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Review

Use of CPR feedback devices in resuscitation training: A systematic review and meta-analysis of randomized controlled trials

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on behalf of the Education Implementation Team Task Force of the International Liaison Committee on Resuscitation ILCOR[1]

Abstract

Objectives: The use of cardiopulmonary resuscitation (CPR) feedback devices during training is increasing. This review evaluates whether incorporating CPR feedback devices in training improves patient survival, CPR quality in actual resuscitation, skill acquisition and retention after training.

Methods: This systematic review was part of the continuous evidence evaluation process of the International Liaison Committee on Resuscitation (ILCOR). We searched MEDLINE, EMBASE, and SCOPUS databases from inception to September 30, 2024, including randomized controlled trials (RCTs) in all languages (with an English abstract) comparing CPR training with and without feedback devices. Outcome included patient survival, quality of clinical performance in resuscitation, and CPR skill acquisition and retention. Non-RCT studies, unpublished work without peer review or animal studies were excluded. Risk of bias was assessed using Cochrane tools, and certainty of evidence was graded using the Grading of Recommendations Assessment, development and Evaluation (GRADE) approach. Standardized mean difference (SMD) were calculated and pooled effects were analyzed using random-effects models. PROSPERO CRD42023488130.

Results: We identified 20 RCTs with 4579 participants. Risks of bias ranged from low to critical (low: 8, moderate: 9, and critical: 3). No studies evaluated the patient survival, clinical performance in resuscitation or cost-effectiveness. Compared to no feedback, using CPR feedback devices during training significantly improved key quality metrics. Pooled effect sizes were 0.76 (95%CI 0.02 – 1.50) for mean compression depth (15 studies), 0.98 (95%CI: 0.10 – 1.87) for depth compliance (16 studies), 0.29 (95%CI: 0.10 – 0.48) for mean rate (17 studies), 0.44 (95%CI: 0.23 – 0.66) for rate compliance (9 studies), and 0.53 (95%CI: 0.31 – 0.75) for recoil compliance (10 studies) in favour of using feedback devices during training. Heterogeneity was large ($I^2 > 50\%$) in all analyses. Planned subgroup analyses revealed no statistically significant interaction between healthcare professionals and laypersons. Using the GRADE approach, the certainty of evidence was downgraded for certain outcomes due to critical risk of bias for 3 studies and inconsistency but upgraded for strong association.

Abbreviations: BLS, basic life support, CPR, cardiopulmonary resuscitation, EIT, Education, Implementation and Teams, GRADE, Grading of Recommendations Assessment, Development and Evaluation, HCP, healthcare professional, ILCOR, International Liaison Committee on Resuscitation, PRISMA, Preferred Reporting Items for Systematic Review and Meta-Analysis, RCT, randomized controlled trial, ROB 2, Risk of Bias 2

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Conclusion: The use of CPR feedback devices during resuscitation training improves key quality metrics of CPR performance, with moderate to high certainty of evidence. However, further studies are needed to evaluate the impact on cost-effectiveness, clinical performance and patient outcomes.
Keywords: Resuscitation, CPR Feedback, Training, Basic Life Support, Medical Education

Introduction

Cardiac arrest remains a major public health problem; with the incidence of out-of-hospital cardiac arrest varying from 30.0 to 97.1 cases per 100,000 population across the world.[1–4] The Utstein Formula for Survival emphasizes the critical role of effective resuscitation education in improving survival rates for cardiac arrest victims.[5] However, the deterioration of CPR skills following resuscitation training remains a persistent issue.[6] Developing strategies to enhance the acquisition and retention of CPR skills could significantly improve the quality of resuscitation efforts during cardiac arrest, ultimately leading to better patient outcomes.

Recent scientific statements highlight a growing trend in the use of CPR feedback devices during resuscitation training courses.[7] The use of CPR feedback devices addresses the issue of poor visual assessment skills amongst healthcare providers and CPR instructors. Earlier reviews suggested that CPR feedback devices may improve short-term educational outcomes.[8] Since then, new international resuscitation guidelines have been published, introducing optimal targets for compression depth and rate to enhance resuscitation outcomes.[9,10] Technological advancements now enable the objective measurement of CPR quality, providing precise, quantifiable data that can be synthesized to draw stronger, evidence-based conclusions.

Furthermore, a substantial number of new studies, including randomized controlled trials, have been published on this topic in recent years. These studies offer high-quality evidence, highlighting the need for an updated and comprehensive analysis to inform current practice and training standards. In this systematic review, we aim to determine whether the use of CPR feedback devices during resuscitation training, compared to training without such devices, improves CPR skill acquisition, skill retention, clinical performance quality during actual resuscitations, and patient survival.

Methods

Eligibility criteria

Members of the Education, Implementation and Teams (EIT) Task Force of the International Liaison Committee on Resuscitation (ILCOR) conducted this systematic review as part of the continuous evidence evaluation process of resuscitation literature informing international consensus treatment recommendations.[11,12] The review is reported in compliance with the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines (Supplementary I),[13] and was registered with the Prospective Registry for Systematic Reviews (PROSPERO CRD42023488130). The research question was structured using the ‘PICOST’ (Population, Intervention, Comparison, Outcome, Study Design, Timeframe) format as per ILCOR evidence reviews:

Population: All laypersons and healthcare professionals receiving resuscitation training.
Intervention: Use of CPR feedback/guidance device during resuscitation training.
Comparison: No use of CPR feedback / guidance device during resuscitation training.
Outcomes: Patient Survival [Critical], skill performance in real resuscitation [Critical], cost-effectiveness [Important], skills acquisition [Important] and retention [Important] (i.e. CPR quality, chest compression depth, rate and recoil).
Study Design: Randomized controlled trials (RCTs) were eligible for inclusion. All relevant publications in any language were included as long as an English abstract was available.
Timeframe: Inception to September 30, 2024.

All included studies should use feedback devices in a resuscitation training course or simulated resuscitation event for the purpose of training and education only. Non-randomized studies, unpublished studies (without peer review) and animal studies were excluded in this review.

Definitions

For this systematic review, we defined CPR feedback devices as any tool that evaluates performance and provides information (audio, visual or both) about the quality of chest compressions, or offer guidance (i.e. such as a metronome) to improve performance metrics such as compression depth, rate, and chest recoil.

Information sources and search strategy

We utilized a search strategy developed in conjunction with an information specialist (CM) using (but not limited to) the following key terms: “cardiopulmonary resuscitation”, “CPR”, “basic life support”, “advanced life support”, “cardiac arrest”, “chest compressions”, “feedback device”, “training” and searched Medline, Embase, and Scopus databases from inception until September 30, 2024. The detailed search strategy is shown in Supplementary II. Grey literature was not searched. Reference lists of identified studies and review articles were scanned to identify additional relevant publications.

Study selection

Rayyan software (a web-based software for systematic reviews) was used to detect duplicates, with one reviewer (YL) screening and removing all relevant duplicates. Five pairs of reviewers independently (AC, YL; RG, TM; AD, AB; AL, FS; AC, BF) screened titles and abstracts and excluded all papers not meeting eligibility criteria. Disagreements amongst reviewer pairs were resolved via discussion to reach a consensus. In the rare instance when a consensus was not reached, full text of the paper was obtained for review. The full texts of remaining papers were independently reviewed for eligibility by four pairs of reviewers (AC, AB; TM, AL; YL, FS; AD, AB). The remaining disagreements were discussed amongst reviewer pairs to reach consensus on the final group of articles.

Data extraction

After identification of the final group of articles, four pairs of reviews (AC, AB; TM, AL; YL, FJS; AD, AB) independently extracted relevant data from all the relevant articles into an Excel spreadsheet. Extracted data was double checked, with discrepancies resolved through review and discussion. Data extracted included author, publication year, country, study design, population, sample size, intervention and comparison, outcome measures, and results.

Risk of bias assessment

Four pairs of reviewers (AC, AB; TM, AL; YL, FS; AD, AB) independently assessed the included papers for risk of bias using the Risk of Bias 2 (RoB 2) tool for RCTs.[14] Disagreements between reviewers was resolved by discussion to reach consensus.

Synthesis of results

The overall certainty of evidence was assessed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology. EIT task force members discussed the extracted data and results tables on several virtual conference calls to craft treatment recommendations and identify key insights and future opportunities for research.[15,16]

Means and standard deviations or odds ratios/risk differences reported by the included studies were converted to standardized mean differences (SMD, Hedges' *g* effect size). For studies that reported medians and interquartile ranges, the effect size was estimated under the assumption of a normal data distribution. If insufficient information was available to calculate an effect size, the authors were contacted via email to request the missing data. The Chi^2 test and I^2 statistic were used to assess inconsistency (heterogeneity) across studies. Due to the high heterogeneity observed in most analyses, random-effects models were employed to pool the effect sizes. Planned subgroup analyses were performed based on the type of trainees (healthcare professionals vs. lay persons), with statistical significance of interactions evaluated using the *z* test. Some planned subgroup analyses were not conducted due to insufficient data (e.g. corrective feedback vs guidance feedback, incorporating feedback with other instructional design, gender, age and race). Forest plots were used to visually display the results of individual studies and synthesis. All analyses were conducted using R software (version 4.3.0) and the "meta" package.[17] A two-sided alpha level of 0.05 was used to define statistical significance. Certainty of evidence was assessed using the Grading of Recommendations Assessment, development and Evaluation (GRADE) approach.

Results

Study characteristics

Our initial literature search yielded 9756 citations. After removing 3440 duplicates, 6316 articles underwent title and abstract screening. From these, 115 articles were identified for full-text review, resulting in the inclusion of 18 studies. An additional 2 studies were identified via search of references lists of relevant articles, bringing the total to 20 studies (4579 participants) included in the final analysis, with publication years ranging from 2007 to 2023. (Fig. 1).

None of the included studies evaluated the impact of CPR feedback devices during resuscitation training on patient survival outcomes, quality of performance in actual resuscitation or cost-effectiveness of training. All 20 studies examined the CPR skills at the conclusion of the courses[18–37], and 8 of them also examined the CPR skill retention 3 months post-training[18,22,25,28,29,33,34,37]. Among the 20 studies, 17 were conducted in healthcare professionals[18,20–25,27–29,31–37], while 3 focused on lay persons.[19,26,30] (Table 1). Regarding the risk of bias, 8 studies rated as having minor concerns[19,22,23,26,27,29,30,36], 9 studies having some concerns[18,21,24,25,28,32,34,35,37], and 3 studies as having serious

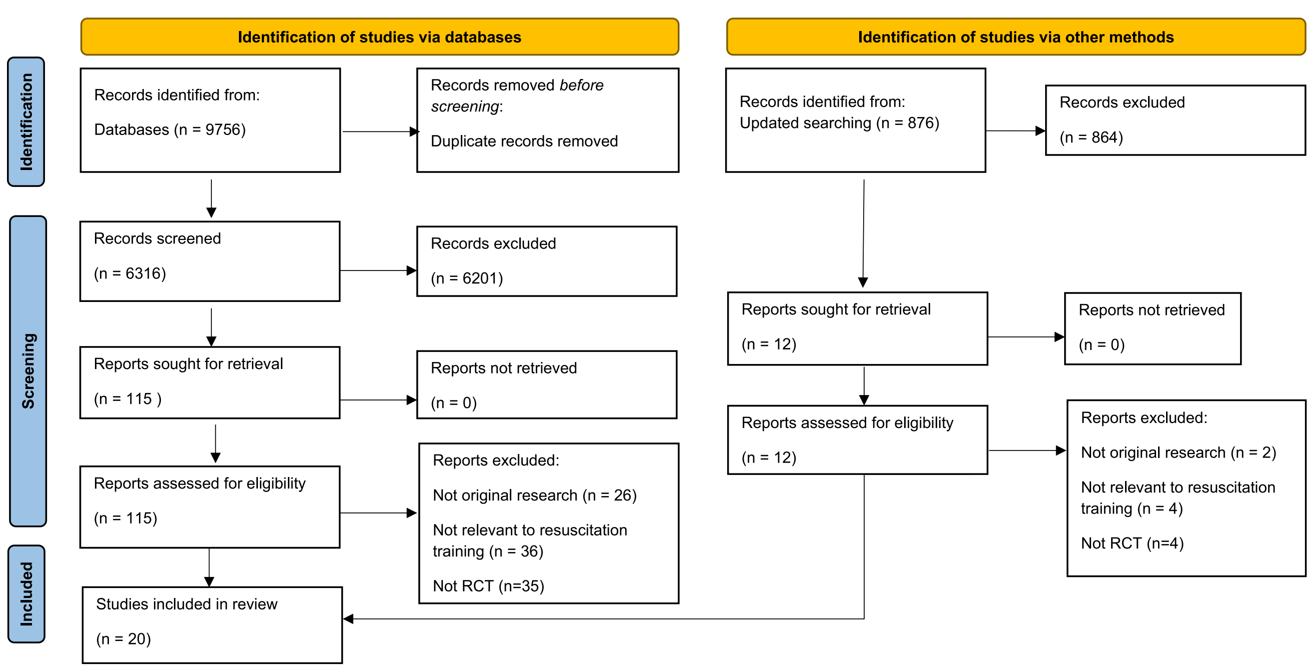

Fig. 1 – PRISMA flow diagram.

Table 1 – Summary of included studies.

Study	Country	Mean depth	Mean rate	Depth compliance	Rate compliance	Recoil compliance	Overall score *	Overall quality **	Provider	Skill Acquisition	Skill Retention
Allan 2013	Canada	+	+	–	–	–	–	–	HCP	+	+
Cortegiani 2017	Italy	+	+	+	+	+	+	–	LP	+	–
Ghaderi 2023	Iran	–	–	+	+	+	–	–	HCP	+	–
Gonzalez-Santano 2020	Spain	+	+	+	–	+	+	–	HCP	+	–
Jang 2020	Korea	+	+	+	–	–	–	–	HCP	+	+
Jiang 2024	China	+	+	+	+	–	–	–	HCP	+	–
Kardong-Edgren 2010	US	+	+	+	–	–	–	–	HCP	+	–
Katipoglu 2021	Poland	+	+	+	+	+	+	–	HCP	+	+
Kong 2020	Korea	+	+	+	–	+	+	–	LP	+	–
Labuschagne 2022	South Africa	–	+	+	+	–	+	–	HCP	+	–
Lee 2023	Taiwan	–	–	+	+	+	+	–	HCP	+	+
Lin 2018	Canada	–	–	+	+	+	–	+	HCP	+	+
Meng 2021	China	–	+	+	–	–	–	–	LP	+	–
Min 2016	Korea	+	+	+	–	–	–	–	HCP	+	–
Pavo 2016	Switzerland	+	+	+	–	–	+	–	HCP	+	–
Spooner 2007	UK	+	+	–	–	–	–	–	HCP	+	+
Suet 2020	France	+	+	–	–	+	+	–	HCP	+	+
Sutton 2011	US	+	+	–	–	–	–	+	HCP	+	–
Wagner 2019	Canada	+	+	+	+	+	–	–	HCP	+	–
Zhou 2020	China	+	+	+	+	+	–	–	HCP	+	+

* Overall chest compression quality measured by software with limited validity evidence.
** Overall chest compression quality measured dichotomously (Overall quality considered good if depth, rate and recoil all meeting guidelines)HCP: healthcare professionals; LP: Lay persons.

Study	Randomization	Deviations from intended intervention	Outcome data missing	Measurement of outcome	Selection of reported results	Overall
Allan 2013	Unclear	Low	Low	Low	Low	Some
Cortegiani 2017	Low	Low	Low	Low	Low	Minor
Ghaderi 2023	High	Low	Low	Low	Low	Serious
Gonzalez-Santano 2020	Unclear	Low	Low	Low	Low	Some
Jang 2020	Low	Low	Low	Low	Low	Minor
Jiang 2024	Low	Low	Low	Low	Low	Minor
Kardong-Edgren 2010	Unclear	Low	Low	Low	Low	Some
Katipoglu 2021	Unclear	Unclear	Low	Low	Low	Some
Kong 2020	Low	Low	Low	Low	Low	Minor
Labuschagne 2022	Low	Low	Low	Low	Low	Minor
Lee 2023	Low	Low	Unclear	Low	Low	Some
Lin 2018	Low	Low	Low	Low	Low	Minor
Meng 2021	Low	Low	Low	Low	Low	Minor
Min 2016	High	Low	Low	Low	Low	Serious
Pavo 2016	Low	Low	Low	Low	Unclear	Some
Spooner 2007	Unclear	Low	Unclear	Low	Unclear	Serious
Suet 2020	Unclear	Low	Low	Low	Low	Some
Sutton 2011	Unclear	Low	Low	Low	Low	Some
Wagner 2019	Low	Low	Low	Low	Low	Minor
Zhou 2020	Unclear	Low	Low	Low	Low	Some

Fig. 2 – Risk of bias assessment.

concerns.[20,31,33] (Fig. 2). Using the GRADE approach, the certainty of evidence was downgraded for certain outcomes due to critical risk of bias for 3 studies and inconsistency but upgraded for strong association. The overall certainty of evidence was moderate to high. A detailed description of certainty of evidence is presented in Supplementary III.

Chest compression depth

Fifteen RCTs involving 4185 participants evaluated the effect of CPR feedback devices on objectively measured mean compression depth.[18–19,21–26,31–37] The results indicated that participants trained with feedback devices achieved significantly greater mean compression depth compared to those trained without them (SMD = 0.76, 95% CI: 0.02–1.50, p = 0.04, I^2 = 94%) immediately after training. The difference in effect size between the healthcare professionals and lay persons were not statistically significant (p = 0.10). (Fig. 3, Supplementary IV-Fig. 1). Five studies comprising 431 participants showed the effect of feedback devices on mean compression depth skill retention. The results indicated no significant difference in mean compression depth at 3 months post training. (SMD = 1.56, 95%CI; −0.32 – 3.43, p = 0.10, I^2 = 97). (Fig. 4, Supplementary IV-Fig. 2).

Sixteen RCTs involving 4304 participants examined the effect of CPR feedback devices during resuscitation training on compression depth compliance.[36,37,19–32] Compression depth compliance was quantitatively measured as the percentage of compressions meeting the resuscitation guidelines during assessment. The use of CPR feedback devices during training had a large impact on depth compliance (SMD = 0.98, 95% CI: 0.10–1.87, p = 0.03, I^2 = 94%). The difference in effect size between the healthcare professionals (SMD 1.14, 95%CI: 0.04–2.24) and the lay persons (SMD 0.17, 95%CI: 0.01 – 0.32) was not statistically significant (p = 0.09). (Fig. 3, Supplementary IV-Fig. 3) Furthermore, five RCTs with 478 participants reported a large effect size of feedback devices on depth compliance three months after the training (SMD = 1.77, 95%CI: 0.25 – 3.30, p = 0.02, I^2 = 97%). (Fig. 4, Supplementary IV-Fig. 4).

Chest compression rate

Seventeen RCTs involving 4,327 participants assessed the effect of CPR feedback devices on objectively measured mean compression rate.[18,19,21–27,30–37] Participants trained with feedback devices had a significantly lower mean compression rate compared to those trained

Outcome	Study	Participant	Effect Size [95%CI]	P value for Interaction
Mean Depth (mm)				
Healthcare Professionals	13	1496	0.86 [0.01, 1.72]	
Lay Persons	2	2738	0.15 [0.07, 0.22]	
Combined	15	4234	0.76 [0.02, 1.50]	0.10
Mean Rate (bpm)				
Healthcare Professionals	14	1549	0.27 [0.04, 0.50]	
Lay Persons	3	2778	0.36 [0.03, 0.69]	
Combined	17	4327	0.29 [0.10, 0.48]	0.67
Depth Compliance (%)				
Healthcare Professionals	13	1526	1.14 [0.04, 2.24]	
Lay Persons	3	2778	0.17 [0.01, 0.32]	
Combined	16	4304	0.98 [0.10, 1.87]	0.09
Rate Compliance (%)				
Healthcare Professionals	8	780	0.44 [0.19, 0.68]	
Lay Persons	1	125	0.49 [0.14, 0.85]	
Combined	9	905	0.44 [0.23, 0.66]	0.80
Recoil Compliance (%)				
Healthcare Professionals	8	723	0.67 [0.52, 0.82]	
Lay Persons	2	2738	0.20 [−0.24, 0.64]	
Combined	10	3461	0.53 [0.31, 0.75]	0.05
Overall Performance (software)				
Healthcare Professionals	6	523	0.87 [0.53, 1.21]	
Lay Persons	2	2738	0.33 [0.03, 0.63]	
Combined	8	3261	0.71 [0.40, 1.03]	0.02
Overall Performance				
Healthcare Professionals	3	349	0.39 [0.02, 0.77]	

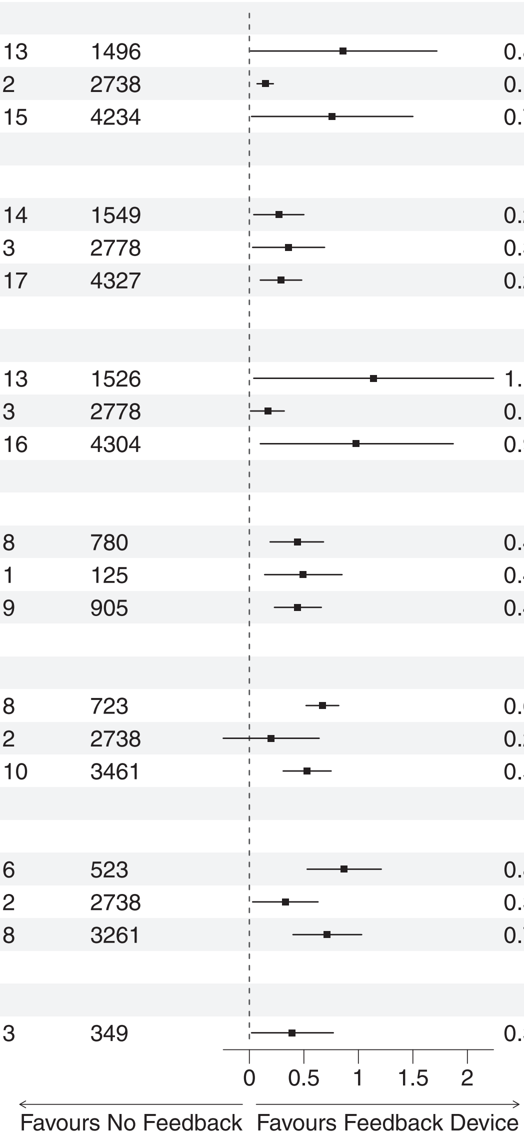

Fig. 3 – Effect of feedback device use during training on CPR quality immediately post-training.

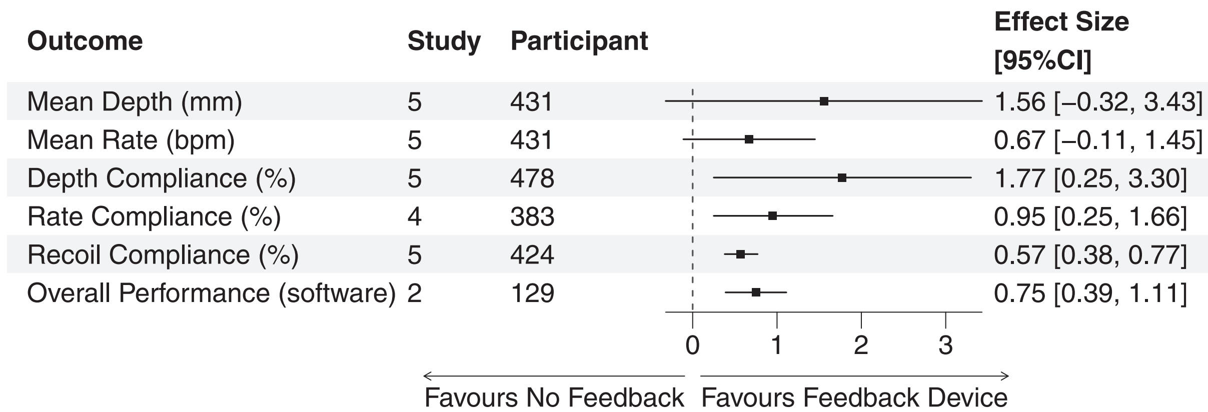

Fig. 4 – Effect of feedback device use during training on CPR quality 3 months post-training.

without them, as participants in the non-feedback group tended to compress too quickly (>120 bpm) (SMD = −0.29, 95% CI: −0.49 to −0.10, $p < 0.01$, $I^2 = 73\%$). Subgroup analysis showed the effect of the feedback device on mean compression rate was not statistically significant between healthcare professionals and lay persons ($p = 0.67$). (Fig. 3, Supplementary IV–Fig. 5). Five RCTs involving 431 participants reported a non-significant difference on mean compression rate at 3 months post-training (SMD = −0.67, 95%CI: −1.45 – 0.11, $p = 0.09$, $I^2 = 93\%$). (Fig. 4, Supplementary IV–Fig. 6).

Additionally, nine RCTs involving 905 participants examined the effect of CPR feedback devices during resuscitation training on compression rate compliance.[19,20,23,25,36,37,27–29] Compression rate compliance was quantitatively measured as the percentage of compressions within the guideline-recommended rate of 100–120 bpm. CPR feedback devices had a substantial impact on rate compliance (SMD = 0.45, 95% CI: 0.23–0.66, $p < 0.01$, $I^2 = 61\%$) immediately after the training. Subgroup analysis showed the effect of the feedback device on rate compliance was not statistically significant between healthcare professionals and lay persons ($p = 0.80$) (Fig. 3, Supplementary IV-Fig. 7). Four RCTs with 383 participants indicated a large effect on rate compliance at 3 months post-training (SMD 0.95, 95%CI: 0.25 – 1.66, $p < 0.01$, $I^2 = 90\%$) (Fig. 4, Supplementary IV-Fig. 8).

Chest recoil

Ten RCTs with 3,496 participants assessed the effect of CPR feedback devices during training on chest recoil.[25–26,28–29,34,36–37,19–21] Chest recoil was quantitatively measured as the percentage of compressions with complete chest recoil. CPR feedback had a significant effect on recoil compliance (SMD = 0.53, 95% CI: 0.31–0.75, $p < 0.01$, $I^2 = 87\%$) immediately after the training. Subgroup analysis showed that the effect of the feedback device on recoil compliance was significantly higher in healthcare professionals than in the lay persons. ($p = 0.05$). (Fig. 3, Supplementary IV-Fig. 9). Five RCTs involving 424 participants showed the effect of feedback device on recoil compliance remained significant 3 months post-training (SMD 0.57, 95%CI: 0.38 – 0.77, $p < 0.01$, $I^2 = 0\%$). (Fig. 4, Supplementary IV-Fig. 10).

Overall quality of CPR

Eight RCTs involving 3261 participants evaluated the effect of CPR feedback devices on overall CPR quality during resuscitation training.[19,21,34,36,25–28] Overall quality of CPR was assessed by computer software integrating all three metrics of chest compression (depth, rate and recoil) with limited validity evidence. The results showed that the use of feedback devices significantly improved the overall quality of CPR, with a pooled effect size of 0.71 (95% CI: 0.40–1.05, $p < 0.01$, $I^2 = 86\%$). Subgroup analysis showed that the effect of the feedback device on the overall CPR score was significantly higher in the healthcare professionals than in the lay persons ($p = 0.02$). (Fig. 3, Supplementary IV-Fig. 11) In the 2 RCTs with 129 participants examining overall CPR skill retention, the effect of feedback device remained significant (SMD 0.75, 95%CI: 0.39 – 1.11, $p < 0.01$, $I^2 = 0\%$). (Fig. 4, Supplementary IV-Fig. 12).

Three randomized controlled trials (RCTs) with 349 participants evaluated the effect of CPR feedback devices on overall CPR quality during resuscitation training.[29,32,35] CPR quality was assessed dichotomously, based on whether compression depth, rate, and recoil all met guideline standards. The use of feedback devices significantly improved the overall quality of CPR, with a pooled risk difference of 0.19 (95% CI: 0.01–0.38, $p = 0.04$, $I^2 = 78\%$), which is equivalent to an effect size of 0.39 (95%CI: 0.02 – 0.77). (Supplementary IV-Fig. 13).

Discussion

This systematic review on randomized controlled trials highlights the impact of using CPR feedback devices during resuscitation training on learning outcomes. By synthesizing the results of 20 randomized controlled trials, we demonstrated that incorporating feedback devices during resuscitation training significantly improves CPR skill acquisition and retention across all metrics of CPR quality for both healthcare professionals and lay persons.

Traditional Basic Life Support training that lacks CPR feedback devices fails in delivering objective feedback and in the accurate measurement of CPR quality. In these courses, CPR quality is typically assessed visually by an instructor, which has been proven inaccurate, even among experienced providers in acute care units.[38] This often leads to an overestimation of CPR quality, giving false reassurance to learners that are performing poorly.[39] In all forms of psychomotor skill learning, accurate feedback from an external source is crucial for correct skill development, as it provides learners with information beyond their inherent awareness.[40] A previous systematic review of 8 manikin studies investigating the impact of real-time feedback during resuscitation training reported mixed results.[8]

Despite the heterogeneity in outcome measures, most evidence supported use the feedback during CPR training to improve skill acquisition. However, few studies in that review have objectively measured CPR performance. Our review, in contrast addresses this gap by conducting *meta*-analyses on the CPR metrics objectively assessed at the conclusion of the course.

CPR feedback devices are both feasible and practical for use in training programs. While the mandatory use of feedback devices may potentially pose a financial barrier in some lower resource settings, the availability of low-cost options helps to mitigate this concern.[41] Feedback devices have been used in resuscitation training programs for years, and the growing body of literature across the world underscores their acceptability and practicality among key stakeholders[42,43]. Moreover, numerous studies and reviews demonstrate their effectiveness during real resuscitation events,[43,44] further validating their role in training. If feedback devices are valuable in improving outcomes during real resuscitation, integrating them into simulation training programs is both logical and essential.

We observed that the effect of CPR feedback during training appeared larger in healthcare professionals than on laypersons, though this difference was not statistically significant. This trend could partially be explained by adult learning theory and cognitive load theory[45,46]. Healthcare professionals, driven by intrinsic motivation and prior knowledge, engage deeply with feedback to refine their skills, as they see its relevance to their professional roles. Lay persons, often starting without prior CPR knowledge, focus on acquiring basic skills.[45] Based upon cognitive load theory,[46] interpreting CPR feedback on performance can increase extraneous load during training, which refers to cognitive effort unrelated to the primary learning task. For lay persons, processing real-time feedback from CPR devices requires mental resources to understand and act on the information, often competing with their focus on mastering basic skills like chest compressions. This additional demand can overwhelm their cognitive capacity, making it harder to concentrate on the essential aspects of CPR performance. These findings suggest the need to tailor training resources: feedback devices can help healthcare professionals maintain precision, while simpler tools and instructional design may better suit lay persons.

Our systematic review demonstrated that the use of CPR feedback devices during resuscitation training significantly improved CPR skill retention, which is a key determinant of real-world performance. Feedback devices provide immediately, objective guidance, reinforcing correct techniques and helping learners develop habits that persist beyond the training environment. While no direct evidence was identified linking the use of feedback devices during training to improved patient outcomes, there is a clear "chain of evidence"[47] logically connecting these elements. Feedback devices enhance CPR training by helping participants achieve guideline-compliant chest compressions, including proper depth, rate, and recoil. High-quality CPR, in turn, has been shown to significantly improve survival rates and neurological outcomes in cardiac arrest victims.[48–50] Therefore, improvements in training quality facilitated by feedback devices are likely to lead to better real-world CPR performance and, ultimately, better survival outcomes for cardiac arrest patients.

Limitations, knowledge gaps, and future research

Our review has several limitations. First, we failed to identify any studies examining CPR quality in real clinical care or patient outcomes. Second, despite of inclusion of randomized trials only, the heterogeneity among the studies remains high in this review. Third, we did not find evidence to address the cost-effectiveness of the feedback device used during resuscitation. Future research should also consider examining the relative and synergistic effect of CPR feedback device use when combined with other instructional design and educational strategies (e.g. spaced learning or deliberate practice). The return on investment associated with implementing CPR feedback device during resuscitation training needs further exploring. Further studies should explore transfer of CPR skills to the real clinical environment (e.g. CPR quality during real cardiac arrest event), which would further clarify the true effectiveness of the CPR feedback device use during resuscitation training.

Conclusion

CPR feedback device used during resuscitation training significantly improve the CPR quality of the learners for both skill acquisition and retention. CPR feedback devices should be used during resuscitation training for both healthcare professionals and lay persons.

Other disclosures

None.

Ethical approval

Not applicable.

Disclaimers

None.

CRediT authorship contribution statement

Yiqun Lin: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation. **Andrew Lockey:** Writing – review & editing, Methodology, Investigation, Data curation, Conceptualization. **Aaron Donoghue:** Writing – review & editing, Methodology, Data curation, Conceptualization. **Robert Greif:** Writing – review & editing, Supervision, Methodology, Investigation, Data curation, Conceptualization. **Andrea Cortegiani:** Writing – review & editing, Methodology, Data curation, Conceptualization. **Barbara Farquharson:** Writing – review & editing, Methodology, Data curation, Conceptualization. **Fahad Javaid Siddiqui:** Writing – review & editing, Methodology, Data curation, Conceptualization. **Arna Banerjee:** Writing – review & editing, Methodology, Data curation, Conceptualization. **Tasuku Matsuyama:** Writing – review & editing, Methodology, Data curation, Conceptualization. **Adam Cheng:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Data curation, Conceptualization.

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: YL, AL, AD, RG, AC (Andrea Cortegiani), BF, TM and AC (Adam Cheng) are members of the ILCOR EIT Task Force (RG is chair, AC is vice-chair). RG is the European Resuscitation Council Director of Guidelines and ILCOR, AL is Vice President of Resuscitation Council UK. AC, AL, and RG are Editorial Board members of Resuscitation Plus.

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Data availability statement

The data collection forms, extracted data, and analytic codes are available from the corresponding author upon reasonable request.

Appendix 1

*Collaborators form the ILCOR Task Force the Education Implementation Team for this study are: Cristian Abelairas-Gomez, Katherine Allan, Jan Breckwoldt, Kathryn Eastwood, Ming-Ju Hsieh, Tracy Kidd, Ying-Chih Ko, Kasper G Lauridsen, Sabine Nabecker, Kevin Nation, Alexander Olaussen, Sebastian Schnaubelt, Taylor Sawyer, Chih-Wei Yang, and Joyce Yeung.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.resplu.2025.100939.

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