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A quasi-experimental evaluation of simulation-based versus video-assisted training on ACLS knowledge and skills among emergency nurses

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Abstract

This study emphasizes the importance of effective ACLS training for emergency nurses, particularly in managing pregnant patients, to improve outcomes and reduce maternal mortality. It aligns with SDG 3 (health and well-being) and SDG 4 (quality education), highlighting the global relevance of enhancing clinical skills through targeted education. The primary aim of this study is to assess the effectiveness of simulation-based education compared to video-assisted learning in enhancing emergency nurses' clinical skills and knowledge of ACLS in the care of pregnant women. Using a randomized, experimental, pretest-posttest design, emergency nurses at a governmental setting in Saudi Arabia were randomly assigned to one of two groups. Each group received training on the resuscitation of pregnant women, utilizing either simulation-based or video-assisted education. Cognitive knowledge and clinical performance were measured before and after the intervention using validated questionnaires and an observational checklist. The results showed that both educational methods led to improvements in cognitive learning and skill scores. However, the mean increases in both scores after the intervention were significantly greater in the simulation group compared to the video-assisted education group ($P < 0.01$). Training nurses and midwives in cardiopulmonary resuscitation for pregnant women using a simulator proved to be more effective in enhancing their cognitive learning and clinical skills. Therefore, simulation-based training can be recommended for the initial and ongoing education of healthcare providers.

Keywords: Advanced cardiovascular life support (ACLS), Emergency nurses, Pregnant women, Midwives, Sustainable development goals (SDG), Video-assisted education.

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Institutional Review Board Statement: All participants gave informed consent for the research, and their anonymity was preserved. The IRB committee at Prince Sattam bin Abdulaziz University approved the study. The research conforms to the provisions of the Declaration of Helsinki (as revised in Brazil 2013).
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1. Background

Pregnancy-related cardiac arrest is a rare event with critical implications for both mother and fetus [1], occurring in roughly one out of every 30,000 live births [2]. Effective management of such emergencies demands that healthcare providers have both advanced clinical expertise and practical skills adapted to the unique physiological changes of pregnancy [3]. Resuscitating a pregnant woman presents added challenges, as it requires protecting both maternal and fetal well-being through specialized measures like uterine displacement and modifications to standard ACLS protocols [1, 2]. Although ACLS guidelines are well-defined, evidence suggests a considerable deficiency in healthcare providers' readiness to manage maternal cardiac arrest. Research shows that midwives and emergency nurses frequently lack sufficient training and confidence to implement these protocols effectively in practice [4]. This gap is further exacerbated by the infrequency of maternal cardiac arrest cases, which limits opportunities for practical experience and long-term skill retention [5].

Educational interventions play a vital role in overcoming these gaps in preparedness. Of the various strategies available, simulation-based training has become widely recognized as the gold standard for translating theoretical knowledge into practical skills. By recreating realistic clinical scenarios in a safe, controlled setting, simulation enables participants to strengthen decision-making abilities, minimize errors, and improve team dynamics without placing actual patients at risk [6, 7]. Video-assisted learning offers a more accessible and self-paced alternative, allowing learners to revisit content as needed. However, limited and inconclusive evidence exists when comparing its efficacy to simulation-based training in maternal ACLS scenarios [8-10].

Due to the life-threatening nature of maternal cardiac arrest and the distinct challenges in its management, it is crucial to identify optimal training strategies. This study will compare the effects of simulation-based and video-assisted ACLS training on the cognitive and practical competencies of emergency nurses. In doing so, it aims to provide valuable, evidence-based insights for refining training protocols and ultimately enhancing both maternal and fetal survival in critical care settings.

2. Method

2.1. Study Design

This quasi-experimental study used a randomized pretest-posttest design.

2.2. Sampling and Sample Size

Participants in a governmental setting will be emergency nurses, divided into two groups: simulation-based education and video-assisted education.

Inclusion criteria for the study were willingness to participate and non-participation in a cardiopulmonary resuscitation retraining course within the last six months. Exclusion criteria included any participation in such a course during the same period. Emergency nurses were assigned to one of two groups (video-assisted education or simulation-based training) using a random number allocation table.

The sample size in each group was 40 people. Based on the results of Shabannia et al. [11] that was estimated using G*power 3.1.5 software with a confidence level of 95% and a power of 90%.

2.3. Measures

2.3.1. Cognitive Learning

The evaluation of knowledge, comprehension, and application was conducted using a validated multiple-choice questionnaire (MCQ), which adhered to the most recent guidelines for CPR in pregnant women. The tool, comprising 17 items, was designed to assess various cognitive levels, including knowledge, understanding, and application. Content validity was established through a review process involving seven experts from different medical disciplines, including Gynecology, Cardiology, Anesthesiology, and Medical Education. The reliability of the questionnaire was confirmed using the test-retest method, with a strong correlation coefficient of 0.91.

2.3.2. Skills

The assessment of performance was conducted using a structured checklist based on the latest CPR guidelines for pregnant women. The checklist decomposed the CPR procedure into discrete actions, assigning 1 point for each correctly performed step and 0 for any incorrect or omitted actions, with a maximum score of 41. A higher score signified better overall performance. Content validity was ensured through expert review, and inter-rater reliability was measured, resulting in a Kappa coefficient of 0.85.

2.3.3. Data Analysis

The data were coded and analyzed using SPSS software version 27 [12]. The means and standard deviations were used to summarize quantitative variables, and qualitative variables were reported as frequencies and percentages. The Kolmogorov-Smirnov test assessed the normality of the quantitative data. To compare demographic characteristics between the two groups, Chi-square tests, Fisher's exact tests, and independent t-tests were applied. The study objectives were evaluated using independent t-tests, paired t-tests, Mann-Whitney U tests, and Wilcoxon signed-rank tests. All analyses were performed with a 95% confidence interval.

2.3.4. Data Collection

Prior to the intervention, participants in both groups underwent assessments of cognitive knowledge through multiple-choice questions (MCQs) and evaluations of practical skills using an observational checklist. These assessments were facilitated by a research assistant with expertise in cardiopulmonary resuscitation and were conducted using a pregnant mother simulator.

In the simulator-based group, an emergency medicine specialist conducted practical training on resuscitating a pregnant woman using a simulation model. The training covered six essential areas: (1) airway management, (2) ventilation techniques, (3) chest compressions, (4) defibrillation and medication administration, (5) ECG monitoring, and (6) operation of defibrillator equipment. After completing all instructional components, participants engaged in group practice sessions, working in teams of four. Upon conclusion of the training, participants took a multiple-choice post-test, and one week later, their practical skills were individually reassessed using a checklist and the simulator.

In the video-assisted education group, three instructional videos were created, each approximately 15 minutes in length and covering two procedural steps. These videos were reviewed and validated by experts in gynecology, cardiology, anesthesiology, emergency medicine, and medical education to ensure high-quality audio-visual content and consistency with the study's goals. After watching each video, participants practiced the demonstrated procedures individually. Upon completing all three videos, they took part in group practice sessions, similar to those conducted in the simulator-based group. Furthermore, the videos were made continuously accessible to participants throughout the intervention period for ongoing review.

Upon completion of the video-assisted training, participants took a multiple-choice post-test. One week later, their practical skills were individually assessed using the same checklist and simulator. Both the simulator-based and video-assisted groups received the same educational content and dedicated an equal amount of time to training.

3. Result

A total of 80 participants—40 in the simulator group and 40 in the video-assisted education group—were included in the study. The mean age was 32.6 ± 5.22 years in the simulator group and 33.4 ± 4.67 years in the video-assisted education group, with no significant difference between the two groups (p = 0.71). The average work experience was also comparable, at 10.2 ± 6.54 years in the simulator group and 9.8 ± 6.21 years in the video-assisted group (p = 0.45).

Regarding Educational qualifications showed that most participants held a bachelor's degree: 95% in the simulator group and 90% in the video-assisted group, with no significant difference (p = 0.73).

Finally, 77.5% of the simulator group and 65% of the video-assisted group had previously performed CPR on real patients, with no statistically significant difference (p = 0.34).

These findings confirm the homogeneity of the two groups across all measured demographic variables (p > 0.05). (Table 1).

Table 1.
Homogeneity of the demographic characteristics of participants in the two groups.

Variable	Group		P
	Simulator (N=40)	video-assisted (N=40)	
Age Mean ± SD	32.6 ± 5.22	33.4 ± 4.67	0.71*
work experience Mean ± SD	10.2 ± 6.54	9.8 ± 6.21	0.45*
Education n (%)			
Associate degree	2 (5)	4 (10)	0.73***
Bachelor	38 (95)	36 (90)	
Perform CPR on a real patient n (%)			
Yes	31 (77.5)	26 (65)	0.34**
No	9 (22.5)	14 (35)	

Note: *independent t-test **Chi-square ***Fisher's exact test

The mean cognitive learning scores (knowledge, understanding, and application) of participants regarding cardiopulmonary resuscitation of pregnant women significantly improved after the intervention in both the simulator and video-assisted education groups (P = 0.01; P = 0.01; P = 0.02), respectively. Before the intervention, there were no statistically significant differences between the two groups in knowledge (P = 0.46), understanding (P = 0.50), or application (P = 0.38). However, following the intervention, the simulator group demonstrated significantly higher scores than the video-assisted group across all three domains.

Specifically, the simulator group's knowledge score increased from 6.6 ± 0.61 to 8.2 ± 0.97 (P = 0.01), while the video-assisted group increased from 5.6 ± 0.45 to 5.8 ± 0.40 (P = 0.01).

For understanding, the simulator group improved from 4.3 ± 0.78 to 7.8 ± 0.88 (P = 0.01), and the video-assisted group improved from 2.8 ± 0.11 to 3.7 ± 0.11 (P = 0.01).

In terms of application, the simulator group rose from 1.56 ± 0.52 to 2.93 ± 0.76 (P = 0.02), while the video-assisted group improved from 1.9 ± 0.57 to 3.1 ± 0.76 (P = 0.02).

The total cognitive learning score increased significantly in both groups. The simulator group improved from 7.4 ± 0.74 to 12.1 ± 0.31 (P = 0.01), whereas the video-assisted group improved from 8.1 ± 1.14 to 9.4 ± 1.42 (P = 0.01). Notably, the post-intervention total score in the simulator group was significantly higher than in the video-assisted group (P = 0.01), indicating a greater effectiveness of simulation-based education (Table 2).

Table 2.
Comparison of the mean cognitive learning score before and after the intervention in two groups.

Variable		**Group**		P_{value}
		Simulator (N=40)	**video-assisted (N=40)**	
		Mean ± SD	**Mean ± SD**	
Knowledge	Before intervention	6.6 ± 0.61	5.6 ± 0.45	0.46***
	After intervention	8.2 ± 0.97	5.8 ± 0.40	0.01***
Intragroup comparison		0.01*	0.01*	-
Understanding	Before intervention	4.3 ± 0.78	2.8 ± 0.11	0.50***
	After intervention	7.8 ± 0.88	3.7 ± 0.11	0.01***
Intragroup comparison		0.01*	0.01*	-
Application	Before intervention	1.56 ± 0.52	1.9 ± 0.57	0.38***
	After intervention	2.93 ± 0.76	3.1 ± 0.76	0.02***
Intragroup comparison		0.01*	0.01*	-
Total Score	Before intervention	7.4 ± 0.74	8.1 ± 1.14	0.25****
	After intervention	12.1 ± 0.31	9.4 ± 1.42	0.01****
Intragroup comparison		0.01**	0.01**	-

Note: *P value Wilcoxon, **P value paired t-test, ***P value Mann-Whitney
****P value Independent t-test

The analysis revealed that there was no statistically significant difference in the mean skill scores between the simulator group (25.0 ± 2.11) and the video-assisted group (24.6 ± 2.05) before the intervention (P = 0.70). However, following the intervention, the simulator group demonstrated significantly higher mean skill scores (38.7 ± 1.64) compared to the video-assisted group (31.2 ± 2.12), with a P-value of 0.03. Both groups showed significant improvements in their skill scores after the intervention compared to baseline, with intragroup comparisons yielding P-values of 0.01 for both the simulator and video-assisted groups. The mean change in skill scores after the intervention was significantly greater in the simulator group than in the video-assisted education group (Table 3).

Table 3.
Comparison of the mean skill score before and after the intervention in two groups

Variable		**Group**		**P-value**
		Simulator (N=40)	**video-assisted (N=40)**	
		Mean ± SD	**Mean ± SD**	
Skill	Before intervention	25.0 ± 2.11	24.6 ± 2.05	0.70**
	After intervention	38.7 ± 1.64	31.2 ± 2.12	0.03**
Intragroup comparison		0.01*	0.01*	

Note: *P value paired t-test **P value independent t-test

4. Discussion

Simulation training proved to be significantly more effective than video-assisted methods, likely because of its experiential, hands-on approach. The construct validity of the assessment tools further reinforces the reliability of these outcomes. These findings are consistent with previous research demonstrating the effectiveness of simulation in translating theoretical knowledge into practical skills. Nonetheless, discrepancies with other studies may be attributed to differences in participant characteristics and variations in how the interventions were implemented.

No prior studies have specifically compared the impact of cardiopulmonary resuscitation training for pregnant women using simulation versus video-assisted education on the cognitive learning and practical skills of midwives and emergency nurses. Therefore, the findings of this study offer important insights and add to the existing literature on the subject. While it is generally accepted that all forms of instruction promote learning, the extent and retention of that learning can vary significantly depending on the teaching method employed [13].

Studies conducted by Abd Al Karem et al. [6] and Mohamed et al. [14] focused on the impact of a simulation-based intervention on the performance of maternity nurses in cardiopulmonary resuscitation (CPR). The findings revealed that simulation training significantly enhanced both the knowledge and practical performance of maternity nurses in performing CPR [6, 14].

Umuhoza, et al. [15] demonstrated that nurses' knowledge and skills significantly improved following training in Basic Life Support (BLS), which was delivered using an adapted BLS curriculum Umuhoza, et al. [15]. Shabannia et al. [11] showed that both mannequin-based and video-based training methods can enhance staff awareness of cardiopulmonary resuscitation (CPR). However, hands-on training using mannequins proved to be more effective in improving practical skills [11]. The findings of the referenced studies are consistent with the results of the present study. Simulations are widely utilized as effective tools for both teaching and assessment in medical education. Their advantages include enhancing the competencies of healthcare professionals, promoting patient safety, minimizing clinical errors, and supporting better decision-making. Additionally, video-assisted instruction, when paired with guided skill practice, further reinforces learning. Videos offer the benefit of repeated viewing, providing learners with unlimited access to procedural demonstrations and reinforcing skill acquisition over time.

The study conducted by Monjamed et al. [16] focused on comparing the effectiveness of two CPR teaching methods, mannequin-based training and video-assisted instruction, on the knowledge and performance of nursing students. The findings indicated that there was no significant difference between the two methods in terms of their impact on students' knowledge and practical performance in basic CPR [16]. This finding contrasts with the results of the present study. The discrepancy may be attributed to variations in the study populations, including differences in participants' prior knowledge and experience with cardiopulmonary resuscitation. Additionally, differences in how the training methods were implemented could have influenced the outcomes.

There are several strengths to the present study. Firstly, few studies have been conducted in our country regarding cardiopulmonary resuscitation for pregnant mothers, and the present study is one of the few studies in this field. Secondly, the current research incorporated key principles of motor learning, such as task analysis, practice, and feedback. Task analysis is a systematic approach in which a motor or cognitive skill is deconstructed into smaller, more manageable components. This process enables the identification of specific task elements that can be individually assessed, refined, or modified, thereby enhancing the effectiveness of training and skill acquisition [17, 18]. Providing feedback on performance serves as a motivator for the learner, boosting their engagement and fostering a deeper understanding. It enhances learning by guiding improvements and helps ensure more accurate performance in the future [19]. Thirdly, the present study addressed all stages of procedural and technical skills, including planning, demonstrating the procedure, observing the learner, practice, and adjusting the approach, with the exception of self-evaluation [20].

The study's single-governmental setting and small sample size may limit the generalizability of its findings. Future research should involve a broader range of healthcare settings and larger participant groups to enhance the applicability and robustness of the results.

List of Abbreviations:

ACLS: Advanced Cardiovascular Life Support
MCQ: Multiple-Choice Questionnaire

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