Effectiveness of Mechanical CPR in the Pre-Hospital Setting
Paramedic Mini CAT – Fanshawe College Date of review: 10.03.2022

Author: Nicholas Di Cecco, Primary Care Paramedic student, Fanshawe College, Ontario, Canada.
Second party appraiser: Alan Batt, Professor, Paramedic Programs, Fanshawe College, Ontario, Canada.

Clinical Scenario:
Paramedics are called to a 65-year-old patient complaining of chest pain in a remote area of the local county. When the medics arrive, they find that the patient has gone VSA. Due to the location of the call, additional resources are unable to arrive before transport must be initiated. This leaves one medic to manage CPR during a lengthy transport. Will the medic be able to ensure effective compressions during transport, or should mechanical CPR devices be utilized?

Background:
For patients experiencing a cardiac arrest out-of-hospital, effective CPR – with an emphasis on effective chest compressions – is critical to help in their survival. The purpose behind chest compressions is to help blood perfuse the patient's vital organs despite the heart not working properly. For CPR to be most effective, the compressions in adults should be at least two inches deep, allow for full chest recoil, and occur at a rate of around 100-120 beats per minute. There should also be no lengthy pause in compressions. CPR therefore places great strain on the person performing compressions, and as such it is recommended that rescuers rotate the person doing compressions after each analysis (two minutes). The consensus among medics in the field is that mechanical CPR devices are less effective as paramedics in performing these compressions. However, there may be cases where it is not possible for a person to be performing compressions (extrication) or cases where prolonged CPR could affect quality (transport). Given the importance of CPR in ensuring patient outcomes, it is therefore necessary to research the effectiveness of mechanical CPR devices compared to manually performed CPR.

Review question:
Patient/Problem: Adult patients in cardiac arrest requiring CPR.
Intervention: Effectiveness of mechanical CPR devices in bettering patient outcomes.
Comparison: Current paramedic practice of manual chest compressions.
Outcome: Patient survivability and outcome.

Search strategy (Basic):
("Paramedic" OR "paramedicine" OR "ems" OR "emergency medical service" OR "emt" OR "emergency medical technician" OR "nurse" OR "bystander" OR "pre-hospital" OR "prehospital" OR "emergency medicine")

AND

(“Mechanical CPR” OR “mechanical chest compressions”)

AND

(“Effectiveness” OR “outcomes”)

Limits:
Language: English
Years: Jan. 2012 – Feb. 2022
Peer reviewed

Databases searched: PubMed, MEDLINE

Search results:

PubMed: 65, MEDLINE: 3

Included for review:

Three articles were included for review. The reason for their inclusion was a mixture of study date, with a bias towards more recently published papers, as well as study type. Preference was given to randomized controlled trials. Finally, studies with large sample sizes were given preference.

Title, author, year	Study design & LOE	Population	Intervention	Outcomes	Results	Weaknesses & Strengths
The Comparison of Manual and Mechanical Chest Compression on Survival and Long-Term Neurological Outcome of Nontraumatic Out-of-Hospital Cardiac Arrest Patients. Authors: Halhalli et. al. Year: 2020	Retrospective analytical study. LEO: 2	Inclusion criteria: Adult patients who experienced an out of hospital cardiac arrest (n=818). Exclusion criteria: patients younger than 18, patients with terminal diseases, and patients suffering a traumatic cardiac arrest. All participants were taken from the Kocaeli Derince Training and Research Hospital in Turkey from 2014-2018.	The intervention group (n=473) had CPR conducted via a LUCAS 2 mechanical chest compression system set to a depth of 5cm at a rate of 100bpm. The control group (n=345) was provided with CPR from trained healthcare providers.	Patient outcomes: Return of spontaneous circulation, one day survival, one month survival, 3 month survival, six month survival, and one year survival. Patients were also assessed for a Modified Rankin Score after one year.	Mechanical CPR: 42.3% of patients achieved a ROSC. Manual CPR: 46.4% achieved a ROSC. The percentage of patients with an mRS score under four was 3.5% and 4% for manual CPR and mechanical CPR participants, respectively.	Strengths: - This study utilizes human patients. - Large sample size of 818 patients. - Population group were all adult. Weaknesses: - Study was conducted with patients inside a hospital, not a prehospital environment. - Quality of manual CPR not taken into account.

Mechanical versus manual chest compression for out-of-hospital cardiac arrest (PARAMEDIC): a pragmatic, cluster randomised controlled trial Authors: Perkins et. al. Year: 2015	Cluster randomized controlled trial. LOE: 2	Inclusion criteria: Patients suffering an OHCA, aged 18 or older (n=4471). Exclusion criteria: pregnant patients, patients suffering a traumatic cardiac arrest. All participants were taken from people served by ambulance services in the West Midlands, North East England, Wales, and South Central regions of the United Kingdom.	The intervention group (n=1652) received chest compressions from a LUCAS-2 system set to give compressions at a depth of 40-53mm at a rate of 102bpm, all while allowing full chest recoil. The control group (n=2819) received manual chest compressions from trained paramedics, aiming for a depth of 50-60mm, a rate of 100-120bpm, while allowing for chest recoil.	The primary outcome was to study patient survivability 30 days after the cardiac arrest. Secondary outcomes analyzed were survival to 3 months, 12 months, and neurological outcomes. Favourable neurological outcomes are defined as a Cerebral Performance Category (CPC) score of 1 or 2 at 3 months.	Intervention group: of the 1652 cases, 32% received a ROSC, 6% survived to 30 days, 6% survived to 3 months, and 5% survived to 12 months. Those who survived with a favourable neurological outcome numbered 5% Control group: of the 2819 cases, 31% received a ROSC, 7% survived to 30 days, 6% survived to 3 months, and 6% survived to 12 months. Those who survived with a favourable neurological outcome numbered 6%.	Strengths: - Utilizes real human patients in the field. - Conducted by emergency services in the prehospital environment. - Large sample size that was chosen randomly. Weaknesses: - There was no way of monitoring the quality of manual CPR provided to patients. - Limited availability of LUCAS-2 devices meant less participants in the intervention group than control.

Manual versus Mechanical Chest Compressions on Surfaces of Varying Softness with or without Backboards: A Randomized, Crossover Manikin Study. Author: Putzer et. al. Year: 2016	Randomized, crossover manikin study. LOE: 2	Twenty four advanced life support (ALS) certified rescuers, certified in both manual and mechanical CPR. CPR was performed on Resusci-Anne manikins on different surfaces. Mannikins had 15kg added on to correct for torse weight of an adult patient.	Rescuers formed into teams of two with each rescuer performing the same CPR scenario on different surfaces. Scenarios were both completed utilizing manual compressions and mechanical compressions. Scenarios each lasted six minutes. Mechanical compressions scenario: performed with the use of a LUCAS-2 device. Manual compression scenario: teams performed CPR to ALS	The primary outcome was the percentage of chest compressions performed correctly relative to the number of total compressions. Correct compressions were defined as 50-60mm in depth, 100-120bpm, and allowing for full recoil. The secondary outcome was a measurement of hands-off time.	90% of mechanical chest compressions were performed correctly compared to 30% for manual compressions. This was mainly due to manual compressions failing to compress the chest to the proper depth. Hands off time was 15-20 seconds longer for mechanical compressions compared to manual compressions.	Strengths: - Ability to monitor the quality of manual compressions and mechanical compressions scientifically with use of a manikin. Weaknesses: - CPR was performed on manikins, therefore results may not be reflective in human patients. - Small population of only twenty four. - Short scenario length is unrealistic of OHCA cases.

Title, author, year	Study design & LOE	Population	Intervention	Outcomes	Results	Weaknesses & Strengths
			standards and rotated compressors every two minutes.			- Laboratory setting not representative of CPR in the field.

Comments:
The articles were chosen for this review for the following reasons. First, articles that presented information irrelevant to the research question and studies that duplicated methods previously undertaken were removed from selection. Secondly, selection was based in a way to provide a range of study focuses. Therefore, each article selected for review looked at a different aspect of mechanical vs. manual CPR. One looked at it in the hospital setting, one in the prehospital setting, and one on manikins in a laboratory setting.

Considerations:
There are a few things to consider when using the evidence provided here. It is worth noting that these articles were selected purely on the aspect of analyzing the effectiveness of mechanical CPR devices on patients in cardiac arrest. Therefore, studies looking at possible cost/benefits of utilizing mechanical over manual CPR were not analyzed. Furthermore, the studies included all had CPR being performed by trained healthcare professionals, therefore manual CPR results may not be applicable to the general public.

It is also worth noting that the only article to show that mechanical CPR was superior to manual CPR was conducted on manikins and not humans.

Clinical bottom line:
The bottom line is that mechanical and manual CPR are nearly equally effective in real world scenarios where trained professionals are conducting the CPR.

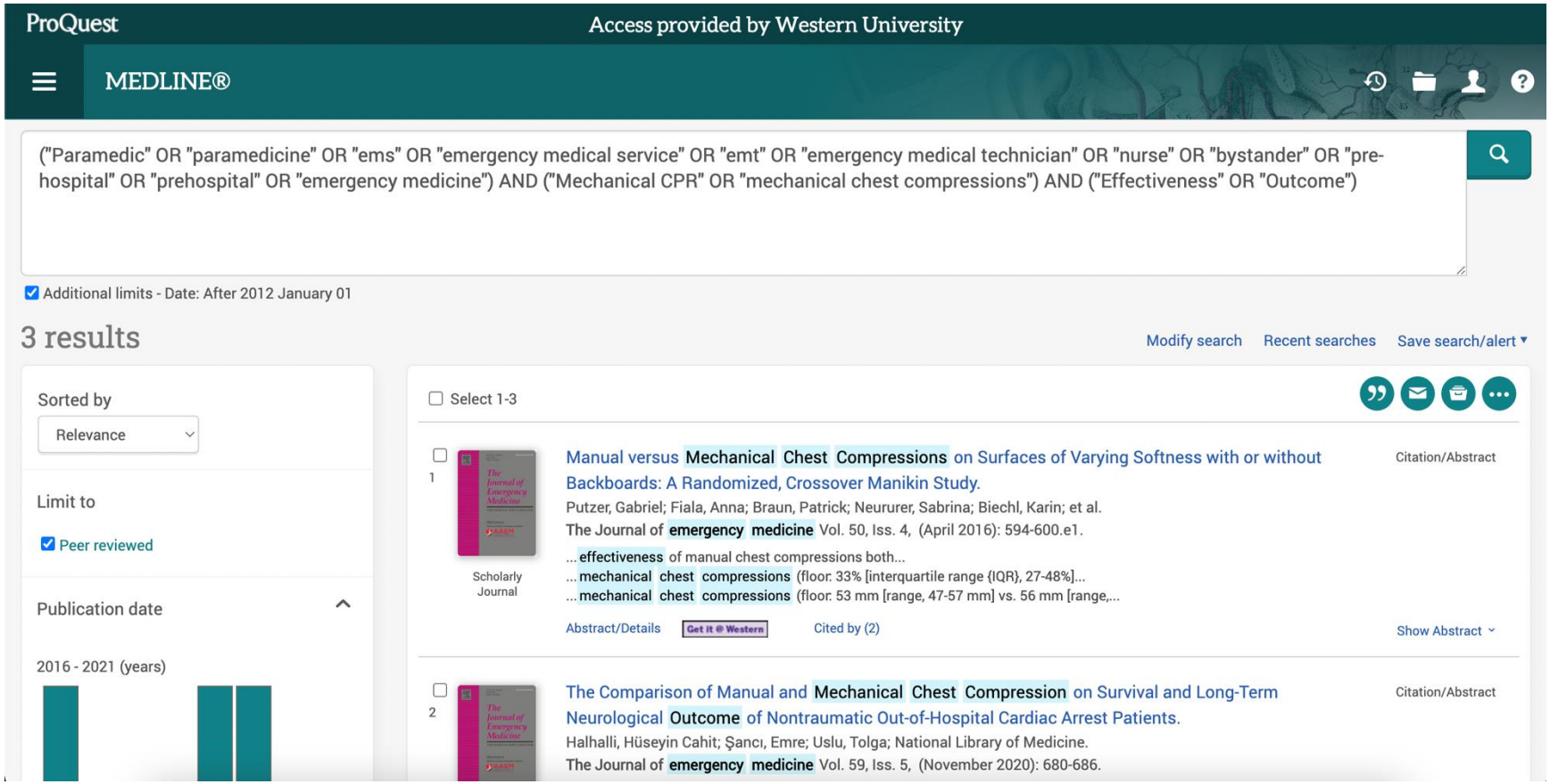
References

Halhalli, H. C., Şancı, E., & Uslu, T. (2020). The comparison of manual and mechanical chest compression on survival and long-term neurological outcome of nontraumatic out-of-hospital cardiac arrest patients. *The Journal of Emergency Medicine*, *59*(5), 680–686. https://doi.org/10.1016/j.jemermed.2020.06.010

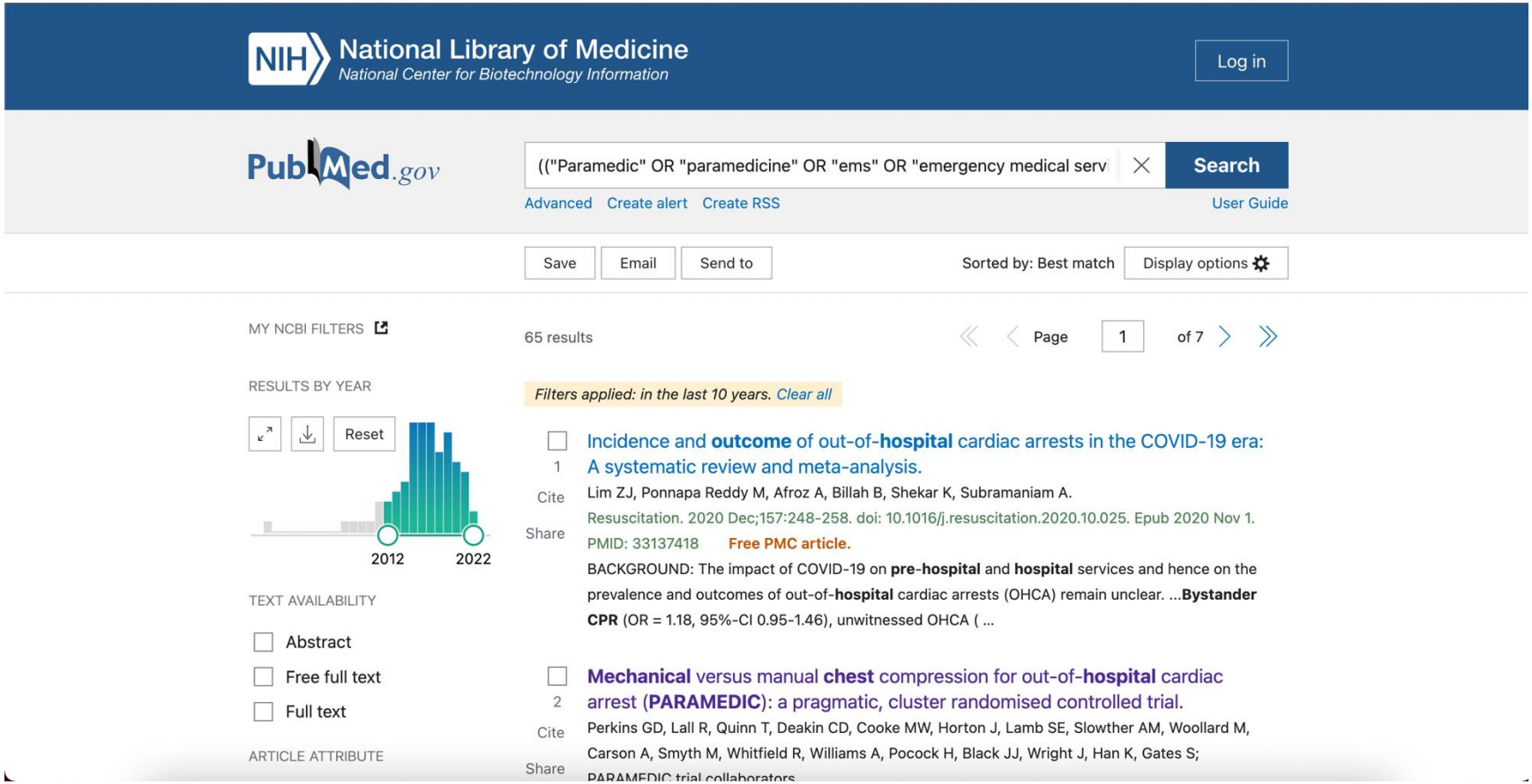
Perkins, G. D., Lall, R., Quinn, T., Deakin, C. D., Cooke, M. W., Horton, J., Lamb, S. E., Slowther, A.-M., Woollard, M., Carson, A., Smyth, M., Whitfield, R., Williams, A., Pocock, H., Black, J. J., Wright, J., Han, K., & Gates, S. (2015). Mechanical versus manual chest compression for out-of-hospital cardiac arrest (Paramedic): A pragmatic, cluster randomised controlled trial. *The Lancet*, *385*(9972), 947–955. https://doi.org/10.1016/s0140-6736(14)61886-9

Putzer, G., Fiala, A., Braun, P., Neururer, S., Biechl, K., Keilig, B., Ploner, W., Fop, E., & Paal, P. (2016). Manual versus mechanical chest compressions on surfaces of varying softness with or without backboards: A randomized, Crossover Manikin Study. *The Journal of Emergency Medicine*, *50*(4). https://doi.org/10.1016/j.jemermed.2015.10.002

Appendix A


ProQuest
Access provided by Western University
MEDLINE®
("Paramedic" OR "paramedicine" OR "ems" OR "emergency medical service" OR "emt" OR "emergency medical technician" OR "nurse" OR "bystander" OR "pre-hospital" OR "prehospital" OR "emergency medicine") AND ("Mechanical CPR" OR "mechanical chest compressions") AND ("Effectiveness" OR "Outcome")
Additional limits - Date: After 2012 January 01
3 results
Modify search
Recent searches
Save search/alert
Sorted by
Relevance
Limit to
Peer reviewed
Publication date
2016 - 2021 (years)
Select 1-3
1
Manual versus Mechanical Chest Compressions on Surfaces of Varying Softness with or without Backboards: A Randomized, Crossover Manikin Study.
Citation/Abstract
Putzer, Gabriel; Fiala, Anna; Braun, Patrick; Neururer, Sabrina; Biechl, Karin; et al.
The Journal of emergency medicine Vol. 50, Iss. 4, (April 2016): 594-600.e1.
... effectiveness of manual chest compressions both...
... mechanical chest compressions (floor: 33% [interquartile range {IQR}, 27-48%]...
... mechanical chest compressions (floor: 53 mm [range, 47-57 mm] vs. 56 mm [range,...
Scholarly Journal
Abstract/Details
Get it @ Western
Cited by (2)
Show Abstract
2
The Comparison of Manual and Mechanical Chest Compression on Survival and Long-Term Neurological Outcome of Nontraumatic Out-of-Hospital Cardiac Arrest Patients.
Citation/Abstract
Halhalli, Hüseyin Cahit; Şancı, Emre; Uslu, Tolga; National Library of Medicine.
The Journal of emergency medicine Vol. 59, Iss. 5, (November 2020): 680-686.

Appendix B


National Library of Medicine
National Center for Biotechnology Information
Log in
PubMed.gov
(("Paramedic" OR "paramedicine" OR "ems" OR "emergency medical serv
Search
Advanced
Create alert
Create RSS
User Guide
Save
Email
Send to
Sorted by: Best match
Display options
MY NCBI FILTERS
65 results
Page 1 of 7
RESULTS BY YEAR
Reset
2012
2022
Filters applied: in the last 10 years. Clear all
TEXT AVAILABILITY
Abstract
Free full text
Full text
ARTICLE ATTRIBUTE
1
Cite
Share
Incidence and outcome of out-of-hospital cardiac arrests in the COVID-19 era: A systematic review and meta-analysis.
Lim ZJ, Ponnapa Reddy M, Afroz A, Billah B, Shekar K, Subramaniam A.
Resuscitation. 2020 Dec;157:248-258. doi: 10.1016/j.resuscitation.2020.10.025. Epub 2020 Nov 1.
PMID: 33137418 Free PMC article.
BACKGROUND: The impact of COVID-19 on pre-hospital and hospital services and hence on the prevalence and outcomes of out-of-hospital cardiac arrests (OHCA) remain unclear. ...Bystander CPR (OR = 1.18, 95%-CI 0.95-1.46), unwitnessed OHCA (...
2
Cite
Share
Mechanical versus manual chest compression for out-of-hospital cardiac arrest (PARAMEDIC): a pragmatic, cluster randomised controlled trial.
Perkins GD, Lall R, Quinn T, Deakin CD, Cooke MW, Horton J, Lamb SE, Slowther AM, Woollard M, Carson A, Smyth M, Whitfield R, Williams A, Pocock H, Black JJ, Wright J, Han K, Gates S;
PARAMEDIC trial collaborators