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The Effectiveness of Feedback-Integrated and Traditional Adult Basic Life Support Training Methods on Knowledge and Skills Retention Among Healthcare Providers in Clinical Settings: *A Systematic Review*

Ayman Ghatasheh[1], Mohammed NY Saleh[1,2], Raid Abu Jebbeh[3,*], Seirsa AL-Quraan[1,4], Ammin Abu Elshaer[5] & Mohammad Almzayen[6]

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Abstract: Background: Cardiovascular diseases are the leading global cause of death, with sudden cardiac arrest as a significant contributor. Although Basic Life Support training might increase survival rates, healthcare personnel's skills and knowledge often deteriorate three to six months after training. Traditional approaches may be beneficial in the near term but usually do not maintain competence. Training approaches that include feedback can improve long-term retention of these critical skills. **Aim:** This review assesses the effectiveness of feedback-integrated training compared to traditional Basic Life Support methods in promoting sustained retention of knowledge and skills among healthcare providers in clinical settings. **Methods:** This systematic review followed PRISMA guidelines. The database searches retrieved 211 articles from 2014 to 2024 using relevant keywords. Inclusion and exclusion criteria: We included quantitative studies assessing BLS knowledge or skill retention among healthcare providers. We excluded studies that did not evaluate retention, involved non-healthcare populations, lacked a feedback-based component, were not in English, or did not follow RCT, quasi-experimental, or longitudinal designs. Data on study characteristics, interventions, and outcomes were systematically extracted and synthesized. **Results:** Database searches in PubMed, Cochrane Library, Scopus, and Web of Science identified 211 articles, with 98 remaining after removing 113 duplicates. After screening, 55 full-text articles were assessed, and 12 met the inclusion criteria. These studies showed that feedback-integrated training—using automated, video-based, and simulation feedback—led to better long-term retention of CPR skills and knowledge among healthcare providers. While traditional methods improved performance initially, skills declined significantly after six months. In contrast, feedback-integrated training-maintained competency for up to twelve months, enhancing compression depth, ventilation quality, and overall resuscitation outcomes. **Conclusion:** Feedback-integrated Basic Life Support training significantly improves long-term skill retention and is adaptable to diverse clinical settings, including low-resource environments. Future research should explore the long-term impacts, cost-effectiveness, and comparison with other resuscitation techniques to provide global recommendations for healthcare training.

Keywords: Basic Life Support, feedback-integrated training, skill retention, cardiopulmonary resuscitation, healthcare training.

Introduction

Cardiovascular diseases are the number the first leading cause of death worldwide, claiming more than 17.9 million lives annually, and sudden cardiac arrest has been listed as one of the leading causes [1, 2]. Basic life support (BLS) is touted to be a vital component in improving survival outcomes after cardiac arrest, according to the American Heart Association—AHA— [3]. However, one of the most common outcomes of such training is the decay in BLS knowledge and skills among health professionals between 3 to 6 months after training [4]. The inadequate retention of BLS training necessitates the evaluation of the current training methodologies and their subsequent modification to enhance enduring retention [1, 3, 4].

On the other hand, the essential determinant of enhanced patients' survival in both in- and out-of-hospital settings due to cardiac arrest is recertification for cardiopulmonary resuscitation since early intervention can ensure better results in such cases. However, most research has found that traditional instructor-led BLS training results in poor long-term retention of practical skills, as those receiving the training tend to demonstrate a decline in acquiring these skills. This trend is worrying since poor

1 Department of Nursing, Faculty of Nursing, The University of Jordan, Amman, Jordan. Email: a.ghatasheh@istiklalhospital.com
2 E-mail: m.saleh@ju.edu.jo
3 Department of Nursing, Faculty of Nursing, Al-Zaytoonah University of Jordan, Amman, Jordan.
* Correspondng author: r.abujebbeh@zuj.edu.jo
4 Email: seirsathebest@gmail.com
5 RN, PhD, Istiklal Hospital, Amman- Jordan. Email: a.abuelshaer@istiklalhospital.com.
6 RN, MSN, Int. Senior Program Manager, AHA, email: mohammad.almzayen@hqsuae.ae

competence in basic BLS procedures, such as chest compressions and ventilation, is likely to translate into poor outcomes regarding cardiopulmonary resuscitation survival rates. This would necessitate even more efficient or parallel training methods, such as incorporating feedback since they effectively enhanced knowledge retention and psychomotor skills among trainees.

The principal concern emphasized in this examination is the necessity for the sustainable reinforcement of BLS competencies among members of healthcare teams, which consequently impedes the achievement of long-lasting successful resuscitation outcomes within clinical settings. Nevertheless, conventional BLS training possesses certain constraints, primarily attributed to the deterioration of participants' skills over extended periods, whether in years or months [5]. The importance of this review lies in its examination of feedback-integrated Basic Life Support (BLS) training methodologies that focus precisely on mitigating skill deterioration due to feedback and continuing reminders [6]. The review aims, therefore, to give recommendations on the effectiveness of BLS training by comparing these methods with conventional techniques for training healthcare professionals to optimize their response capability to cases of cardiac arrest [7].

Research proves that BLS skill retention stays between 10% and 50% even six months after training, while primary investigations suggest a considerable drop in knowledge within one year [8]. For example, Castanha et al. [1] showed in Brazil one year later that while students of health sciences in Brazil retained a much lower percentage than immediately after the training, the median BLS knowledge dropped from 15.0 to 8.0 points, p<.001. Similarly, Al Jadidi and Al Jufaili [9] also reported that healthcare workers whose training performance did not include feedback dropped to 79.4% after 12 months from 88.5% after 6 months (p = 0.010). All these findings emphasize the requirement for frequent BLS and education and to remind the staff about every CPR performance with advanced high-quality BLS skills [10, 11]. Traditional CPR practice is a challenging issue that may be solved by feedback-integrated training methods that provide metadata during CPR practice to enable healthcare providers to receive immediate quantitative and qualitative feedback to improve their practices [5]. In the randomized controlled trial by [12], the authors described enhanced chest compression performance in medical students after BLS training followed by reflective feedback versus traditional training (71.12 ± 56.04 vs. 57.24 ± 54.80; p = 0.04). In a similar study by Miri, Yaghoubi [5], results also showed that video feedback improved CPR skills, with the feedback group achieving, on average, a better compression depth of 81.6 % as opposed to 57.9 % in the infographic group, statistical significance at p = 0.045. In the airway management training, the feedback group achieved a better percentage of 84.2% as compared to the infographic group; thus, the use of feedback mechanisms is correlated with the consistency of enhancing CPR performance [3, 13].

The implications of this review are significant, as it addresses a critical gap in BLS education: the problem of skill depletion among healthcare workers. Based on the results of the current study, there is the possibility of informing policy shifts of the training undertaken in clinical, clinical feedback-integrated methods of maintaining the competence of the clinicians from the current traditional skills in healthcare of clinical supervisors, nurses, and other healthcare professionals [7]. In addition, the review discusses the benefits of courses that are taken periodically, such as the study of Al Jadidi and Al Jufaili [9] participants who received a feedback-integrated refresher course six years after the initial training provided a better CPR skill compared to the group who did not (93.8% versus 79.4%, p=0.010) at one year later. This evidence supports that traditional BLS education will wane off with time [14].

Therefore, this review highlights the importance of considering different training methods on BLS to ensure that people are trained during their lifetime for feedback, given the importance of feedback mechanisms in long-term skills retention. Despite producing a high degree of learning in the short term, more than a selection of rather traditional BLS instruction is required to retain the requisite superior levels of skills [13]. Hence, feedback-integrated training has developed into a superior training model with more advantages regarding knowledge acquisition and retention and the development of practical skills over time [5]. Since healthcare organizations around the globe are in pursuit of keeping patients alive during cardiac arrest episodes, it could go a long way in helping by employing these complex training techniques to prepare healthcare professionals for when that time comes.

Aim of the review

This systematic review aims to synthesize the best current evidence for comparing feedback-integrated versus traditional adult BLS training methods in promoting long-term retention of knowledge and skills among healthcare providers in clinical settings.

Materials and Methods

Design

This systematic review was conducted based on the guidelines provided by the PRISMA statement. The review compared feedback-integrated BLS training techniques with other traditional training methods to identify critical techniques that are more effective in retaining knowledge and valuable skills among healthcare providers over a long period. Randomized controlled trials and quasi-experimental studies were included to widen the view and provide a more comprehensive assessment of the evidence provided.

Eligibility Criteria

The eligibility criteria for study selection were established based on specific inclusion and exclusion criteria:

- Population: The study's population includes all healthcare providers (e.g., nurses, doctors, and paramedics) who underwent BLS training in clinical settings.
- Interventions: Studies focusing on feedback-integrated BLS training (e.g., automated feedback from manikins, video feedback) and traditional BLS training (e.g., instructor-led, lecture-based).
- Outcomes: Studies that assessed BLS knowledge retention (measured via knowledge tests) and practical CPR skills retention (measured via manikins or other objective tools) over time.
- Study Design: RCTs, quasi-experimental, and longitudinal studies published in peer-reviewed journals were considered.
- Timeframe applied: Studies published between the period 2014 to 2024
- Exclusion Criteria: Studies that did not evaluate BLS knowledge or skill retention, those involving non-healthcare populations (e.g., laypersons), or those lacking a feedback-based component were excluded. Additionally, studies that were not published in English or did not follow RCT, quasi-

experimental, or longitudinal study designs were also excluded.

Search Strategy

A comprehensive search strategy was developed in consultation with a research librarian and employed across major electronic databases, including PubMed, Cochrane Library, Scopus, and Web of Science, covering publications from 2014 to 2024. Search terms included "Basic Life Support," "BLS," "feedback training," "automated feedback," "traditional training," "knowledge retention," "skills retention," and "healthcare providers." Boolean operators were used to combine the search terms effectively. The search strategy was refined by applying filters and limiting studies to human subjects, healthcare professionals, and English-language publications. Additionally, manual searches were conducted in the reference lists of included studies to ensure all relevant articles were included.

Study selection

The study selection process was documented using a PRISMA flow diagram, outlining the stages of identification, screening, eligibility, and inclusion for this systematic review. A total of 211 records were initially identified through database searches. After the removal of 113 duplicate records, 98 records remained for screening. Of these, 43 were excluded based on title and abstract review for failing to meet the inclusion criteria. Full-text reviews were sought for 55 reports, but 11 still needed to be retrieved. After assessing 44 studies for eligibility, 27 were excluded for not being relevant, 4 for having a different population, and 1 for insufficient methodological quality. Ultimately, 12 studies met the eligibility criteria and were included in the review. The PRISMA flow diagram visually details this process (see Figure 1).

Data Extraction

Data were systematically extracted from the included studies using a predesigned data extraction sheet. The following data were collected from each study: author names, publication year, country of origin, study design, sample size, population characteristics, type of BLS training (feedback-integrated or traditional), tools used for knowledge and skill assessment, timing of assessments (pre-intervention, post-intervention, and follow-up periods), and key findings related to learning and skill retention. Two independent reviewers extracted the data; discrepancies were resolved through discussion or a third reviewer if necessary (Appendix A).

Risk of Bias Assessment

The risk of bias assessment for the 12 studies included in this review was conducted using the Joanna Briggs Institute (JBI) checklist. The assessment covered multiple domains, including randomization, allocation concealment, blinding, and outcome assessment. While most studies demonstrated a moderate to low risk of bias, specific concerns were noted, particularly regarding the blinding of outcome assessment in several RCTs.

Some quasi-experimental studies, such as those by [15] and [16] exhibited potential bias due to the lack of blinding and control group comparisons. Studies utilizing simulation and feedback methods [5] and [9] showed strong methodological rigor by employing randomized controlled trial designs, ensuring participant randomization, and minimizing selection bias.

Most studies reported clear outcomes; however, some exhibited attrition bias, particularly in long-term assessments [1,8,13]. Despite these limitations, the overall quality of the included studies was considered acceptable for this review. A detailed risk of bias assessment for each study is presented in (Appendix B).

Data Synthesis

A narrative synthesis approach was used to combine the findings of the included studies due to the heterogeneity in study designs, populations, and outcome measures. Studies were grouped based on the type of intervention (feedback-integrated versus traditional BLS training), and the results were synthesized within these categories. Descriptive statistics were used to summarize critical outcomes, including the mean knowledge and skill retention scores at different time points (immediately post-training and at follow-up). Where appropriate, meta-analytic techniques were considered, but formal meta-analysis was only feasible with the variability in outcome measures and follow-up durations. Instead, trends in knowledge and skill retention over time were identified, with attention given to statistically significant improvements in feedback-integrated versus traditional training methods.

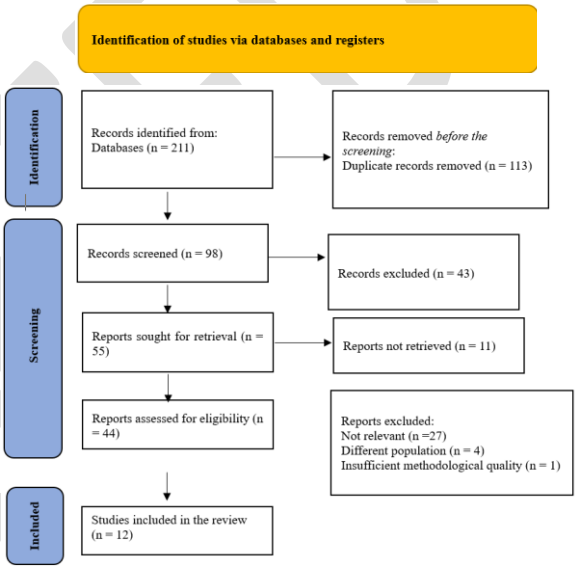

Figure (1): PRISMA flow diagram.

Results

Characteristics of the included studies

Results: Database searches identified 211 records. After removing 113 duplicates, 98 records remained for screening, of which 43 were excluded based on title and abstract. Full-text retrieval was sought for 55 reports, but 11 could not be retrieved. Of the 44 full-text reports assessed for eligibility, 27 were excluded for not being relevant, 4 for involving a different population, and 1 for insufficient methodological quality. Ultimately, 12 studies met the inclusion criteria and were included in the final systematic review.

The 12 studies included in this review were conducted across diverse countries: Oman (1), Malaysia (1), Iran (1), Jordan (1), India (2), Germany (1), Turkey (1), Nigeria (1), Thailand (1), Brazil (1), and Australia (1). Regarding study designs, seven studies were randomized controlled trials (RCTs) [5,6,9,10,11,12,13]. One study was a quasi-experimental design [15], two were pre-experimental studies [14,16], one was an interventional study [1], and one was a longitudinal study [8]. The sample sizes ranged from 38 participants to 287 participants, and the samples included healthcare providers, nursing students, medical students, and dental professionals. Five studies used various study designs to focus on traditional BLS training methods, such as lecture-demonstrations and instructor-led training. Kose and Akin [15] conducted a quasi-experimental

study on nursing students, while Saidu and Lee [13] performed an RCT comparing video self-instruction with traditional methods. Srivilaithon and Amnuaypattanapon [8] carried out a prospective cohort study assessing knowledge retention, Arora, Bala [14] implemented an interventional study examining the impact of an additional video session, and Castanha, Tavares [1] conducted a longitudinal study evaluating BLS knowledge retention one year after training. Many looked at how well BLS knowledge or skills were retained over time, and some showed significant retention drops with time. Seven studies focused on the impact of feedback-integrated BLS training, utilizing various study designs. Al Jadidi and Al Jufaili [9] conducted a randomized controlled trial (RCT) assessing the effectiveness of a feedback-integrated refresher course. Wan Jusoh and Yahaya [6] performed an experimental study evaluating a modified BLS module incorporating feedback. Miri, Yaghoubi [5] carried out an RCT comparing video feedback with infographic-based education. Abu-Wardeh, Ahmad [10] conducted an RCT examining simulation-based BLS training with feedback. Jelly and Aggarwal [16] used a pre-experimental design to assess structured simulation-based feedback training. Thommes and Schmidt [12] conducted an RCT investigating the effect of reflective practice as feedback in BLS training. Wilson and Furness [11] performed an RCT comparing automated manikin feedback with traditional instructor-led feedback. Two research combined traditional education with feedback in a mixed manner, for example, by integrating video feedback with infographic-based instruction. The study aimed to investigate how well different BLS training techniques affected the retention of knowledge and skills. Several pointed out the advantages of incorporating feedback mechanisms to improve retention compared to traditional methods.

Effectiveness of Traditional BLS Training Methods

Based on findings from five studies, this section discusses the retention of skills and knowledge in healthcare personnel by applying traditional BLS training methodologies. Traditional BLS training is often practical to improve skills and knowledge and generally consists of lecture demonstrations, instructor-led seminars, or video-based education. The methods have been criticized for their inability to maintain competency over time without repeated reinforcement. Studies in this section have investigated the effects of traditional instruction on short-term gains and longer-term skill retention. The populations studied are nursing and medical students and health workers in Turkey, Nigeria, Thailand, India, and Brazil.

Kose, Akin [15] evaluated the effects of traditional BLS training on knowledge and practical skills in a quasi-experimental research study of 65 nursing students in Turkey. Participants received theoretical and practical BLS training per the most recent AHA standards. Their knowledge and practical skills were evaluated using an observation checklist and a self-developed questionnaire. The results showed a significant improvement in knowledge scores, which increased from 14.12 ± 7.73 pre-training to 27.82 ± 5.95 post-training ($t = -12.442$, $p = 0.000$), and practical skills also showed substantial enhancement, rising from 4.56 ± 7.11 to 27.11 ± 3.60 ($t = -22.899$, $p = 0.000$). A slightly favorable relationship between post-training knowledge and skills ($r = 0.39$, $p < 0.01$) indicated that more significant knowledge increases were linked to better practical abilities. However, this study's lack of long-term follow-up restricts our understanding of how well those benefits increased over time.

In Nigeria, Saidu, Lee [13] conducted a randomized controlled trial involving 150 nurses to compare video self-instruction (intervention) with traditional instructor-led training (control) for CPR knowledge and skill retention. At the same time, both groups demonstrated significant improvements immediately post-training (AOR = 80.885, $p < 0.001$), retention declined by the 6-month follow-up, with knowledge retention dropping to an adjusted odds ratio of 0.518 ($p = 0.095$) and skill retention to 0.310 ($p = 0.003$). These findings emphasize that although both training types were influential in the short term, periodic refresher courses are essential for sustaining BLS competencies over more extended periods.

A prospective cohort study by Srivilaithon, Amnuaypattanapon [8] in Thailand assessed knowledge and skill retention among 149 second-year medical students. The study included pre-test, immediate post-test, and six-month retention assessments, focusing on BLS knowledge and essential skills like detection, activation, and compression. After training, knowledge scores increased significantly from 8.52 (SD 1.88) to 12.12 (SD 1.52, $p < 0.001$). However, knowledge retention had decreased at six months, with compression skill retention dropping by 0.66 times ($p = 0.04$). This study underscored the limitation of traditional BLS methods in sustaining long-term retention of critical skills like chest compression, indicating a need for reinforcement to maintain essential life-saving techniques over time.

Arora, Bala [14] conducted an interventional trial in India among 92 second-year medical students to check if an additional short video session might further enhance the CPR skills that had already been achieved after a conventional BLS course. The results showed that while the knowledge scores improved after the first workshop from 1.95 ± 1.33 to 7.47 ± 0.99 ($p < 0.001$), there was no further statistically significant improvement in practical CPR skills after the additional video session. It also shows how this research portrays a discrepancy in the improvement of theoretical knowledge and practical performance, meaning that traditional BLS training with video interventions little to the improvement in skill performance without practical experience or feedback systems.

Finally, one year following the traditional lecture approach, Castanha, Tavares [2] conducted a longitudinal study to determine the long-term retention of BLS knowledge for undergraduate health sciences students in Brazil. Training professionals gave a 50-minute lecture-based demonstration of the basic competencies of BLS, including the use of an AED, chest compressions, and CPR skills. Knowledge retention was assessed immediately following training and at one year. Median correct answers significantly increased from 7.0 [95% CI: 7.0-8.0] post-training to 15.0 [95% CI: 14.0-15.0, $p < 0.001$], dramatically decreasing to 8.0 [95% CI: 7.0-8.0, $p < 0.001$] one year later. This also supports the fact that traditional BLS methods have many challenging features related to sustaining long-term proficiency in critical skills without frequent reinforcement.

Impact of Feedback-Integrated BLS Training

This section reviews the impact of feedback-integrated BLS training on knowledge and skills retention based on the results of seven studies [5,6,9,10,11,12,16]. In feedback-integrated training, trainees receive immediate performance feedback through automated feedback systems, video feedback, and simulation-based feedback. Compared with traditional methods, these methods have increased cognitive and psychomotor abilities while offering a more practical approach to retaining critical life-support competencies. The studies included in this feedback-integrated method were conducted in multiple countries: Germany, Australia, Oman, Malaysia, Iran, Jordan,

and India. It included participants with different experiences in the field of healthcare: dental professionals, early-career physicians, and nursing students. Al Jadidi and Al Jufaili [9] evaluated the effectiveness of the refresher training program incorporating feedback about CPR competencies in Oman using a randomized controlled trial among 38 healthcare workers.

Participants were assigned to one of two groups: a control group without refresher training and an intervention group with refresher training and feedback at six months. CPR skill was assessed at baseline, six, and twelve months on Little Anne® QCPR manikins. After one year, the intervention group had significant gains in ventilation, $p = 0.028$, and interruption time, $p = 0.020$, with a significant difference in retaining skills, 93.8% vs 79.4%, $p = 0.010$. The results show that CPR skills can be maintained by refresher training with feedback; such training should be completed within six months after certification to minimize the decline in skills. Wan Jusoh, Yahaya [6] evaluated the effectiveness of a feedback-integrated BLS curriculum on 125 university students in Malaysia who were both medical and non-medical.

The intervention included lectures, video demonstrations, and practice with feedback. Marked improvement was seen in both groups on knowledge and attitude scores ($p < 0.001$), while 64.8% showed competent chest compression performance. Comparing medical and non-medical students' performances did not significantly differ ($p = 0.200$). However, the study stressed the utility of integrating feedback in attaining better CPR knowledge, attitudes, and performances across different educational backgrounds. In Iran, Miri, Yaghoubi [5] conducted a randomized controlled study to compare infographic-based education with video feedback among nursing students. While both methods improved skills, video feedback led to more significant practical skill gains, including improvements in chest compression depth (81.6% vs. 57.9%, $p = 0.045$) and airway management (84.2% vs. 36.8%, $p < 0.001$). The study found that infographic education was more effective for theoretical knowledge. At the same time, video feedback better supported practical motor skills, suggesting that combining these methods could comprehensively address BLS training's cognitive and psychomotor learning needs.

In Jordan, Abu-Wardeh, Ahmad [10] conducted a randomized controlled trial with 102 newly employed nurses, comparing standard BLS training to simulation-based BLS training with feedback. Results showed significant improvements in both knowledge ($F(2, 182) = 58.514$, $p < 0.001$) and practice scores ($F(2, 182) = 20.134$, $p < 0.001$) in the simulation group, with large effect sizes, indicating the potential of feedback-integrated simulation to enhance skill retention.

In India, Jelly, Aggarwal [16] evaluated the effects of structured simulation-based BLS training with feedback from dental professionals. In a pre-experimental design with a pretest-posttest structure, 97 dental professionals demonstrated substantial improvement in BLS knowledge post-training (mean score = 22.01 ± 1.86 vs. 13.69 ± 4.37, $p = 0.001$), with 93.8% of participants noting that feedback enhanced their skills. This study demonstrated that hands-on feedback in simulation-based training effectively reinforces essential BLS skills.

In Germany, Thommes, Schmidt [12] assessed the effect of adding a reflective practice exercise to standard BLS training among 287 medical students. The intervention group showed better compression performance (71.12 ± 56.04 vs. 57.24 ± 54.80, $p = 0.04$) and began compressions more quickly ($p < 0.01$) compared to the control group. These findings suggest that even self-guided reflection can improve BLS skill acquisition, though its long-term impact requires further study.

In Australia, Wilson, Furness [11] compared automated manikin feedback with traditional instructor feedback among junior doctors. The study found significantly better performance in cardiac compressions with automated feedback (mean score of 88.00 vs. 75.81, $p < 0.000$), highlighting automated feedback as a cost-effective and consistent alternative for CPR skill training. While there was no significant difference in bag-valve-mask ventilation scores, most participants preferred automated feedback, indicating the potential of technology-enhanced training in BLS skill retention.

These studies collectively illustrate that feedback-integrated training methods offer substantial advantages over traditional methods, particularly in terms of long-term retention of both CPR knowledge and skills.

Comparison of Traditional and Feedback-Integrated Methods

The 12 studies compare traditional and feedback-integrated BLS training methods and reveal a clear statistical advantage for feedback-integrated approaches, particularly in retaining CPR knowledge and practical skills. Feedback mechanisms, whether delivered through video, real-time instructor input, or automated systems, consistently lead to better knowledge retention and skill performance outcomes over time compared to traditional methods that lack integrated feedback.

From a performance metrics standpoint, studies like Al Jadidi and Al Jufaili [9] illustrate the tangible benefits of feedback in maintaining CPR skills over the long term. In this randomized controlled trial, participants who received feedback-integrated refresher training at six months demonstrated significantly better skill retention at the 12-month mark, with a CPR skill retention rate of 93.8% compared to just 79.4% in the control group, who received no feedback. The difference was statistically significant ($p = 0.010$), underscoring the importance of feedback in enhancing long-term skill retention. In addition, the intervention group showed marked improvements in specific CPR metrics such as ventilation ($p = 0.028$) and interruption time ($p = 0.020$), highlighting how feedback can refine technical aspects of CPR that are often prone to decay without consistent reinforcement.

On the other hand, while effective in the short term, traditional BLS training methods generally show a more significant decline in skill retention over time. Kose, Akin [15], for example, found that traditional theoretical and practical BLS training resulted in significant improvements in nursing students' knowledge and skills, with practical skills increasing from 4.56 ± 7.11 to 27.11 ± 3.60 post-training ($t = -22.899$, $p = 0.000$). However, while statistically significant, these improvements are less sustained than feedback-integrated methods. The absence of ongoing feedback in traditional methods likely contributes to the gradual erosion of knowledge and practical skills, necessitating frequent refresher training to maintain proficiency.

Knowledge retention outcomes further highlight the superior efficacy of feedback-integrated methods. In Miri, Yaghoubi [5], feedback delivered through video proved particularly effective in retaining practical motor skills, while infographic-based education was more beneficial for theoretical knowledge retention. The video feedback group showed significantly better practical skill retention, with metrics such as chest compression depth and rate improving more than the infographic group (compression depth: 81.6% vs. 57.9%, $p = 0.045$; compression rate and speed: 84.2% vs. 55.3%, $p = 0.006$). This study demonstrates that feedback, particularly real-time or near real-time, plays a critical role in sustaining the practical application of BLS techniques, which are vital for effective CPR.

In contrast, studies using traditional methods without feedback show more pronounced knowledge decay over time. Srivilaithon, Amnuaypattanapon [8], for instance, observed that while traditional BLS training significantly improved knowledge and skills immediately after training (mean knowledge scores increased from 8.52 to 12.12, p<0.001), these gains diminished over six months, especially in the critical area of chest compressions, where retention dropped by 0.66 times (95% CI: 0.45-0.98, p=0.04). This highlights the limitations of traditional methods in sustaining long-term knowledge and skill retention without integrating feedback mechanisms.

Feedback integration also positively affects learner engagement and self-confidence, as Thommes, Schmidt [12] show. This study demonstrated that the addition of reflective practice to standard BLS training improved compression quality and reduced the time to start the first compression, both immediately after training and one week later (time to first compression: 24.57 ± 7.60 vs. 28.65 ± 9.05, p < 0.001). Though self-reported confidence did not show significant differences between groups, the objective improvements in skill performance suggest that feedback is crucial in enhancing technical proficiency and decision-making speed in real-time emergency scenarios.

Feedback-integrated methods consistently outperform traditional BLS training in knowledge and skill retention. Whether delivered through real-time manikin feedback, video assessment, or instructor guidance, the feedback mechanism helps learners correct errors and refine techniques, leading to statistically significant improvements in critical CPR metrics. While beneficial in the immediate post-training phase, traditional methods show a more rapid decline in effectiveness without the reinforcing benefits of feedback. This suggests that integrating feedback into BLS training is essential for maintaining high knowledge and competency levels in practical application.

Table (1): Comparison of Traditional and Feedback-Integrated BLS Training Methods.

Study	Country	Training Method	Sample Size	Immediate Knowledge Improvement (p-value)	Long-Term Knowledge Retention (p-value)	Skill Improvement (p-value)
Al Jadidi and Al Jufaili [9]	Oman	Feedback-Integrated	38	p=0.682	p=0.010	p=0.028
Wan Jusoh, Yahaya [6]	Malaysia	Feedback-Integrated	125	p<0.001	No long-term follow-up	p=0.200
[5]	Iran	Feedback-Integrated (Mixed)	76	p=0.032	No long-term follow-up	p=0.004
Abu-Wardeh, Ahmad [10]	Jordan	Feedback-Integrated	102	p<0.001	No long-term follow-up	p<0.001
[16]	India	Feedback-Integrated	97	p=0.001	No long-term follow-up	p=0.001
[12]	Germany	Feedback-Integrated	287	p<0.01	No long-term follow-up	p=0.04
[15]	Turkey	Traditional	65	p=0.000	No long-term follow-up	p=0.000
[13]	Nigeria	Traditional	150	p<0.001	p=0.518	p<0.001
[8]	Thailand	Traditional	149	p<0.001	p=0.04	p<0.001
[14]	India	Traditional	92	p<0.001	p<0.05	No significant improvement
[2]	Brazil	Traditional	151	p<0.001	p<0.001	No skill measurement
[11]	Australia	Feedback-Integrated (Mixed)	56	p<0.000	No long-term follow-up	p<0.000

Discussion

The 12 research studies included in this systematic review provide critical new data regarding the relative effectiveness of feedback-incorporated and traditional methods of BLS training, specifically related to learning skills and knowledge retention. Traditional methods of BLS training, such as instructor-led lectures and AHA guideline-based hands-on exercises, immediately improved knowledge and skill levels among participants. Kose, Akin [15] and Arora, Bala [14] realized significant post-training knowledge gains and showed p-values less than 0.001. However, this was subject to decay, and after six months, sharp declines in retention were realized by Srivilaithon, Amnuaypattanapon [8]. Besides that, conventional methodologies worked relatively well in the short term.

However, in a study done by Castanha, Tavares [2], they needed support to retain their skills for the longer term. Knowledge retention fell one year following the training itself, as was presented by a p-value of less than 0.001. Saidu, Lee [13] also showed this drop in establishing significant gains within the immediate post-training period. However, their knowledge and skills retention decreased after six months, with an AOR of 0.518 at p=0.095. The findings showed that although traditional approaches facilitate effective immediate information transmission, they result in relatively lower efficiency in retaining practical skills or knowledge significantly beyond the period of practice or reinforcement. The effectiveness of BLS training methods may also be influenced by healthcare providers' emotional resilience, as studies have shown that compassion fatigue can impact performance in high-stress environments [17]. By contrast, in almost all cases, integrated feedback methods consistently outperformed traditional methods regarding long-term retention of skills and knowledge.

In support, Al Jadidi and Al Jufaili [9] established clear evidence that refresher training integrated with feedback ensures better retention of CPR skills in the intervention group, retaining 93.8% of the skills as against 79.4% for the control group at 12 months (p = 0.010). For example, [5] and Wan Jusoh, Yahaya [6] showed that feedback mechanisms- whether video-assisted feedback or modified practical sessions- significantly enhanced depth and speed in skill acquisition. For example, Miri, Yaghoubi [5] established that video feedback resulted in a significant enhancement of the depth of compressions in CPR and airway management, with p < 0.045 and p < 0.001, respectively, hence indicating that such feedback mechanisms actively engage learners and enhance the precision of motor skills. Abu-Wardeh, Ahmad [10] give more weight to these findings, where simulation-based feedback training significantly outperformed traditional, reading-based methods in producing long-lasting gains in knowledge and practice (p < 0.001). Feedback systems offer real-time performance data and reinforcement of proper procedures

lacking in conventional BLS training methods, particularly in skill retention. This makes them a better approach toward both short- and long-term skills in BLS training.

Implications and Recommendations

Healthcare institutions, policymakers, and educators need to establish feedback-integrated BLS training programs that follow structured education methods to improve skill retention. According to institutions, all BLS training programs must implement real-time feedback technologies, including automated manikin feedback systems and video-based performance reviews. After CPR practice sessions, healthcare educators must conduct debriefing programs that reinforce learning while verifying competency. Fresh training should remain obligatory for healthcare providers, and they must engage in hands-on training sessions every six months to stop competence degradation. A robust system must develop inexpensive feedback devices that can reach resource-constrained areas to improve training efficiency. Real-time simulations should become part of clinical practice so healthcare professionals can experience actual resuscitations, providing instant performance feedback. The assessment criteria established by accrediting organizations must update their certification structures to contain regular goal-based tests that utilize objective performance monitoring systems. Policy officials should provide budget resources to establish technology-enhanced training programs while ensuring these programs become operational within healthcare delivery locations. Developing evidence-based best practices requires sustained professional growth among healthcare teams through hospital-university-professional organization collaborations. By embedding feedback-integrated training

Limitations

The limitations of this systematic review include the heterogeneity of the studies in terms of sample sizes, study designs, and measurement tools, which may affect the comparability of outcomes. Additionally, most studies were conducted in single institutions or specific geographic regions, limiting the generalizability of the findings. The varying follow-up periods also present challenges in consistently assessing long-term retention of skills and knowledge. Furthermore, several studies had relatively small sample sizes, reducing the statistical power to detect significant differences, and there was a lack of uniformity in defining and measuring "feedback-integrated" methods across the studies.

Conclusion

This review concludes by showing that feedback-integrated BLS training techniques perform noticeably better than traditional approaches regarding healthcare professionals' short- and long-term retention of CPR knowledge and practical skills. The noticeable skill degradation within six months to a year after training shows that, while traditional methods provide instant gains, they often fail to maintain proficiency over time. Feedback methods, on the other hand, whether automated systems, video, or real-time instructor coaching, consistently provide more significant results in preserving the cognitive and physical skills necessary for performing CPR. According to the outcomes, including feedback on BLS training is crucial for enhancing the quality of resuscitation efforts and guaranteeing that healthcare providers maintain vital life-saving skills, eventually improving patient outcomes in cardiac arrest scenarios. This evidence emphasizes how important it is that legislators and healthcare organizations make feedback-integrated approaches a standard component of BLS training.

Discourse Data

- **Ethics approval and consent to participate:** Not applicable, as this study is a systematic review and does not involve human participants or direct data collection from patients.
- **Consent for publication:** Not applicable, as no individual patient data or identifiable personal information is included in this study.
- **Availability of data and materials:** All data supporting the findings of this study are included within the manuscript and references. Additional data, if required, can be made available upon reasonable request.
- **Author's contribution:** Ayman Ghatasheh led the study, including conceptualization, literature search, data analysis, and manuscript drafting. Raid Abu Jebbeh served as the corresponding author and provided assistance. Mohammed N.Y. Saleh, Ammin Abu Elshaer, and Mohammad Almzayen contributed to the systematic review process, particularly in study selection, data extraction, and quality assessment. All authors reviewed and approved the final manuscript.
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