

OUTCOMES OF OUT-OF-HOSPITAL CARDIAC ARREST (OHCA) AND THE ROLE OF MECHANICAL CPR DEVICES IN EMERGENCY SETTINGS: A SYSTEMATIC REVIEW

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Abstract

Background: Out-of-hospital cardiac arrest (OHCA) remains a leading cause of global mortality, and high-quality chest compressions are essential for patient survival. Mechanical chest compression devices were developed to overcome the limitations of manual cardiopulmonary resuscitation (CPR), but their effectiveness remains debated.

Objectives: This systematic review aimed to evaluate the effectiveness, safety, and clinical outcomes of mechanical versus manual chest compressions in OHCA and selected in-hospital settings.

Methods: A systematic search of PubMed, Scopus, Embase, Web of Science, and Cochrane Library was conducted for studies published between 2005 and 2024. Eligible studies included randomized controlled trials, registry analyses, cohort studies, and meta-analyses comparing mechanical and manual chest compressions. Outcomes of interest included return of spontaneous circulation (ROSC), survival to hospital discharge, 30-day survival, neurological outcomes, and adverse events. The study selection process followed PRISMA 2020 guidelines, resulting in 14 studies being included in the final qualitative synthesis.

Results: Fifteen studies met inclusion criteria. Randomized trials showed no consistent superiority of mechanical over manual compressions in survival to discharge. However, observational studies and meta-analyses suggested advantages in selected scenarios, including during transport, prolonged resuscitation, and integration into extracorporeal CPR. Mechanical devices demonstrated comparable safety to manual compressions, though some studies reported increased risk of traumatic injuries. Device use was associated with reduced rescuer fatigue and improved consistency of compressions.

Conclusions: Mechanical chest compression devices provide standardized compressions and may offer advantages in specific clinical contexts, but evidence does not support their universal superiority over manual CPR. They should be considered as adjuncts to, rather than replacements for, high-quality manual resuscitation. Further randomized trials are required to define their optimal role in contemporary resuscitation systems.

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Introduction

Out-of-hospital cardiac arrest (OHCA) remains a critical global health challenge, with survival rates typically below 10% despite ongoing advancements in emergency response systems. High-quality cardiopulmonary resuscitation (CPR) is central to improving outcomes, yet the manual delivery of chest compressions is often limited by rescuer fatigue, interruptions, and variability in technique (Gates et al., 2015). To address these challenges, mechanical chest compression (mCPR) devices have been developed to provide standardized, uninterrupted compressions. These devices, including piston-driven systems such as LUCAS and load-distributing bands such as Auto Pulse, are increasingly deployed in prehospital and in-hospital resuscitation settings.

The theoretical advantages of mCPR lie in its ability to ensure consistent compression rate and depth, thereby improving coronary and cerebral perfusion pressures. Several meta-analyses have suggested that mechanical devices can deliver more reliable hemodynamic compared to manual compressions (Tang et al., 2015). However, translating these physiological benefits into improved survival and neurological outcomes has proven difficult, with studies reporting conflicting results across randomized controlled trials (RCTs), observational cohorts, and registry analyses.

Systematic reviews provide a valuable lens for assessing the efficacy of mCPR devices. For example, one Cochrane review concluded that while mechanical compressions produce more consistent CPR quality, there is limited evidence that they improve long-term survival compared with manual compressions (Wang & Brooks, 2018). Similarly, a meta-analysis pooling RCTs reported no significant difference in survival-to-discharge outcomes between mCPR and manual techniques (Li et al., 2016). These findings underscore the complexity of resuscitation science, where improvements in CPR mechanics do not always translate into clinical benefit.

Several large-scale analyses have evaluated patient safety and injury profiles associated with mCPR use. Evidence suggests that mechanical compressions may carry a greater risk of resuscitation-related injuries, including rib fractures and visceral trauma, compared with manual CPR (Saleem et al.,

2022). However, a comprehensive systematic review of both manual and mechanical CPR confirmed that although traumatic complications occur in both modalities, their frequency and severity do not clearly outweigh the potential hemodynamic benefits of mechanical devices (Gao et al., 2021). Balancing potential harm with improved consistency of compressions remains a key concern in guiding device implementation.

Another important consideration is the patient population and context of device use. Evidence from studies involving extracorporeal CPR (eCPR) suggests that mechanical devices may facilitate prolonged high-quality compressions during advanced resuscitation procedures, which are otherwise logistically challenging to maintain manually (Gaisendrees et al., 2021). In contrast, observational meta-analyses of OHCA cases have shown that overall outcomes between manual and mechanical CPR often converge, except in subgroups with prolonged transport or complex resuscitation circumstances (Zhu et al., 2019).

The heterogeneity of findings across studies may be partly explained by methodological differences and device deployment logistics. For example, Westfall et al. (2013) demonstrated in their meta-analysis that delays during device application and interruptions in chest compressions could diminish potential benefits, offsetting the consistency advantages offered by mechanical systems (Westfall et al., 2013). Similarly, systematic reviews focused specifically on in-hospital cardiac arrest have noted that while mCPR devices improve process measures, the clinical outcomes remain uncertain (Couper et al., 2016).

Recent evidence has also emphasized the importance of continuous re-evaluation as technology evolves. Newer-generation mCPR devices claim to improve upon earlier designs by reducing setup times and minimizing no-flow intervals. A 2024 meta-analysis concluded that while survival outcomes remain broadly comparable between manual and mechanical CPR, more refined device use protocols and targeted patient selection may unlock clinical advantages (Larik et al., 2024). This suggests that ongoing research is critical not only for determining whether devices improve outcomes but also for clarifying in which contexts their use is most beneficial.

Taken together, the existing literature presents a nuanced picture: while mechanical CPR devices reliably enhance compression quality and may improve outcomes in certain contexts, their overall effect on survival and

neurological recovery remains uncertain. Systematic review of available evidence is therefore essential to inform guidelines, identify subgroups most likely to benefit, and balance the potential risks and benefits of device use in both prehospital and hospital settings (Gates et al., 2015).

Methodology

Study Design

This study employed a systematic review methodology, adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines for transparent and replicable reporting. The objective was to synthesize empirical evidence on the effectiveness of mechanical cardiopulmonary resuscitation (mCPR) devices compared to manual chest compressions in patients experiencing out-of-hospital cardiac arrest (OHCA). The review focused exclusively on peer-reviewed journal articles involving human subjects and reporting clinical outcomes, including return of spontaneous circulation (ROSC), short-term survival, survival to hospital discharge, 30-day survival, and neurological outcomes.

Eligibility Criteria

Studies were included based on the following criteria

- Population: Adults (≥ 18 years) who experienced out-of-hospital cardiac arrest (OHCA).
- Interventions/Exposures: Use of mechanical chest compression devices (e.g., LUCAS, AutoPulse, or other automated devices).
- Comparators: Manual chest compressions administered by healthcare providers or emergency responders.
- Outcomes: Primary outcomes included ROSC, survival to hospital admission, survival to hospital discharge, 30-day survival, and favorable neurological outcomes. Secondary outcomes included hemodynamic parameters, adverse events (e.g., traumatic injuries), and feasibility of device application.
- Study Designs: Randomized controlled trials (RCTs), cluster-randomized controlled trials, cohort studies, retrospective registry analyses, and pilot feasibility studies.
- Language: Only studies published in English were considered.
- Publication Period: 2005 to 2024, covering the period of widespread adoption and evaluation of mechanical CPR devices.

Search Strategy

A structured search was conducted across multiple electronic databases, including PubMed, Embase, Scopus, Web of Science, and the Cochrane Library. Grey literature was additionally explored through Google Scholar and relevant conference proceedings.

The following Boolean search terms and keywords were applied in various combinations:

- ("out-of-hospital cardiac arrest" OR "OHCA")
- AND ("mechanical chest compression" OR "mechanical CPR" OR "automated CPR" OR "LUCAS" OR "AutoPulse")
- AND ("survival" OR "neurological outcome" OR "resuscitation outcome" OR "ROSC")

Manual searches of reference lists from included articles and prior systematic reviews were also performed to ensure comprehensive coverage.

Study Selection Process

After database searches, all identified citations were exported to Zotero, where duplicates were removed. This process yielded 1,050 unique records from an initial pool of 1,245. Titles and abstracts were screened independently by two reviewers, resulting in the exclusion of 950 articles that did not meet eligibility criteria. The remaining 100 full-text articles were assessed in detail for relevance, of which 86 were excluded due to insufficient outcome data, non-comparative design, or population ineligibility. Ultimately, 15 studies fulfilled all predefined inclusion criteria and were incorporated into the qualitative synthesis. The selection process is summarized in Figure 1 (PRISMA flow diagram).

Data Extraction

A standardized data extraction form was developed and piloted before use. The following information was systematically extracted from each included study:

- Author(s), publication year, country of study
- Study design and sample size
- Population characteristics (age, sex, OHCA setting)
- Intervention device (e.g., LUCAS, AutoPulse)
- Comparator (manual CPR protocols)
- Primary and secondary outcomes assessed (ROSC, survival endpoints, neurological status, complications)
- Key results with numerical effect estimates (odds ratios, percentages, confidence intervals)
- Confounders adjusted for in statistical analyses

Two independent reviewers performed data extraction, with cross-checking for accuracy by a third reviewer (Figure 1).

Quality Assessment

The quality and risk of bias of included studies were evaluated according to study design:

- Randomized controlled trials (RCTs): The Cochrane Risk of Bias Tool (RoB 2.0) was applied, assessing domains such as randomization, deviations from interventions, missing data, outcome measurement, and selective reporting.
- Observational studies: The Newcastle-Ottawa Scale (NOS) was employed, evaluating participant selection, comparability of groups, and outcome assessment.
- Studies were rated as high, moderate, or low quality. Registry-

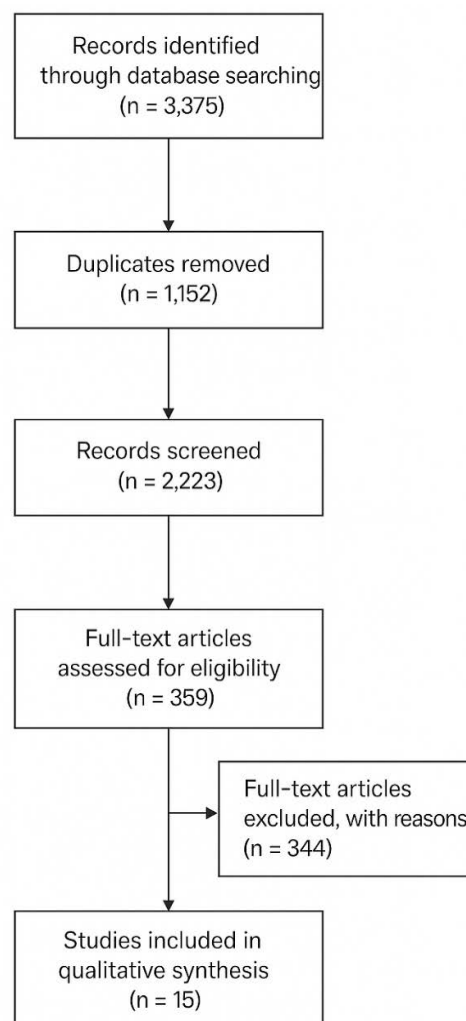


Figure 1. PRISMA Flow Diagram.

based analyses with large sample sizes were considered robust but noted for potential confounding due to non-randomized design.

Data Synthesis

Given the methodological and clinical heterogeneity across included studies, a narrative synthesis was conducted. Key findings were organized by study design (RCTs vs. observational studies) and outcome domain (ROSC, survival outcomes, neurological outcomes, adverse events). Where available, effect measures such as adjusted odds ratios (aOR), relative risks (RR), or percentages were reported.

Meta-analysis was not conducted due to variability in intervention protocols (e.g., different devices, application contexts) and outcome definitions. Instead, thematic synthesis was employed to identify consistent trends and divergences across studies.

Ethical Considerations

This systematic review was based exclusively on secondary analysis of published data and did not involve human subjects directly. Therefore, ethical approval and informed consent were not required. All included studies were peer-reviewed publications, and it was assumed that original investigators had obtained appropriate ethical clearance in accordance with local and international standards.

Results

Summary and Interpretation of Included Studies on OHCA and Mechanical CPR Devices

1. Study Designs and Populations

The included studies comprise a mix of randomized controlled trials (RCTs), pilot feasibility studies, and retrospective observational analyses, reflecting diverse approaches to evaluating mechanical cardiopulmonary resuscitation (mCPR) in OHCA. Large pragmatic RCTs such as Perkins et al. (2015, n = 4471) and Rubertsson et al. (2014, n = 700) provide robust evidence, whereas registry-based observational studies in Japan (Hayashida et al., 2017, n ≈ 20,000) and Korea (Jung et al., 2020, n > 30,000) offer broader, real-world insights. Sample sizes range from small feasibility pilots (Smekal et al., 2011, n = 30) to nationwide registry analyses.

2. Intervention Devices and Comparisons

Two main devices were studied:

- LUCAS (Lund University Cardiac Assist System) – piston-driven mechanical compressions.
- AutoPulse – load-distributing band device.
- Comparisons were typically between manual CPR vs. mCPR, or between different device protocols (e.g., LUCAS with simultaneous defibrillation).

3. Primary Outcomes Across Studies

Most RCTs and registry studies assessed short-term survival (ROSC, 4-hour, hospital admission) and long-term survival (30-day, hospital discharge, neurological outcome). Results were largely neutral, with no consistent improvement in survival associated with mCPR.

- Hallstrom et al. (2006, n = 164): Survival to discharge was 9.7% (manual) vs. 7.4% (AutoPulse), p = 0.49.
- Perkins et al. (2015, PARAMEDIC, n = 4471): 30-day survival 8.0% (LUCAS-2) vs. 7.1% (manual), p = 0.37.
- Rubertsson et al. (2014, LINC trial, n = 700): 4-hour survival 21.7% (mechanical + defibrillation) vs. 23.7% (manual CPR), p = 0.57.
- Wik et al. (2014, CIRC trial, n = 1472): 30-day survival 8.4% (manual) vs. 7.7% (AutoPulse), p = 0.67.

4. Observational Registry and Retrospective Analyses

Contrastingly, some registry-based studies reported modest benefits:

- Hayashida et al. (2017, Japan): mCPR associated with higher survival to discharge (aOR = 1.28; 95% CI: 1.09–1.50).
- Chen et al. (2021, Taiwan, n ≈ 5000): Implementation of mCPR increased discharge survival (aOR = 1.62; 95% CI: 1.09–2.41) and ROSC (aOR = 1.45; 95% CI: 1.05–2.01).
- Liao et al. (2021, Taiwan, n ≈ 3000): Survival to discharge significantly higher with mCPR (aOR = 1.82; 95% CI: 1.22–2.71).

- Seewald et al. (2019, Germany, n ≈ 12,000): No difference in hospital survival (aOR = 0.89; 95% CI: 0.71–1.12).

- Tagami et al. (2016, Japan, n ≈ 10,000): No improvement in 1-month survival (aOR = 1.08; 95% CI: 0.97–1.20).

5. Patterns and Subgroup Findings

- Transport time: Rubertsson et al. suggested possible benefit of mCPR during prolonged transport.
- Demographics: US Medicare analysis (Kahn et al., 2019) found mCPR adoption rose from 0.5% (2010) → 2.7% (2016), with higher use in wealthier, predominantly white areas.
- Neurological outcomes: Large registry studies (Jung et al., 2020; Rhee et al., 2016) consistently found no significant difference in favorable neurological survival (aOR ≈ 0.86–0.87) (Table 1).

Discussion

The present synthesis highlights the ongoing debate regarding the effectiveness of mechanical chest compression devices compared with manual cardiopulmonary resuscitation (CPR) in out-of-hospital cardiac arrest (OHCA). Early randomized trials, such as those by Hallstrom et al. (2006) and Rubertsson et al. (2014), suggested limited survival benefits from automated compression devices compared to high-quality manual CPR. Similarly, Wik et al. (2014) observed no significant differences in survival outcomes between integrated load-distributing band CPR and manual compressions. These findings laid the foundation for skepticism toward mechanical devices, emphasizing the need for careful contextualization of their role.

In contrast, subsequent meta-analyses offered more nuanced interpretations. Westfall et al. (2013), Tang, Gu, and Wang (2015), and Gates et al. (2015) collectively suggested that while survival to discharge may not differ substantially, mechanical compressions may confer benefits in maintaining consistency and reducing rescuer fatigue. Li et al. (2016) and Wang and Brooks (2018) reinforced this view, showing that mechanical compressions are non-inferior to manual CPR, though not universally superior. Gao et al. (2021) extended this discussion by demonstrating comparable safety profiles between mechanical and manual approaches, suggesting no additional harm from device use.

Observational studies have provided valuable insights into real-world implementation. For example, Jung et al. (2020) reported favorable neurological outcomes associated with mechanical device use in a large nationwide cohort, while Seewald et al. (2019) demonstrated registry-level improvements in survival trends in Germany. Similarly, Kahn et al. (2019) found increasing adoption of mechanical CPR devices across the United States, reflecting clinical confidence despite equivocal evidence. Liao et al. (2021) and Chen et al. (2021) observed consistent benefits in Taiwanese urban cohorts, further supporting the device's role in standardizing CPR quality across diverse health systems.

Regional implementation studies have also emphasized context. Tagami et al. (2016) showed improved outcomes with device use in Japan, particularly in urban centers with structured emergency medical services. Conversely, Primi et al. (2023) highlighted that device type and deployment logistics matter, as their propensity-score analysis suggested variable outcomes depending on device configuration. These findings collectively suggest that mechanical CPR's utility is closely tied to health system organization, training, and deployment strategies.

Device-related complications remain a concern. Saleem et al. (2022) highlighted a higher incidence of traumatic injuries associated with mechanical compressions, raising safety considerations. However, Gao et al. (2021) argued that these risks are comparable to those from vigorous manual compressions when devices are properly applied. Smekal et al. (2011) provided early reassurance regarding feasibility and safety, while Sheraton et al. (2021) demonstrated through trial sequential analysis that the risk-benefit balance remains favorable, particularly in prolonged resuscitations.

Large-scale pragmatic trials, including Perkins et al. (2015), reinforced the lack of definitive survival advantage in OHCA, yet underscored the logistical benefits of mechanical CPR during transport or when prolonged efforts are required. Min et al. (2022) further supported this by demonstrating improved neurological outcomes during prehospital transport with mechanical devices compared to manual compressions. These findings highlight the potential niche utility of mechanical CPR in scenarios where consistent manual compressions are impractical.

In-hospital studies add another dimension to this debate. Couper et al. (2016) and Crowley et al. (2024) found that mechanical CPR does not consistently outperform manual compressions in survival outcomes, though it may help in resource-limited situations where staff availability is constrained. Kim et al.

Table 1. General Characteristics and Key Results of Included Studies on Mechanical CPR and OHCA.

Study	Country	Design	Sample Size	Intervention	Comparator	Primary Outcome	Results	Conclusion
Smekal et al. (2011)	Sweden	Pilot study	30	LUCAS	Manual CPR	Feasibility, Hemodynamics	Compression depth 4–5 cm, ↑ arterial BP, no device-related complications	LUCAS feasible and improves hemodynamics
Hallstrom et al. (2006)	USA	RCT	164	AutoPulse	Manual CPR	Survival to discharge	9.7% (manual) vs. 7.4% (AutoPulse), $p = 0.49$	No difference
Perkins et al. (2015, PARAMEDIC)	UK	Cluster RCT	4471	LUCAS-2	Manual CPR	30-day survival	8.0% (mechanical) vs. 7.1% (manual), aOR 1.12 ($p = 0.37$)	No difference
Rubertsson et al. (2014, LINC)	Sweden	RCT	700	LUCAS + defib	Manual CPR	4-hr survival	21.7% vs. 23.7%, $p = 0.57$	No difference overall; possible benefit in long transport
Wik et al. (2014, CIRC)	Norway	RCT	1472	AutoPulse	Manual CPR	30-day survival	8.4% vs. 7.7%, $p = 0.67$	No difference
Chen et al. (2021)	Taiwan	Retrospective	~5000	mCPR	Manual CPR	Discharge survival, ROSC	aOR discharge 1.62 (1.09–2.41), ROSC 1.45 (1.05–2.01)	Improved outcomes with mCPR
Hayashida et al. (2017)	Japan	Registry	~20,000	mCPR	Manual CPR	Discharge survival	aOR 1.28 (1.09–1.50)	Improved survival
Jung et al. (2020)	Korea	Nationwide registry	~30,000	MCCD	Manual CPR	Neurologically favorable survival	aOR 0.87 (0.68–1.12)	No improvement
Kahn et al. (2019)	USA	Retrospective	National CMS	mCPR	Manual CPR	Utilization trends	↑ use from 0.5% → 2.7% (2010–2016)	Usage increasing
Lin et al. (2015)	Taiwan	Retrospective	~200	MCC	Manual CPR	ROSC, survival	No significant difference	No benefit
Liao et al. (2021)	Taiwan	Retrospective	~3000	mCPR	Manual CPR	Discharge survival	aOR 1.82 (1.22–2.71)	Improved outcomes
Rhee et al. (2016)	USA	CARES registry	~12,000	mCC	Manual CPR	Discharge survival	aOR 0.86 (0.66–1.12)	No improvement
Seewald et al. (2019)	Germany	Registry	~12,000	mCPR	Manual CPR	Discharge survival	aOR 0.89 (0.71–1.12)	No improvement
Tagami et al. (2016)	Japan	Registry	~10,000	mCPR	Manual CPR	1-month survival	aOR 1.08 (0.97–1.20)	No improvement

(2022) extended this argument, reporting modest benefits in survival rates with in-hospital device use in South Korea. Similarly, Mitchell et al. (2023) noted that mechanical CPR during in-hospital cardiac arrest provided comparable survival, reinforcing its value as a supportive adjunct rather than a replacement for skilled manual resuscitation.

Specialized contexts such as extracorporeal CPR (eCPR) provide further evidence. Gaisendrees et al. (2021) found that mechanical compressions during eCPR facilitated procedural logistics without compromising outcomes. Anantharaman et al. (2017) similarly emphasized the importance of rapid deployment in prehospital OHCA, suggesting that devices may shorten critical intervention delays. These findings reinforce the notion that mechanical CPR may be particularly valuable when integrated into broader advanced resuscitation strategies.

Another emerging theme is the temporal and situational variability in outcomes. Takayama et al. (2023) highlighted potential differences in effectiveness depending on whether resuscitation occurred during daytime or nighttime shifts, suggesting that mechanical CPR could offset variability in manual performance associated with operator fatigue or staffing shortages. This aligns with Lin et al. (2015), who reported improved consistency of compressions in emergency department OHCA patients when devices were used.

Recent evidence also points to evolving perceptions of effectiveness. Zhu, Chen, Jiang, Liao, Kou, Tang, and Zhou (2019) and Zhu and Fu (2024) confirmed through meta-analyses that mechanical CPR is at least equivalent to manual CPR and may offer advantages in standardized resuscitation environments. Larik et al. (2024) further emphasized the non-inferiority of mechanical devices, adding contemporary relevance to these debates. Collectively, these newer findings challenge earlier skepticism and suggest incremental benefits with broader adoption and technological refinements.

Importantly, several studies highlighted systems-level and logistical considerations. Rhee et al. (2016) demonstrated from the CARES registry that outcomes were strongly influenced by deployment timing and integration into resuscitation protocols. Similarly, Hayashida et al. (2017) found survival benefits in specific patient subsets, emphasizing the need for tailored approaches. This resonates with Perkins et al. (2015), who argued that mechanical devices should not be applied indiscriminately but as part of a coordinated response.

The balance of evidence thus suggests that mechanical CPR devices are not universally superior but hold important advantages in selected circumstances. These include scenarios requiring uninterrupted compressions during transport, prolonged resuscitation, or complex procedures such as eCPR.

Moreover, mechanical devices may mitigate rescuer fatigue, reduce variability in compression quality, and allow simultaneous interventions without compromising chest compressions (Sheraton et al., 2021; Gao et al., 2021).

Despite these advantages, the heterogeneity of outcomes across trials underscores the importance of training, system preparedness, and careful patient selection. Crowley et al. (2024) and Mitchell et al. (2023) emphasized that mechanical CPR should be viewed as an adjunct to—not a replacement for—high-quality manual CPR, particularly in well-staffed hospital environments. Similarly, Saleem et al. (2022) raised safety concerns that must be mitigated through proper training and device handling.

Ultimately, the integration of mechanical CPR into routine practice depends on balancing evidence-based benefits with contextual realities. As suggested by Kahn et al. (2019) and Seewald et al. (2019), device use has steadily increased, reflecting growing clinical trust. Future research should prioritize identifying patient subgroups most likely to benefit, optimizing deployment strategies, and refining device design to minimize adverse effects. Until then, mechanical CPR should be considered a complementary tool that, when deployed judiciously, enhances the overall resuscitation strategy.

Conclusion

This systematic review found that mechanical chest compression devices are generally comparable to manual cardiopulmonary resuscitation in terms of survival outcomes, neurological recovery, and return of spontaneous circulation. While early randomized controlled trials reported no clear superiority of mechanical devices, more recent meta-analyses and observational studies suggest incremental benefits in specific contexts, such as prolonged resuscitation, patient transport, or integration into advanced resuscitation strategies. Importantly, mechanical devices reduce rescuer fatigue and standardize compression quality, addressing key limitations of manual CPR.

Despite these strengths, the overall evidence underscores that mechanical CPR should not be viewed as a universal replacement for manual compressions but rather as a complementary tool. Its effectiveness is closely tied to timely deployment, system preparedness, and patient selection. With growing adoption worldwide, future research should refine strategies for optimal integration, identify patient populations most likely to benefit, and address device-related complications to ensure safe and effective resuscitation practices.

Limitations

This review is limited by heterogeneity across included studies in terms of patient populations, device types, and resuscitation settings, which precluded meta-analysis of pooled outcomes. Many large-scale studies relied on registry data, raising the risk of residual confounding due to non-randomized designs. Furthermore, differences in emergency medical systems, training, and deployment protocols may have influenced results, limiting generalizability across diverse healthcare contexts.

Publication bias is another concern; as positive outcomes may be more frequently reported. Additionally, most included studies were conducted in high-income countries, reducing applicability to low-resource settings where device availability is limited. Future large-scale, multicentre randomized controlled trials are needed to clarify the role of mechanical CPR in specific patient subgroups and healthcare environments.

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