

Manual versus mechanical cardiopulmonary resuscitation complications after successful resuscitation for out-of-hospital cardiac arrest

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Introduction

- Over 300,000 people in the United States annually suffer from an out of hospital cardiac arrest (OHCA); 90% of cases are fatal.¹
- EMS-treated OHCA approximately has a 30% rate of Return of Spontaneous Circulation (ROSC), but not all survive to hospital admission or discharge.²
- Quality cardiopulmonary resuscitation (CPR) provides vital organ reperfusion until cardiac activity can be restored.
- Mechanical CPR is increasingly being used for field OHCA care. It is most often performed by the Lund University Cardiopulmonary Assist System (LUCAS) device, a piston chest compressor which incorporates a mechanism for active chest recoil.
- Benefits of mechanical CPR:
 - Uninterrupted chest compressions at a more consistent rate.³
 - Allows CPR to be performed while moving patients.
 - Frees healthcare personnel's hands to focus on other aspects of emergency care.

Aims and Objectives

- Our primary objective of this study is to compare frequency of injury between patients who receive manual or mechanical CPR in a large suburban EMS system.
- Our secondary objective is to compare hospital outcomes including length of stay (LOS) and survival between these two CPR methods.

Methods

- Retrospective observational study admitted to 3 Beaumont hospitals (Farmington Hills, Royal Oak, and Troy).
- Target population: Adult patients resuscitated from OHCA during calendar years 2017-2021.
- Patients will be included if they received EMS CPR and were transported to a hospital within our health system and admitted to one of three study hospitals.
- We exclude patients transported from an out of system hospital.
- Patients can be identified using the Cardiac Arrest to Enhance Survival (CARES) database.^{4,5}
- EPIC® database for all patients will be queried for determining length of stay in the hospital or intensive care unit (ICU), and whether a truncal (chest/abdomen/pelvic) computed tomography (CT) was performed.
- Identified injuries noted from ICD-10 codes and radiology report narratives.
- Statistical methods:
 - Chi square tests were utilized to compare categorical variables by CPR method.
 - T-tests were used to compare continuous variables between groups.
 - Nonparametric alternatives were utilized when relevant conditions were not met.
 - All tests were two-sided with an alpha of 0.05.
 - Analysis was completed using SAS v9.

Results

- 808 cardiac arrest records admitted after OHCA
 - 235 patients (132 manual CPR, 103 mechanical CPR) meeting the inclusion criteria (Figure 1).
- Demographics between groups were similar in age, gender, or BMI (Table 1).
- No difference in the rate of Chest CT imaging by CPR method (Table 1).
- No differences identified in survival to hospital discharge (Table 1).
- Any CPR associated injury was identified in 23.0% patients with more injuries in the manual CPR group (Table 2).
- Manual CPR was associated with an increased rate of rib(s), sternum, or thoracic spine fracture (Table 2).
- No difference identified in days regarding median hospital LOS and ICU LOS, and ventilator time between groups (Table 3).
- Out of patients who survived discharge, those who received mechanical CPR were associated with longer median hospital LOS and ICU LOS (Table 4).
- There was a non-significant increased ventilator time (Table 4).

Table 1: Demographics, CT scans received, Discharged alive and CPR Method of All Patients

	Manual CPR (N=132)	Mechanical CPR (N=103)	Total (N=235)	P-value
Age	67 (52, 76)	62 (52, 76)	66 (54, 76)	0.47
Gender (%)	F: 59 (44.7%) M: 73 (55.3%)	F: 46 (44.7%) M: 57 (55.3%)	F: 105 (44.7%) M: 130 (55.3%)	1.00
BMI	29.5 (23.9, 36.4)	28.3 (23.0, 32.8)	28.7 (23.3, 35.6)	0.20
Chest CT, n (%)	105 (79.5%)	86 (83.5%)	191 (81.3%)	0.44
Discharged Alive, n (%)	39 (29.5%)	29 (28.2%)	68 (28.9%)	0.80

Table 2: CPR-associated Injuries and CPR Method of All Patients

	Manual CPR (N=132)	Mechanical CPR (N=103)	Total (N=235)	P-value
Any Injury, n (%)	38 (28.8%)	16 (15.5%)	54 (23.0%)	0.02
Visceral Injury	1 (0.8%)	0 (0.0%)	1 (0.4%)	1.00
Pneumothorax	4 (3.0%)	0 (0.0%)	4 (1.7%)	0.13
Fracture of rib(s), sternum and thoracic spine, n (%)	36 (27.3%)	15 (14.6%)	51 (21.7%)	0.02

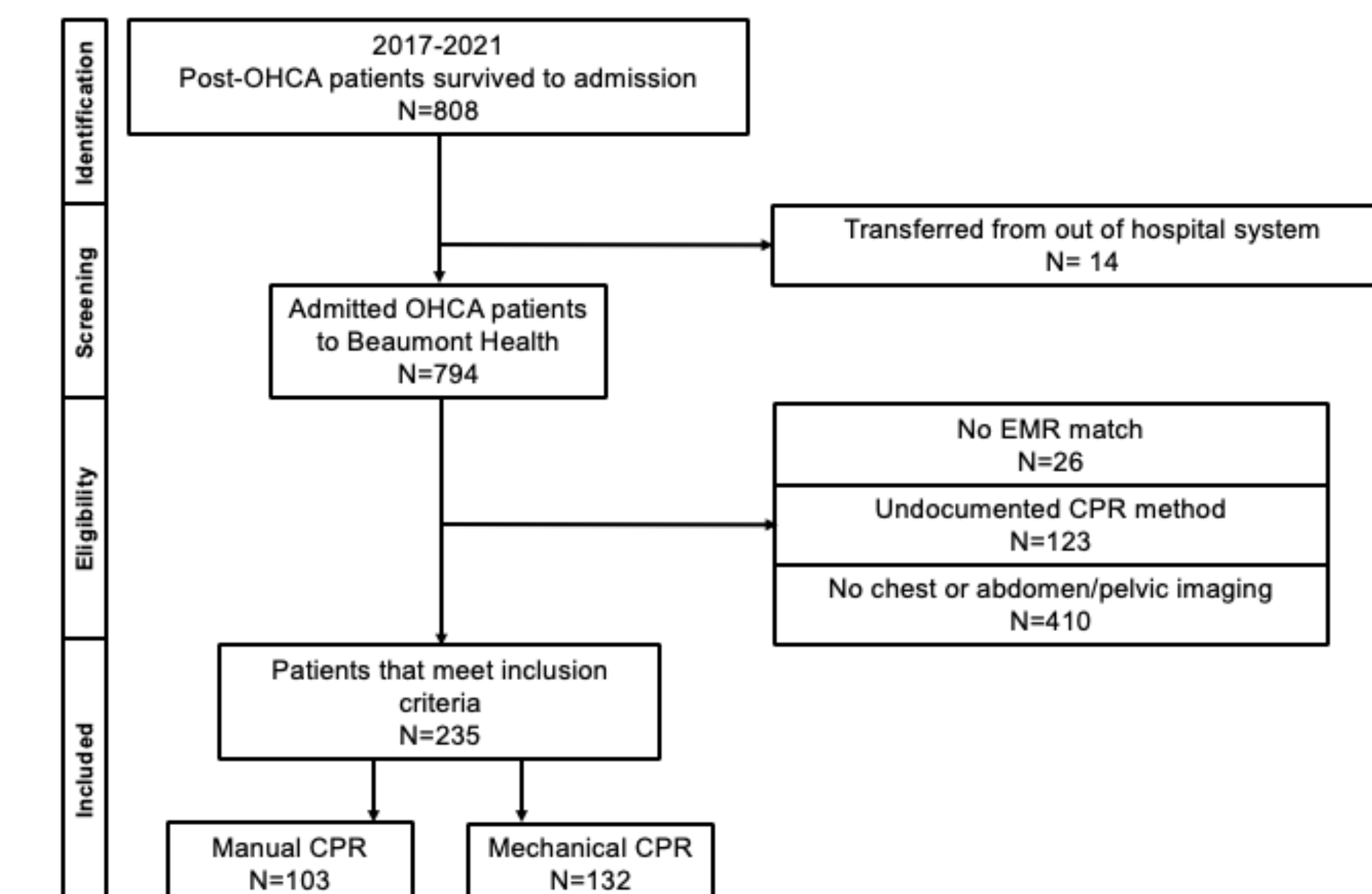
Table 3: Length of Stay & Ventilator Duration of All Patients

	Manual CPR (N=132)	Mechanical CPR (N=103)	Total (N=235)	P-value
Hospital LOS (days)	5.5 (2.1, 10.4)	5.4 (2.6, 13.7)	5.4 (2.2, 11.9)	0.27
ICU LOS (days)	4.1 (1.7, 7.3)	4.2 (2.7, 9.8)	4.2 (2.0, 9.0)	0.55
Ventilator Duration (days)	3.7 (1.5, 5.9)	3.6 (1.7, 8.4)	3.6 (1.7, 6.7)	0.45

Table 4: Length of Stay & Ventilator Duration of Patients who Survived

	Manual CPR (N=39)	Mechanical CPR (N=29)	Total (N=68)	P-value
Hospital LOS (days)	11.0 (7.7, 18.2)	15.7 (12.2, 31.7)	13.8 (9.0, 22.4)	0.01
ICU LOS (days)	5.9 (3.9, 9.9)	10.1 (5.1, 14.6)	7.3 (4.1, 11.3)	0.05
Ventilator Duration (days)	4.1 (2.5, 5.8)	5.5 (2.8, 11.0)	4.5 (2.6, 8.1)	0.23

Figure 1: Stratification of Study Population



Conclusions

- We identified a higher rate of injury with manual CPR compared to mechanical CPR.
- We did not identify any association between CPR method and ICU LOS, ventilator time, and hospital outcomes overall.
- Further work is needed to assess impact of CPR method and injuries typically associated with resuscitation.

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