Original Article

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Effect of an Interprofessional Simulation Based Cardiopulmonary Resuscitation Training Program on Teamwork and Clinical Competence in Emergency Care

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Received: August 12, 2025

Revised: March 30, 2026

Accepted: May 12, 2026

Citation: Heydari S, Sadat Alavi Z, HajiMaghsoudi M , Nasiriani KH , Antikchi M . Effect of an Interprofessional Simulation Based Cardiopulmonary Resuscitation Training Program on Teamwork and Clinical Competence in Emergency Care. J Surg Trauma. 2026;14(3):XX-XX. DOI: 10.61882/jsurgtrauma.14.3.XX

Abstract

Introduction: Effective teamwork is critical for successful resuscitation in emergency departments. Interprofessional education has been recognized as an essential approach to enhance collaborative competencies among healthcare providers. This study aimed to design, implement, and evaluate an interprofessional, simulation based training program for cardiopulmonary resuscitation (SAFE CPR) and to assess its impact on teamwork performance, learning outcomes, and learner satisfaction.

Methods: A pre experimental pretest-posttest design was conducted at Shahid Sadoughi University of Medical Sciences, Yazd, Iran. A total of 142 participants (27 medical, 91 nursing, and 24 anesthesiology students) completed the SAFE CPR course in simulated emergency scenarios. Evaluation was performed based on Kirkpatrick's three levels: reaction, learning, and behavior. Validated instruments including the Team Emergency Assessment Measure, Interprofessional Collaborative Competency Attainment Survey, and Simulation Effectiveness Tool-Modified (SET M) were used. Data were analyzed using paired sample t tests and effect size (η^2) calculations.

Results: Posttest scores showed significant improvements in teamwork and interprofessional collaboration competencies ($P<0.001$, $\eta^2=0.71$). Learner satisfaction was high across all SET M domains (mean =4.43±0.42). The program's structured design and high fidelity simulation effectively enhanced participants' preparedness for coordinated resuscitation in emergency settings.

Conclusion: The SAFE CPR interprofessional training program significantly improved teamwork, communication, and learner satisfaction among healthcare students. Integrating similar simulation based interprofessional modules into medical curricula can improve readiness for real life emergency resuscitations and promote safer, more efficient patient care.

Keywords: Cardiopulmonary resuscitation (CPR), Emergency department, Healthcare teams, Interprofessional education, Simulation training

Introduction

The health needs of individuals in today's world have become so complex and multidimensional that no single medical discipline can fully address them alone. These challenges can only be resolved through the cohesive collaboration of

interprofessional teams, consisting of various healthcare specialists working within an effective and goal-oriented communication framework (1, 2). Today, healthcare professionals operate in a complex environment that requires awareness of the roles and responsibilities of other related professions, as well as mastery of communication and teamwork skills (3). This reality has made interprofessional collaboration and team-based care—an unavoidable necessity—one that not only responds to the complex health needs of communities but also enhances patient safety and improves the quality of healthcare services (4). Indeed, interdisciplinary collaboration is an essential aspect of effective patient-centered care (5).

To provide high-quality and safe care, effective interprofessional and collaborative practice is essential, requiring clear definitions of the roles and responsibilities of different healthcare professionals. Such interprofessional collaborative training necessitates that individuals from different professions learn together (6). Interprofessional Education (IPE) refers to educational settings where learners from various health disciplines train together to acquire the skills necessary for delivering effective, patient-centered care (7). The primary goal of IPE is to equip learners with teamwork skills, specialized knowledge, and professional values to provide interprofessional care focused on improving patient outcomes (8). This educational approach enhances collaborative performance and care quality, as it prepares learners for effective teamwork, ensuring the achievement of broader healthcare system goals, including safe, optimal, and community-oriented treatment (9, 10). Key benefits of IPE include the development of communication skills, increased mutual trust among professions, facilitated discussion of patient issues, clarification of roles, and ultimately, quantitative and qualitative improvements in care services (11-13).

However, a current challenge in healthcare systems is role ambiguity and insufficient interprofessional collaboration, which can lead to professional tensions and reduced service quality (14). This reality underscores the necessity of expanding IPE as a fundamental strategy to overcome these challenges.

One area where interprofessional skills and teamwork are critically evident is cardiopulmonary resuscitation (CPR). CPR is a high-stakes, high-stress intervention whose success depends on the coordination and interprofessional skills of the resuscitation team (7). Research shows that poor-quality CPR and weak team communication during cardiac emergencies lead to unfavorable outcomes and even irreversible patient harm (15). In fact, the lack of a cohesive team and insufficient communication skills among members are among the primary barriers to successful resuscitation (16).

Despite the importance of teamwork in healthcare, professionals are often trained in isolation, with limited opportunities to practice interprofessional collaboration. This leads to misunderstandings about interdependent roles and reduces team effectiveness. Evidence suggests that well-coordinated teams with clearly defined responsibilities make fewer errors and enhance patient safety (14, 17). Therefore, strengthening joint training and improving team communication in resuscitation is a key requirement for advancing the quality of medical care.

Given that studies indicate a significant portion of healthcare adverse events stem from communication failures among treatment team members and considering the critical importance of teamwork and effective communication as core interpersonal skills in CPR (4, 18), there is a clear need for structured educational strategies that strengthen these competencies within healthcare teams. However, conventional CPR training programs often provide limited opportunities for interprofessional practice, with learners from different disciplines typically trained separately. This lack of integrated training can hinder effective communication, role clarity, and coordinated decision making during real resuscitation events. Therefore, structured interprofessional educational approaches are increasingly recognized as essential for improving team performance in emergency care. To address this gap, the present study conducted a quasi experimental single group pretest-posttest evaluation of an interprofessional simulation based CPR curriculum (SAFE CPR). This program was designed to provide realistic interprofessional team based practice, clarify professional roles, and strengthen communication and teamwork behaviors during resuscitation.

The study aimed to examine the effectiveness of the SAFE CPR program in improving learners' reactions to the training experience, their interprofessional collaborative competencies, and their observable teamwork performance, corresponding to the reaction, learning, and behavior levels of the Kirkpatrick evaluation model. The findings may provide evidence supporting the integration of structured interprofessional CPR

training into health sciences curricula and contribute to improved team performance and patient safety during real cardiac emergencies.

Methods

Study Design

This study employed a pre-experimental single-group pretest–posttest design to evaluate the effectiveness of a simulation-based IPE program on CPR teamwork competencies. Data were collected at two time points: immediately before the educational intervention (pretest) and immediately after program completion (posttest).

Setting and Participants

The study was conducted during the 2022–2023 academic year at Shahid Sadoughi University of Medical Sciences, Yazd, Iran. Participants included students from three health professions who were expected to participate in hospital resuscitation teams: medicine, nursing, and anesthesia.

A total of 142 learners participated in the program across three implementation phases. The sample consisted of 27 medical students, 91 nursing students, and 24 anesthesia students. Participants were organized into interprofessional teams of five to six members to simulate real clinical resuscitation teams.

Eligibility criteria included completion of the theoretical CPR coursework and a willingness to participate in the simulation activities. Participants who withdrew from the program or did not complete both assessments were excluded from analysis.

Educational Intervention

The SAFE-CPR program was developed by the research team as a structured educational intervention informed by the principles of simulation-based learning, IPE, and structured reflective debriefing approaches.

The SAFE-CPR program was implemented as a structured simulation-based interprofessional training program consisting of five sequential phases.

Pre-briefing and Scenario Design

Authentic emergency department scenarios-including sudden cardiac arrest, respiratory arrest, and arrhythmic shock-were developed by the instructional team based on current international CPR guidelines. Participants were oriented to the learning objectives, simulation environment, and interprofessional roles prior to scenario execution.

Simulation-Based Interprofessional Practice

Participants managed time-limited clinical scenarios in interprofessional teams under the supervision of an emergency medicine instructor. Each scenario required rapid patient assessment, coordinated CPR, and collaborative decision-making.

To enhance simulation fidelity, a cardiac dysrhythmia simulation software was used to dynamically modify heart rhythm patterns, patient responses, and clinical outcomes based on team interventions. This design allowed learners to practice both technical CPR skills and non-technical competencies, including communication, leadership, prioritization, and team coordination.

Structured Debriefing

After each simulation, structured debriefing sessions were conducted using established frameworks (PEARLS and GROW). These sessions focused on analyzing clinical decisions, teamwork behaviors, communication patterns, and leadership dynamics.

Reflective Interprofessional Learning

Participants engaged in facilitated discussions and individual reflective exercises to analyze their learning experiences and better understand the professional perspectives of other disciplines.

Consolidation Phase

In the final stage, standard CPR algorithms were reviewed, selected team performance videos were analyzed, and participants completed self-assessment and team-assessment forms. Individual and team feedback were provided to reinforce learning outcomes.

Outcome Measures

Program outcomes were evaluated using Kirkpatrick's evaluation framework, including reaction, learning, and behavioral outcomes.

Reaction (Level 1)

Learner satisfaction with the training program was assessed using the Simulation Effectiveness Tool-Modified (SET-M) and a researcher-developed questionnaire rated on a five-point Likert scale.

Learning (Level 2)

Participants' clinical and teamwork performance was assessed using:

- Team Emergency Assessment Measure (TEAM)
- Team-based Objective Structured Clinical Examination (TOSCE)

Behavioral Change (Level 3)

Interprofessional collaboration competencies were measured using validated questionnaires:

- Interprofessional Collaborative Competency Attainment Survey (ICCAS)
- TeamSTEPPS Teamwork Perceptions Questionnaire (T-TPQ)

Content validity of researcher-developed instruments was assessed using expert panel review (content validity ratio=0.85; content validity index=0.76). Internal consistency reliability was confirmed with Cronbach's alpha (α=0.88). For observational assessments, multiple trained instructors independently evaluated team performance using standardized checklists.

Sample Size

Given the educational nature of the intervention and cohort availability, all eligible students participating in the program were included (census sampling). The final sample size (n=142) exceeded the minimum sample size recommended for detecting moderate effect sizes in paired comparisons with 80% statistical power.

Data Analysis

Data were analyzed using SPSS (version 23). Descriptive statistics (mean, standard deviation, and frequency) were used to summarize participant characteristics and satisfaction scores.

For pre- and post-intervention comparisons, paired t-tests were conducted. Effect size was calculated using eta-squared (η^2). Statistical significance was set at $P<0.05$, and 95% confidence intervals were reported where appropriate.

Results

Participant Characteristics

A total of 142 students participated in the SAFE-CPR interprofessional training program. Participants represented three health professions involved in hospital resuscitation teams: 27 medical students (19.0%), 91 nursing students (64.1%), and 24 anesthesia students (16.9%). All participants completed both pre-intervention and post-intervention assessments, resulting in no attrition in the final analysis.

Most participants reported no prior experience in interprofessional resuscitation teams, although a minority had previous exposure to extracurricular CPR training. Participants were organized into interprofessional teams of five to six members during simulation sessions.

Level 1: Reaction (Learner Satisfaction)

Participants reported a high level of satisfaction with the interprofessional simulation program. The overall mean satisfaction score was 4.7±0.4 on a five-point Likert scale.

The highest ratings were related to the following domains:

- effectiveness of structured debriefing sessions (4.81±0.39),
- realism of the simulation scenarios (4.78±0.41), and
- opportunities for interprofessional collaboration (4.75±0.43).

The lowest score (though still above average) was related to program scheduling (3.97±0.80), suggesting minor logistical challenges in coordinating sessions across different disciplines. (Table 1) presents a detailed summary of learner satisfaction.

Table 1. Learner Satisfaction with the interprofessional simulation-based training program for cardiopulmonary resuscitation (SAFE-CPR) Based on Simulation Effectiveness Tool-Modified (SET-M) Domains (n=142)

SET-M Domain	Mean ± SD	Minimum–Maximum
Realism of simulation environment	4.78±0.41	3.8 – 5.0
Clarity of learning objectives	4.72±0.44	3.7 – 5.0
Effectiveness of debriefing	4.81±0.39	4.0 – 5.0
Interprofessional collaboration experience	4.75±0.43	3.9 – 5.0
Support from facilitators	4.68±0.47	3.6 – 5.0
Opportunity for skill practice	4.70±0.45	3.8 – 5.0
Program scheduling and logistics	3.97±0.80	2.5 – 5.0
Overall satisfaction with program	4.73±0.42	3.9 – 5.0

Notes: Responses were rated on a 5-point Likert scale (1=strongly disagree to 5=strongly agree). Higher scores indicate greater perceived effectiveness of the simulation activity.

Level 2: Learning Outcomes (Team Performance and Clinical Skills)

Team performance during simulated resuscitation scenarios improved significantly following the intervention. The mean TEAM performance score increased from 68.3±8.6 in the pretest to 91.2±6.4 in the posttest. Table 2 presents detailed statistical results, including the paired t-test analysis and confidence intervals. The calculated effect size was large (η^2=0.71), indicating a substantial improvement in team coordination, leadership, communication, and task management during resuscitation.

Performance in the TOSCE also improved significantly after training, with mean scores increasing from 70.5±9.1 before the intervention to 88.7±7.2 after training (Table 2). This improvement reflects better adherence to CPR algorithms and improved coordination of technical interventions during simulated emergencies.

Level 3: Behavioral Outcomes (Interprofessional Collaboration Competencies)

Interprofessional collaboration competencies showed significant improvement after participation in the program.

Scores on the ICCAS increased by approximately 35% compared with baseline values, reflecting improvements in interprofessional communication, mutual respect among professions, understanding of professional roles, shared decision-making, and team leadership during emergency situations. Table 2 presents detailed statistical results.

Similarly, the TeamSTEPPS Teamwork Perceptions Questionnaire (T-TPQ) showed significant improvements in perceived teamwork competencies, particularly in the domains of team structure, leadership, and mutual support.

Table 2 presents the comparative pre- and post-intervention results for all quantitative measures.

Table 2. Changes in Learning and Interprofessional Collaboration Outcomes Before and After the Cardiopulmonary Resuscitation (SAFE CPR) Training Program (n=142)

Outcome Measure *	Pretest Mean ± SD	Posttest Mean ± SD	Mean Difference	t(141)	95% CI	*P*-value	Effect Size (η^2)
TEAM							
Team Performance	68.3 ± 8.6	91.2 ± 6.4	22.9	18.54	20.1 – 25.6	<0.001	0.71
Score							
TOSCE							
Clinical Performance	70.5 ± 9.1	88.7 ± 7.2	18.2	15.37	15.9 – 20.5	<0.001	0.63
ICCAS							
Interprofessional Competency	3.1 ± 0.6	4.2 ± 0.5	1.1	13.28	0.94 – 1.27	<0.001	0.55
T-TPQ Teamwork Perception	3.3 ± 0.5	4.1 ± 0.4	0.8	12.46	0.67 – 0.92	<0.001	0.52

*Values are presented as mean ± standard deviation. Paired t tests were used to compare pre and post intervention scores. Effect size was calculated using eta squared (η^2). Paired t-tests were performed with df=141 for all comparisons.

Qualitative Feedback from Participants

Open-ended responses from participants highlighted several perceived benefits of the training program. The most frequently reported themes included:

- improved understanding of professional roles within resuscitation teams
- enhanced communication and coordination during emergencies
- increased confidence in participating in real clinical resuscitation scenarios

Participants emphasized that the combination of high-fidelity simulation and structured debriefing was particularly valuable for developing teamwork skills.

Discussion

This study aimed to design, implement, and evaluate a SAFE CPR at Shahid Sadoughi University of Medical Sciences in Yazd using a quasi experimental pretest–posttest design. Given the critical importance of teamwork and rapid coordination during resuscitation in hospital emergency departments, the program was developed to strengthen interprofessional collaboration among medical, nursing, and anesthesia students. The findings demonstrated significant improvements in

learners' competencies, teamwork performance, and satisfaction following participation in the program. These results suggest that structured interprofessional simulation training can effectively prepare healthcare students for collaborative decision making and coordinated action in high pressure clinical environments, such as emergency departments.

IPE, through strengthening communication skills and teamwork, plays a significant role in preparing students for effective collaboration in clinical settings. Studies indicate that this type of education not only leads to positive changes in students' attitudes and perceptions regarding various professional roles, but also increase learners' satisfaction and confidence in performing clinical procedures. These findings highlight the importance of integrating IPE into curricula as a key strategy for improving the quality of healthcare services (19-21).

In addition to previous studies, the satisfaction survey results in the current research also indicate a high level of student satisfaction with the program. This demonstrates the importance of team-based training in clinical procedures, which enhances students' motivation and self-confidence. The results of Guraya et al.'s study (2018) reflect the positive impact and effectiveness of IPE interventions across various healthcare disciplines (22). O'Neil-Pirozzi et al. (2019) showed a positive effect on the perceptions of learners in the IPE group compared to the other group, with both self-efficacy and student confidence being significantly higher after the training program (23).

On the other hand, effective team-based CPR is a complex process that requires a high-performance team to achieve optimal resuscitation outcomes. Moreover, given the interdisciplinary diversity, experiences, and skill sets of providers, effective team dynamics are essential. When healthcare provider teams are well-trained in all critical aspects of CPR, resuscitation can be performed more effectively. Hospital CPR is performed by teams where members are primarily assigned specific roles in the resuscitation team and arrive at the scene when a code is called to initiate CPR. Successful CPR management is highly challenging and largely depends on team performance and the ability of the resuscitation team leader to effectively lead during CPR. Therefore, a combination of team training and leadership development is essential for strengthening healthcare providers (17). Studies have shown that after team-based CPR training, checklist scores and self-reported survey results improve (24).

The results of the current study demonstrated that conducting such courses has a significant positive impact on students' competencies. Additionally, the comparison of pre- and post-intervention scores in the present study showed significant improvements in interprofessional collaboration and teamwork performance, indicating that participation in the SAFE-CPR program effectively enhanced learners' practical competencies in simulated resuscitation scenarios. Momeni et al. (2011) examined the effect of IPE on teamwork performance. In their study, 60 healthcare personnel, including physicians, nurses, anesthesiologists, and operating room technicians, were selected through stratified sampling and divided into control and intervention groups. The control group received routine training, while the intervention group was trained using an interprofessional approach with a study guide. The findings showed that the teamwork performance scores of the intervention group increased significantly compared to the pretest scores. After the intervention, the teamwork performance scores of the intervention group were also significantly higher than those of the control group (25).

In the study by Ok and Jong Sun (2024), which aimed to investigate how interprofessional attitudes and training load affect CPR-related self-efficacy following team-based CPR simulation training, the results indicated that higher levels of interprofessional attitudes, particularly regarding team roles and responsibilities, were associated with improved CPR-related self-efficacy (23).

Furthermore, simulation-based training has proven to be an effective method for developing medical students' team skills and enhancing patient safety in emergency situations (4). Research confirms that using realistic clinical scenarios in simulated educational environments allows students to practice evidence-based clinical procedures (26). This method helps them improve their ability to make decisions in critical situations and coordinate among different medical specialties in a safe and controlled environment. Such an educational approach not only facilitates deep and lasting learning but also significantly contributes to improving the quality of healthcare services by reducing the likelihood of medical errors and increasing professional preparedness (27, 28). Simulation-based interprofessional training also provides a safe environment in which learners can practice communication, leadership, and role-clarification skills without risking patient safety,

which may explain the improvements observed in teamwork performance in the present study.

The results of the current study are consistent with previous research. In this study, a statistically significant increase was observed from pretest to posttest scores, indicating a large effect size of the current course on students' learning. Additionally, Fenzi (2024) reported that interprofessional CPR training using self-directed learning in simulated environments provides an innovative and effective approach to improving traditional CPR training paradigms (9).

In this study, student satisfaction with the interprofessional CPR training program was assessed at Level 1 of Kirkpatrick's model across four domains: content, delivery methods, instructors, and learning environment. According to the findings, the highest satisfaction levels were in the domains of delivery methods, content, learning environment, and instructors, respectively. In the study by Gheyrandoust et al., an in-service training program (neonatal resuscitation) for nurses and midwives was evaluated using Kirkpatrick's model. According to their findings, the highest satisfaction levels were in the domains of content (diversity, novelty, or up-to-date nature of the materials), instructors (interaction with learners and their engagement), and organization (classroom facilities, such as lighting, sound, cooling, and heating) (29).

Based on the study results, at the reaction level, the mean scores obtained in all four domains—delivery methods, content, instructors, and learning environment—were above 70%, which is consistent with the results of Dehghani et al.'s study. Therefore, the results of this study suggest that most participants were highly satisfied with the CPR training program (30).

At the learning level of the current study, the comparison of the pretest and posttest results showed that participants' knowledge and skills improved after the CPR training program. These findings suggest that the SAFE-CPR program was effective not only at the reaction level but also at the learning and behavioral levels of the Kirkpatrick model, supporting the educational value of structured interprofessional simulation training. Additionally, the results of Deri et al.'s study indicated that in-service CPR training had a positive impact on all four levels of Kirkpatrick's model (31).

In summary, based on the findings of this research, it can be concluded that conducting interprofessional training programs has played an effective role in increasing student satisfaction. These programs, by creating an interactive and practical learning environment, have not only improved students' academic satisfaction but have also significantly enhanced their professional competencies by strengthening specialized and interdisciplinary skills. Furthermore, the results of this study clearly demonstrate that IPE, by integrating theoretical knowledge and practical experiences, fosters the development of competent and efficient graduates. Such an approach not only addresses students' educational needs but also prepares them for effective collaboration in future professional environments, given the multidimensional nature of real-world challenges. Therefore, the development and continuation of such programs should be considered as a key strategy in higher education.

This study has notable strengths, such as its focus on IPE, use of simulation, and multidimensional evaluation, and shows that such programs can increase student satisfaction and learning. However, the lack of long-term evaluation, selection of students from a single university, and limited generalizability are among the weaknesses that should be addressed in future studies. It is recommended that future research examine the impact of such training on actual performance in clinical settings and compare it with traditional methods. Another limitation is the absence of a control group, which limits the ability to attribute observed improvements solely to the intervention..

Conclusions

In conclusion, the implementation of the SAFE-CPR interprofessional training program, designed through Kern's six-step model, demonstrated a significant positive impact on the clinical competencies and collaborative performance of healthcare students. The quasi-experimental evaluation revealed substantial improvements across Kirkpatrick's levels—specifically in learner satisfaction, clinical skill acquisition, and interprofessional teamwork within simulated emergency department scenarios. By bringing together medical, nursing, and anesthesia students in a high-fidelity simulation environment, this program effectively addressed the critical need for coordinated action in high-pressure resuscitation settings. Given the significant gains in teamwork and communication scores measured using the TEAM, ICCAS, and T-TPQ tools, integrating such structured interprofessional curricula into medical education is highly recommended. Such initiatives

are essential for preparing future healthcare professionals to deliver safer, more efficient care in complex clinical environments, such as the emergency department, ultimately aiming to improve patient survival rates during cardiac arrest.

Ethics Approval and Consent to Participate

This study was conducted in accordance with the ethical principles of the Helsinki Declaration, and all participants signed informed consent forms before the study began. This research was approved by the National Center for Strategic Research in Medical Education with ethics approval code IR.NASME.REC.1402.008.

Consent for Publication

Not applicable.

Data Availability Statement

The datasets generated and analyzed during the current study are not publicly available due to participant confidentiality and institutional restrictions but are available from the corresponding author on reasonable request.

Funding Statement

This research was financially supported by the National Center for Strategic Research in Medical Education, Tehran, Iran, with code 4010172.

Acknowledgements

The authors express their gratitude to all professors and students who contributed to the advancement of this research in any way.

Authors' Contribution

S.H. contributed substantially to the conception and design of the study, development and implementation of the educational intervention, data collection, data interpretation, manuscript drafting, and final revision of the manuscript. Z.A. contributed to data collection, manuscript preparation, and revision of the manuscript. M.H.M. contributed to the study design, interpretation of the data, and critical revision of the manuscript. K.N. and M.A. contributed to study supervision, interpretation of findings, and critical review of the manuscript. All authors read and approved the final manuscript.

Conflict of Interest

The authors declared no conflicts of interest.

Declaration of Generative Artificial Intelligence (AI) in Scientific Writing

During the preparation of this work, the authors used generative artificial intelligence tools for limited English language editing. The authors take full responsibility for the content of the publication.

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