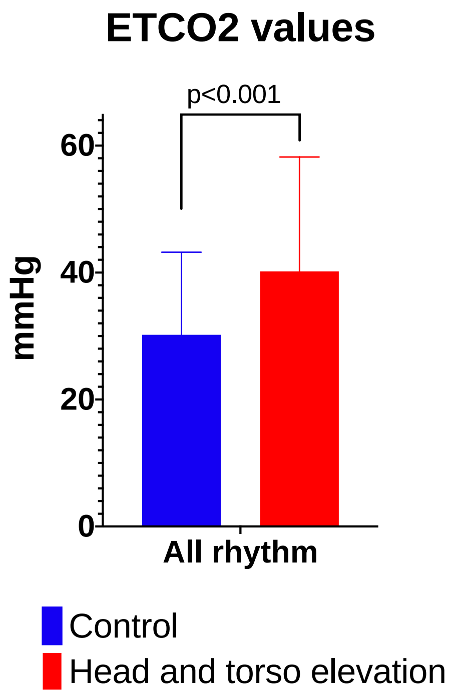
Bundling Technology

Gravity Study

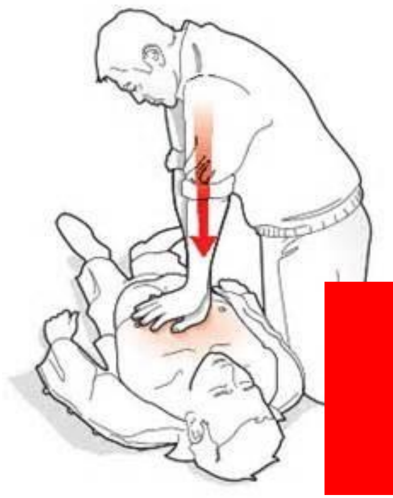
Combination of head-up position, active compression-decompression mechanical cardiopulmonary resuscitation and impedance threshold device to improve outcomes in out-of-hospital cardiac arrest. A prospective controlled quasi-experimental trial

Elegard | Lucas AD | ITD-16

Primary Endpoint - Max ETCO2 during CPR



59 patients



63 patients

+ 36%

30±13 mmHg **41 ±18 mmHg**

P<0.001

Debaty G et al - *Circulation*. 2023;148:A141-A141

Conclusion – Mechanical CPR vs. Manual CPR

Not for all patients but useful in special circonstances

Needed for:

- Transport with ongoing CPR
- Bridge to ECPR
- Organ donation

HANDS FREE
HASSLE FREE