



Evaluating the Effectiveness of CPR Training Programs for Nursing Staff Using Kirkpatrick's Model: An Experimental Study in Al-Rusafa Sector Hospitals, Baghdad

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This study aimed to evaluate the effectiveness of Kirkpatrick's Four-Level Model in assessing the impact of a structured first aid and CPR training program on the performance of nursing staff in Al-Rusafa sector hospitals in Baghdad. An experimental design was adopted. A total of 120 nurses were recruited and divided into two groups: an experimental group (n = 60) and a control group (n = 60). The experimental group received a specialized first aid and CPR training program based on the American Heart Association guidelines (2020–2025), while the control group continued routine clinical practice without receiving the intervention. The training program was evaluated using Kirkpatrick's four levels: Reaction, Learning, Behavior, and Results. Data were analyzed to assess participants' satisfaction, knowledge acquisition, behavioral performance, and changes in selected clinical outcome indicators. The findings showed significant improvements across all four evaluation levels among nurses in the experimental group. The mean trainee satisfaction score reached 4.52 out of 5. Cognitive test scores increased by 68.3%, behavioral performance improved by 71.4%, and medical error rates decreased by 43.2%. These findings indicate that the training program contributed to improvements in nurses' knowledge, practical performance, and selected organizational outcomes. Kirkpatrick's Four-Level Model provides a structured and comprehensive framework for evaluating healthcare training programs. The findings support its use in assessing first aid and CPR training among nursing staff in Iraqi hospitals. The study recommends the adoption of systematic training evaluation models within healthcare institutions to enhance nursing performance, improve the quality of emergency response, and support patient safety.

Keywords: Kirkpatrick's Four-Level Model; CPR Training; Nursing Staff Performance; Training Program Evaluation.

1. Introduction

Cardiopulmonary resuscitation (CPR) is one of the most critical emergency interventions in contemporary healthcare because survival following cardiopulmonary arrest depends substantially on the rapid recognition of deterioration, immediate initiation of effective chest compressions, appropriate airway and ventilation management, early defibrillation when indicated, and coordinated implementation of advanced life support measures. In hospital environments, nurses occupy a particularly important position within the chain of survival because they maintain continuous contact with patients and are often among the first healthcare professionals to identify cardiac arrest or severe clinical deterioration. Their ability to respond promptly and correctly can therefore influence both the immediate quality of resuscitation and subsequent patient outcomes. Nevertheless, competence in CPR cannot be assumed solely on the basis of professional qualification or previous exposure to resuscitation courses. Evidence from hospital and primary healthcare settings indicates considerable variation in nurses' knowledge, attitudes, adherence to protocols, and practical proficiency in CPR. Assessments of staff nurses have revealed gaps in CPR-related knowledge and have highlighted the necessity of continuing professional education rather than reliance on knowledge acquired during basic nursing education (1). Similarly, evaluations of healthcare providers have demonstrated variability in knowledge, attitudes, and proficiency regarding CPR, suggesting that clinical exposure alone may not ensure consistent adherence to current resuscitation standards (2). More recent evidence concerning nurses' knowledge and self-reported adherence to advanced life support guidelines during in-hospital cardiac arrest further indicates that deficiencies may persist even among personnel expected to respond routinely to critical emergencies (3). These findings underscore the importance of systematic, recurrent, and evidence-based CPR education for nursing personnel.

The complexity of contemporary resuscitation also requires nurses to possess competencies extending beyond the memorization of algorithms. High-quality CPR demands integration of theoretical knowledge, psychomotor performance, rapid clinical judgment, situational awareness, effective communication, leadership, role allocation, and

teamwork under substantial time pressure. Nurses must be capable of recognizing cardiac arrest, activating institutional emergency systems, performing effective chest compressions, maintaining adequate ventilation, operating defibrillation equipment, assisting with advanced airway procedures, administering emergency interventions in accordance with protocols, and coordinating with other members of the resuscitation team. In intensive care and emergency settings, additional technologies may also become integral to CPR assessment and management. For example, capnography can provide clinically important information during resuscitation and requires healthcare professionals to understand how physiological monitoring can inform the evaluation of CPR quality and patient response (4). Furthermore, emergency response must be consistent with individual patients' treatment goals and limitations of medical therapy, making resuscitation practice not merely a technical process but also one requiring appropriate interpretation of clinical and institutional information (5). Consequently, effective CPR education should address technical execution, clinical reasoning, teamwork, and the translation of guidelines into contextually appropriate action.

Structured educational interventions have shown considerable potential for improving CPR knowledge and performance among nurses. Educational packages specifically designed for nurses working in intensive care units have been associated with significant improvements in both knowledge and practical performance, demonstrating that competency can be strengthened through targeted instruction and repeated skills practice (6). Reviews of cardiopulmonary-cerebral resuscitation education similarly emphasize the importance of continuing training for nurses, particularly because resuscitation knowledge and skills require periodic reinforcement to remain aligned with evolving evidence and clinical recommendations (7). However, the effectiveness of CPR education depends not only on the content of a training program but also on its instructional design. Contemporary CPR programs employ diverse methods, including lectures, practical workshops, instructor-led demonstrations, simulation, self-directed video learning, repeated competency assessment, scenario-based exercises, and blended approaches. Comparison of different CPR training methods suggests that no single

educational technique addresses all learning needs and that the combination of theoretical and experiential methods may be particularly beneficial in preparing healthcare providers for complex emergencies (8). Therefore, educational planning should move beyond knowledge transmission and create opportunities for participants to practice, receive feedback, correct errors, and apply resuscitation principles in realistic situations.

Simulation-based education has become especially prominent within resuscitation training because it allows nurses to practice high-risk, low-frequency events without exposing actual patients to avoidable risk. Simulation can reproduce many characteristics of clinical emergencies, including time pressure, incomplete information, rapidly changing physiological conditions, communication demands, and the need for coordinated team action. Evidence from governmental hospitals has demonstrated that simulation-based basic life support training can significantly improve nurses' knowledge, supporting its value as an educational strategy in resource-constrained clinical environments (9). Simulation has likewise been shown to strengthen nursing students' education and CPR competencies by facilitating active engagement and repeated application of resuscitation procedures (10). More broadly, multimodal simulation approaches have successfully been applied across intensive care settings to prepare healthcare professionals for complex clinical processes and rapidly changing care requirements (11). Adaptable simulation portfolios have also been developed to increase the efficiency, flexibility, and team-oriented nature of intensive care training, reinforcing the importance of tailoring simulation to clinical needs rather than viewing it as a standardized one-time educational event (12). These developments suggest that high-quality CPR education should incorporate realistic practice environments capable of bridging the gap between theoretical instruction and actual bedside performance.

A major advantage of simulation is its capacity to evaluate how nurses apply knowledge rather than merely whether they can recall it. Case-based simulation has been used to assess nursing performance in applying clinical prediction rules, demonstrating that educational assessment can capture decision-making processes and clinical application in addition to factual knowledge (13). This

distinction is highly relevant to resuscitation because a nurse may achieve a satisfactory score on a written CPR examination yet perform poorly when required to recognize deterioration, organize priorities, communicate with colleagues, and initiate treatment under pressure. Team-based CPR simulation also offers an opportunity to examine nontechnical skills such as leadership, role clarity, communication, and coordination, all of which can affect the effectiveness of a resuscitation attempt. Recent qualitative evidence focusing on the transition from team-based CPR simulation to actual clinical practice has further emphasized that the true educational value of simulation depends on whether participants can transfer what they have learned into real patient care (14). Thus, evaluation of CPR training should not end with immediate post-course testing, because successful learning does not automatically guarantee sustained workplace behavior.

The issue of knowledge and skill retention is another central challenge in resuscitation education. CPR competencies can deteriorate over time when they are not reinforced through repeated practice or clinical exposure, making periodic retraining and longitudinal assessment essential. Video self-instruction has been evaluated as one strategy for improving the retention of CPR knowledge and skills among nurses, with findings supporting the value of repeated and accessible educational exposure (15). Retention is particularly important in settings where cardiac arrest events may be relatively infrequent for individual staff members, because long intervals between actual resuscitation experiences can contribute to loss of confidence and procedural accuracy. Attitudes toward CPR situations may also influence how healthcare professionals behave during emergencies. Research among in-hospital healthcare personnel has shown that attitudes toward resuscitation are associated with a range of potentially influential factors, suggesting that confidence, prior experience, perceived preparedness, and professional role may affect willingness and readiness to intervene (16). Training programs should therefore seek not only to enhance factual knowledge and technical skills but also to support confidence, preparedness, and appropriate behavioral responses in real clinical emergencies.

The quality of resuscitation performance is also influenced by the broader institutional environment. Nurses

working in emergency and intensive care settings operate within complex systems characterized by workload pressures, varying staffing patterns, resource constraints, equipment availability, and differing levels of organizational support. During periods of system-wide strain, such as surges in patient volume or other operational disruptions, maintaining readiness for in-hospital cardiac arrest may become especially difficult. Refresher training focused on code response has been used to support staff preparedness during such periods, demonstrating the importance of reinforcing resuscitation skills under changing organizational conditions (17). Similarly, nurses' experiences with structured resuscitation quality improvement programs indicate that continuous practice, feedback, and institutional reinforcement can support more consistent CPR performance and increase confidence in emergency situations (18). Such findings reinforce the principle that training effectiveness should be assessed not only at the level of the individual learner but also in relation to clinical systems, workplace processes, and organizational outcomes.

The potential organizational impact of CPR training is particularly relevant because healthcare institutions invest considerable time and resources in professional development programs, yet the effectiveness of these programs is often evaluated using only attendance records, satisfaction surveys, or immediate post-training tests. These approaches provide useful information but offer only a partial picture of whether education produces meaningful change. For example, high participant satisfaction does not necessarily demonstrate improved competence, just as higher post-test knowledge scores do not prove that clinical behavior has changed. Likewise, improvements in individual skill performance may be insufficient if they do not contribute to measurable improvements in response times, adherence to protocols, reductions in medical errors, or successful resuscitation outcomes. Research evaluating structured training in critical care environments has shown that targeted CPR education can improve the quality of resuscitation among healthcare providers, supporting the possibility that appropriately designed programs can generate measurable performance benefits (19). For this reason, comprehensive training evaluation frameworks are

needed to determine whether gains at the learner level are translated into behavioral and organizational changes.

Kirkpatrick's Four-Level Model provides a systematic framework for addressing this need by evaluating training across four interconnected dimensions: reaction, learning, behavior, and results. At the first level, reaction focuses on participants' perceptions of the educational experience, including satisfaction, engagement, relevance, and perceived usefulness. At the second level, learning assesses the extent to which participants acquire intended knowledge, skills, attitudes, or competencies. The third level, behavior, examines whether these gains are transferred to actual workplace practice. The fourth level, results, considers the broader effects of training on organizational or service outcomes. Theoretical discussions of training evaluation have long emphasized the necessity of distinguishing between immediate educational responses and longer-term changes in performance and organizational outcomes (20). This distinction is especially important in clinical education because training is ultimately expected to affect patient care rather than remain confined to the classroom or skills laboratory.

The conceptual importance of evaluating consequences beyond immediate participant reaction is also consistent with earlier approaches to program and behavioral evaluation, which emphasized the need to examine broader outcomes rather than relying exclusively on short-term responses (21). Although such early work was not specific to CPR or nursing education, it contributed to the broader methodological understanding that complex interventions should be assessed across multiple dimensions and over time. The Kirkpatrick model operationalizes this principle in a practical way by linking educational experience to learning, workplace application, and institutional results. This multilevel structure has allowed the model to be applied in diverse educational contexts. For example, in-service training for elementary school teachers has been evaluated according to the Kirkpatrick framework to assess effectiveness beyond simple participation and satisfaction (22). The model has also been used to evaluate university curricula and educational programs by examining both learner responses and broader educational consequences (23). Likewise, an English-medium instruction training project in medical education was evaluated using the

Kirkpatrick model, demonstrating its applicability to professional development programs in higher education and health-related settings (24). These applications support the flexibility of the model and its potential utility in evaluating complex nursing education interventions.

Applying the Kirkpatrick framework to CPR education may be particularly valuable because resuscitation competence develops across precisely the kinds of domains represented by its four levels. Nurses may first respond positively or negatively to the training experience, which can influence engagement and motivation. They must then acquire measurable knowledge and procedural skills. Those competencies must subsequently be transferred into real clinical behavior during emergency situations, and ultimately the organization should experience improvements in selected clinical or operational indicators if the training is truly effective. Such a progression is especially relevant to simulation-based and practical CPR programs, where the relationship between classroom learning and real-world performance is a central concern. Research on simulation, refresher education, and intensive care training demonstrates that improvements in learning do not necessarily occur uniformly across participants or persist indefinitely, reinforcing the need to evaluate multiple outcomes and follow participants over time (11, 14, 17). A structured model can therefore help educators distinguish between a training program that is merely well received and one that produces sustained improvements in professional practice.

This issue is particularly important in healthcare systems where professional development opportunities may be inconsistent and where formal mechanisms for evaluating educational effectiveness are not routinely embedded within hospital governance. In such contexts, CPR courses may be delivered without determining whether participants retain knowledge, change their practice, or influence institutional outcomes. The problem is compounded by the fact that nurses in emergency and intensive care departments must operate in high-pressure environments where delays, procedural errors, or failures in team coordination may have immediate consequences for patient safety. International evidence showing variation in nurses' CPR knowledge and adherence to advanced life support guidelines suggests that these concerns are not limited to a single country or health system (1-3). At the same time, studies demonstrating

improvements following structured educational interventions suggest that these deficiencies are potentially modifiable through well-designed training programs (6, 9, 19). The challenge is therefore not simply whether CPR education should be provided, but how its real effectiveness should be demonstrated.

The need for rigorous evaluation is especially relevant to nursing staff working in hospitals in Baghdad, where emergency and intensive care services require rapid and consistent clinical responses. In the Al-Rusafa sector, nurses working in major public hospitals are expected to manage acute deterioration, participate in resuscitation teams, and apply standardized emergency procedures across a range of critical situations. A structured first aid and CPR program that combines theoretical instruction, practical workshops, simulation, case-based learning, and crisis-management exercises may offer a comprehensive approach to competency development. However, without a systematic evaluation framework, it remains difficult to determine whether such a program improves only immediate knowledge or produces broader effects on clinical behavior and organizational indicators. Kirkpatrick's Four-Level Model offers a practical means of addressing this gap by integrating participant satisfaction, learning outcomes, workplace performance, and institutional results within a single evaluative framework. This is particularly relevant in light of evidence that different CPR training methods produce different educational effects and that retention, transfer, and organizational context all influence long-term training effectiveness (8, 15, 18). By examining all four levels simultaneously, a more comprehensive understanding can be obtained of whether training produces meaningful and sustained improvements.

In addition, the application of Kirkpatrick's model can provide decision-makers with evidence that is directly relevant to hospital education policy, nursing management, and quality improvement. Reaction data can help determine whether the program is perceived as relevant and appropriately designed. Learning data can identify gains in knowledge and practical performance. Behavioral assessment can demonstrate whether competencies are applied in clinical settings, while results-level indicators can show whether training contributes to broader outcomes such as reduced medical errors, improved emergency response

times, or higher rates of successful resuscitation. Such information can guide decisions regarding the frequency of retraining, allocation of educational resources, incorporation of simulation into continuing professional development, and the use of objective performance monitoring. The model is therefore not only an academic framework for evaluating education but also a potentially useful managerial tool for linking training investment to patient safety and institutional performance. Given the importance of high-quality CPR, the documented variability in nursing competence, and the growing evidence supporting multimodal and simulation-based approaches, there is a clear need for studies that evaluate training comprehensively rather than relying on a single educational endpoint (10, 12, 13).

Accordingly, the present study aimed to evaluate the effectiveness of a structured first aid and CPR training program for nursing staff in Al-Rusafa sector hospitals in Baghdad using Kirkpatrick's Four-Level Model by assessing participants' reactions, learning outcomes, behavioral performance, and selected organizational results.

2. Methods and Materials

2.1. Study Design and Participants

Study Design and Participants

This study employed an experimental pretest–posttest control-group design with longitudinal follow-up to evaluate the effectiveness of a structured cardiopulmonary resuscitation (CPR) training program for nursing staff according to the four-level Kirkpatrick evaluation model. The experimental design was selected because it permits systematic assessment of changes attributable to the educational intervention while allowing comparisons between nurses who received the training and those who continued their routine professional activities without exposure to the intervention during the study period. The study was conducted in three major public hospitals located in the Al-Rusafa sector of Baghdad, Iraq, namely Imam Ali Hospital, Al-Kindi Hospital, and Al-Sader Hospital. The target population consisted of 460 nurses employed in emergency departments and intensive care units across the three participating hospitals. These clinical settings were selected because nurses working in emergency and critical care environments are frequently required to recognize

cardiopulmonary arrest promptly, initiate basic and advanced resuscitation procedures, coordinate emergency responses, and perform CPR in accordance with standardized clinical guidelines. Nurses were considered eligible for participation if they held at least a bachelor's degree in nursing, had a minimum of two years of clinical nursing experience, were actively employed in an emergency department or intensive care unit in one of the participating hospitals, and were available to participate in the training and follow-up assessments. Nurses who did not meet these requirements or were unavailable during the intervention and evaluation periods were excluded. A total of 120 eligible nurses were recruited from the target population and included in the study. Following verification of the eligibility criteria and completion of the baseline assessment, participants were randomly allocated in equal proportions to an experimental group consisting of 60 nurses and a control group consisting of 60 nurses. Participants in both groups were recruited from all three hospitals to minimize the potential influence of institutional characteristics on study outcomes. Random assignment was used to reduce selection bias and enhance comparability between the study groups. Before implementation of the intervention, the baseline equivalence of the experimental and control groups was examined using relevant demographic and professional characteristics, including age, sex, educational qualification, years of clinical experience, hospital affiliation, and clinical department. The experimental group subsequently received the specialized CPR training program, whereas the control group continued routine clinical practice without receiving the intervention during the study period. Measurements were conducted at baseline and after completion of the intervention, with behavioral outcomes additionally monitored during a three-month follow-up period to determine whether improvements acquired through training were transferred to actual clinical practice.

2.2. Data Collection Tools

Data collection was structured according to Kirkpatrick's four-level training evaluation model, incorporating reaction, learning, behavior, and organizational results as distinct but complementary dimensions of training effectiveness. At the reaction level, participants' immediate perceptions of the

training program were assessed using a 25-item satisfaction questionnaire administered to nurses in the experimental group immediately after completion of the intervention. The questionnaire evaluated participants' satisfaction with the relevance of the training content, quality of instruction, clarity of educational materials, suitability of simulation activities, organization of training sessions, perceived usefulness of the program, and confidence in applying the acquired competencies in clinical settings. Responses were aggregated to obtain an overall measure of participants' reactions to the training program. The internal consistency of this instrument was high, with a Cronbach's alpha coefficient of 0.92, indicating satisfactory reliability. At the learning level, changes in CPR-related knowledge and practical competence were measured using a two-component assessment. The theoretical component consisted of a 40-item examination designed to evaluate knowledge concerning cardiopulmonary arrest recognition, CPR algorithms, airway management, chest compression techniques, defibrillation, emergency medications, team coordination, and advanced resuscitation principles. The practical component consisted of a structured performance checklist with a maximum score of 60 points, through which participants' ability to perform essential CPR procedures was evaluated during standardized practical scenarios. The content validity of the learning assessment was evaluated through expert review, resulting in a content validity ratio of 0.88, indicating adequate representation of the intended CPR competencies. Learning outcomes were assessed in both the experimental and control groups at the pre-intervention and post-intervention stages to determine changes over time and differences attributable to the training program. At the behavior level, a 30-item systematic observation checklist was used to evaluate the extent to which nurses transferred the knowledge and skills acquired during training to their actual clinical practice. Trained clinical supervisors used the checklist during the three-month follow-up period to assess behaviors such as rapid recognition of cardiopulmonary emergencies, correct initiation of CPR, compliance with resuscitation algorithms, effective communication, teamwork, appropriate use of emergency equipment, accuracy of clinical decision-making, and adherence to established CPR protocols. Inter-rater reliability for this instrument was 0.87, indicating a high level of agreement

among observers. At the results level, organizational and clinical outcomes were assessed using quantitative indicators extracted from hospital records. These indicators included medical error rates related to emergency response and resuscitation procedures, response time to cardiopulmonary emergencies, and the percentage of successful resuscitation attempts. Relevant institutional indicators were collected for periods before and after implementation of the training program to determine whether the intervention was associated with measurable improvements beyond individual knowledge and performance. Using multiple instruments across the four levels of Kirkpatrick's model allowed the study to evaluate not only whether nurses were satisfied with the program and acquired CPR knowledge and skills, but also whether these competencies were transferred to clinical practice and translated into meaningful institutional and patient-care outcomes.

2.3. Interventions

The intervention consisted of an intensive Advanced First Aid and CPR training program developed in accordance with the principles and recommendations contained in the 2020–2025 American Heart Association standards for cardiopulmonary resuscitation and emergency cardiovascular care. The program was designed to strengthen nurses' theoretical understanding, psychomotor skills, clinical judgment, teamwork, and ability to respond effectively to cardiopulmonary emergencies in emergency and intensive care environments. The intervention was delivered to the 60 nurses assigned to the experimental group across the three participating hospitals over a two-week period, comprising approximately 80 hours of structured educational activities. The instructional design combined several complementary learning methods to facilitate knowledge acquisition and practical competency development. Approximately 15% of the program was devoted to theoretical instruction covering the pathophysiology of cardiopulmonary arrest, early recognition of clinical deterioration, principles of basic and advanced life support, airway management, appropriate chest compression techniques, ventilation, defibrillation, emergency pharmacological interventions, post-resuscitation care, and current evidence-based CPR

algorithms. Approximately 40% of the program consisted of practical workshops in which participants repeatedly practiced key procedural skills under instructor supervision, including assessment of responsiveness, pulse and breathing evaluation, high-quality chest compressions, bag-mask ventilation, airway maintenance, use of automated and manual defibrillation equipment, and coordinated performance within a resuscitation team. A further substantial component of the program, approximately 25%, consisted of realistic simulation-based training in which nurses participated in standardized emergency scenarios designed to reproduce common and complex cardiopulmonary emergencies encountered in clinical practice. Simulation scenarios required participants to identify cardiac arrest, initiate resuscitation promptly, assign team roles, communicate effectively, perform CPR according to recommended sequences, respond to changes in patient condition, and make appropriate clinical decisions under time pressure. Case-based discussions, crisis-management exercises, scenario debriefings, and guided analysis of clinical errors were incorporated into the remaining training activities to strengthen clinical reasoning and reinforce the translation of theoretical knowledge into practice. Participants received corrective feedback throughout the practical and simulation sessions, allowing deficiencies in technique or decision-making to be identified and addressed immediately. The intervention emphasized consistency with current resuscitation standards, rapid response, high-quality CPR, interdisciplinary communication, leadership during emergencies, and prevention of avoidable errors. Nurses allocated to the control group did not participate in the specialized training program during the study period and continued their routine duties and existing institutional educational activities. Data collection followed the four levels of Kirkpatrick's model. Reaction to the program was assessed immediately after completion of the training among experimental-group participants. Theoretical knowledge and practical skills were assessed before and after the intervention in both groups. Behavioral performance was subsequently monitored by trained supervisors during the three-month follow-up period, while organizational outcome indicators were obtained from hospital records for the relevant periods before and after implementation of the training intervention.

2.4. Data Analysis

The collected data were entered, coded, and analyzed using IBM SPSS Statistics version 26. Descriptive statistics were initially used to summarize participants' demographic and professional characteristics and the distribution of the principal study variables. Continuous variables were described using means and standard deviations, while categorical variables were summarized using frequencies and percentages. Before conducting inferential analyses, the distributional characteristics of continuous outcome variables were examined to determine the appropriateness of parametric statistical procedures. Baseline comparability between the experimental and control groups was assessed to ensure that random allocation had produced groups with broadly similar demographic and professional characteristics before implementation of the training program. Chi-square tests were used to compare categorical baseline characteristics between the two groups, while appropriate parametric comparisons were applied to continuous baseline variables. For the evaluation of learning outcomes, paired-samples t-tests were used to examine changes in theoretical knowledge and practical performance scores from pretest to posttest within each study group, whereas independent-samples t-tests were used to compare experimental and control group scores at relevant measurement points. Between-group differences in continuous outcome measures were further examined using analysis of variance where appropriate. Reaction-level data obtained from the experimental group were analyzed descriptively to determine the overall degree of participant satisfaction with the CPR training program and its principal educational components. Behavioral outcomes obtained through the systematic observation checklist during the three-month follow-up period were analyzed to determine whether the experimental group demonstrated sustained improvements in the application of CPR-related competencies in actual clinical environments. Result-level indicators, including medical error rates, emergency response times, and resuscitation success percentages, were compared across the relevant pre-intervention and post-intervention periods to assess whether improvements at the individual level were accompanied by changes in organizational and clinical performance. Where categorical outcome data were compared between groups or

measurement periods, chi-square procedures were applied as appropriate. All statistical tests were conducted using two-tailed significance testing, and the level of statistical significance was established at $\alpha = 0.05$. This analytical strategy permitted evaluation of the intervention across the multiple dimensions of Kirkpatrick's model, encompassing participants' reactions, acquisition of knowledge and practical skills, transfer of acquired competencies to routine clinical behavior, and changes in measurable institutional outcomes.

3. Findings and Results

A total of 120 nurses from the three participating hospitals met the eligibility criteria and were enrolled in the

study. Participants were randomly allocated into the experimental group ($n = 60$) and the control group ($n = 60$). All enrolled participants completed the assigned study procedures, including the pre-test and post-test assessments and the three-month behavioral follow-up, and all were included in the final analysis.

Table (1) delineates the demographic characteristics of participants in both the experimental and control groups. The results of the Chi-square test indicated no statistically significant differences between the two groups across demographic variables (gender, age, educational qualification, and years of experience). These findings confirm the demographic equivalence and homogeneity of the groups prior to the training intervention.

Table 1

Demographic distribution

Variables	Categories	Experimental groups (n=60)	Control groups (n=60)	Qi-Square	Significance
Gender	Male	24 (40%)	26 (43.3%)	0.135	0.713
	Female	36 (60%)	34 (56.7%)		
Age	25-30 Years	18 (30%)	20 (33.3%)	0.421	0.810
	31-35 Years	25 (41.7%)	23 (38.3%)		
	36-40 Years	17 (28.3%)	17 (28.3%)		
Educational qualification	BSc.	48 (80%)	47 (78.3%)	0.048	0.827
	MSc	12 (20%)	13 (21.7%)		
years of experience	2-5 Years	22 (36.7%)	24 (40%)	0.312	0.856

Table (2) presents the findings from the reaction survey administered to the experimental group immediately following the training program. The results indicate a

notably high level of satisfaction across all dimensions, with an overall mean of 4.52 out of 5.0. This statistically supports the first sub-hypothesis ($H_{1.1}$).

Table 2

Reaction Survey of (Level 1)

Dimension	Mean	Standard Deviation	Rank
Quality of Training Content	4.58	0.42	1
Instructor Effectiveness	4.65	0.38	2
Instructional Methodologies	4.47	0.51	4
Training Environment & Facilities	4.32	0.58	5
Overall Satisfaction & Expected Application	4.56	0.44	3
General Average	4.52	0.39	-

Results showed that 95% of trainees felt the program met or exceeded their expectations, while 92% confirmed they would recommend it to colleagues. Furthermore, 88% of participants expressed high confidence in their ability to implement the acquired skills within their clinical settings.

Table (3) indicates the pre-test and post-test results for both the experimental and control groups. The data show a significant and statistically superior improvement in the experimental group's performance.

Table 3
Knowledge and Skills Assessment Results (Level 2)

Group	Test	Mean (Out of 100)	S.D.	t-value	p-value	Effect Size (Cohen's d)
Experimental	Pre-test	52.3	8.7	28.45	0.002	3.68
	Post-test	88.0	6.2			
Control	Pre-test	51.8	9.1	1.82	0.073	0.24
	Post-test	54.2	8.9			

The improvement rate for the experimental group reached 68.3%, compared to a negligible 4.6% in the control group. The calculated effect size (Cohen's $d = 3.68$) indicates a highly substantial practical significance, thereby validating the second sub-hypothesis ($H_{1.2}$). Segmented analysis showed that the experimental group improved more significantly in practical application (75.2%) than in

theoretical knowledge (58.4%), reflecting the efficacy of the simulation-based training.

Table (4) summarizes the results of the professional behavior observations conducted three months post-intervention. The experimental group demonstrated a tangible enhancement in behavioral performance compared to their counterparts.

Table 4
Professional Behavior Observation Results (Level 3)

Dimension	Experimental Group (Mean/3)	Control Group (Mean/3)	t-value	p-value	Effect Size
Rapid Case Assessment	2.68	1.52	15.32	0.000	2.80
Application of CPR Techniques	2.71	1.48	16.87	0.000	3.08
Teamwork and Communication	2.54	1.63	11.24	0.000	2.05
Protocol Adherence & Safety	2.76	1.71	13.45	0.000	2.46
General Average	2.67	1.56	18.92	0.000	2.74

Behavioral performance improved by 71.4% in the experimental group relative to the control group. Notably, 85% of the experimental group achieved "excellent" or "acceptable" ratings across all dimensions, confirming sub-hypothesis ($H_{1.3}$). The most significant improvement was observed in "CPR Technique Application" (Effect Size =

3.08), highlighting the program's success in refining core technical competencies.

Table (5) presents organizational indicators before and after the training. The experimental group showed substantial improvements across all metrics, confirming the program's positive impact on final institutional results.

Table 5
Institutional Outcome Results (Level 4)

Indicators	Groups	Pre-Training	Post-Training	% Improvement	T-value	p-value
Medical Error Rate (per 100 cases)	Exp. Group	8.7	4.9	-43.7%	12.34	0.000
	Control group	8.5	8.2	-3.5%	0.87	0.388
Avg. Response Time (Min)	Exp. Group	4.8	3.2	-33.3%	10.56	0.000
	Control group	4.7	4.6	-2.1%	0.52	0.605
Resuscitation Success Rate (%)	Exp. Group	42.3	68.7	+62.4%	14.87	0.000
	Control group	41.8	43.2	+3.3%	0.94	0.351
Complication Rate (%)	Exp. Group	12.4	6.8	-45.2%	11.23	0.000
	Control group	12.1	11.7	-3.3%	0.76	0.450

In the experimental group, medical errors decreased by 43.7%, response times improved by 33.3%, and resuscitation

success rates surged by 62.4%. All improvements were highly significant ($p < 0.001$), supporting sub-hypothesis

(H1.4). The lack of significant change in the control group underscores that these outcomes are directly attributable to the training intervention.

4. Discussion and Conclusion

The present study evaluated the effectiveness of a structured first aid and cardiopulmonary resuscitation training program for nursing staff in Al-Rusafa sector hospitals in Baghdad using Kirkpatrick's Four-Level Model. The findings demonstrated improvement across all four levels of the model, indicating that the intervention was positively received by participants, enhanced learning outcomes, improved observable clinical behavior, and was associated with favorable changes in selected organizational indicators. Specifically, the mean trainee satisfaction score reached 4.52 out of 5, cognitive test scores increased by 68.3%, behavioral performance improved by 71.4%, and medical error rates decreased by 43.2%. Taken together, these findings suggest that the intervention was not limited to producing short-term gains in theoretical knowledge but was also associated with transfer of learning into clinical performance and measurable changes in the healthcare environment. This pattern is consistent with the fundamental logic of Kirkpatrick's model, which conceptualizes training effectiveness as a progression from participant reaction to learning, behavioral application, and broader results. Previous applications of the model in educational and professional training contexts have similarly shown that evaluating multiple levels provides a more comprehensive understanding of program effectiveness than relying solely on participant satisfaction or post-training test performance (22-24).

The high satisfaction score observed at the reaction level indicates that nurses generally perceived the training program as relevant, useful, and appropriately structured. A mean score of 4.52 out of 5 suggests that the intervention was well accepted by participants and that its combination of theoretical instruction, practical workshops, simulation activities, case-based exercises, and crisis-management scenarios corresponded closely with their perceived professional needs. Positive reaction is an important component of training because participants who regard an educational program as relevant and clinically meaningful may be more engaged in the learning process and more

willing to transfer acquired competencies into practice. However, reaction alone cannot be regarded as proof of effectiveness, which makes the concurrent improvements observed at the other levels particularly important. The favorable participant response in the present study is consistent with literature emphasizing the value of clinically contextualized and practice-oriented resuscitation training. Nurses participating in structured resuscitation quality improvement initiatives have reported positive experiences with repeated practice and competency-focused education, particularly when training closely reflects actual clinical responsibilities (18). Similarly, qualitative investigations of resuscitation training have emphasized that learners value educational environments that provide opportunities for realistic practice, feedback, and direct relevance to emergency situations (25). The high level of satisfaction in the present study may therefore reflect the practical orientation of the intervention and its alignment with the real resuscitation responsibilities of emergency and intensive care nurses.

At the learning level, the 68.3% increase in cognitive test scores represents a substantial improvement in CPR-related knowledge following the intervention. This finding indicates that the structured program was effective in strengthening participants' understanding of resuscitation principles, clinical algorithms, emergency decision-making, airway management, chest compression procedures, defibrillation, and related aspects of advanced first aid and CPR. Similar improvements following structured educational interventions have been reported in previous research. Kuchaki et al. found that a CPR educational package significantly improved both knowledge and performance among nurses working in intensive care units, demonstrating the effectiveness of systematic instruction for clinical staff who are frequently exposed to critically ill patients (6). Likewise, simulation-based basic life support education has been shown to improve nurses' knowledge in governmental hospitals, supporting the educational value of combining theoretical content with practical and scenario-based learning (9). Research among nursing students has also demonstrated that simulation can improve CPR education and competency by encouraging active participation, repetition, and immediate application of knowledge (10). The magnitude of improvement observed in the present

study may therefore be explained by the multimodal structure of the intervention, in which theoretical instruction was reinforced through practical workshops and simulations rather than delivered as passive classroom teaching alone.

The improvement in cognitive performance also aligns with evidence indicating that the method of CPR instruction can strongly influence the effectiveness of learning. CPR training has increasingly shifted away from purely lecture-based models toward approaches that integrate simulation, self-directed learning, repeated skills practice, and feedback. Narrative evidence comparing different CPR training approaches suggests that multimodal and interactive methods may be more effective than traditional instruction for developing durable knowledge and competence (8). Video self-instruction has also been shown to improve retention of CPR knowledge and skills among nurses, particularly when learners are able to revisit standardized material and reinforce procedural sequences over time (15). In addition, reviews of cardiopulmonary-cerebral resuscitation training for nurses have emphasized the importance of periodic and updated training because both theoretical knowledge and psychomotor skills may deteriorate in the absence of reinforcement (7). The significant increase in cognitive scores in the present study is therefore consistent with a broader body of literature indicating that structured and recurrent education can address deficiencies in CPR knowledge and promote more reliable adherence to current clinical guidelines.

The most substantial improvement observed in the study was at the behavioral level, where performance increased by 71.4%. This result is particularly important because behavioral transfer represents a more demanding outcome than immediate post-training learning. Improvement in test performance demonstrates that participants acquired knowledge, whereas behavioral improvement indicates that they were able to apply that knowledge within clinical practice. The observed behavioral gains suggest that the intervention influenced how nurses responded to real or realistically simulated emergencies, including recognition of cardiopulmonary arrest, initiation of CPR, adherence to procedural algorithms, communication, teamwork, and use of emergency equipment. This finding strongly supports the value of incorporating realistic simulation and supervised practical training into CPR education. Team-based

simulation is increasingly recognized as an effective strategy for facilitating transfer from the educational setting to clinical practice because it exposes learners to the interpersonal and organizational demands of resuscitation, not merely its technical components (14). Similarly, adaptable simulation programs in intensive care settings have been developed specifically to improve team functioning and the practical application of emergency procedures under changing conditions (12). The behavioral improvement found in the present study therefore suggests that the intervention was successful in narrowing the commonly observed gap between knowing what to do and actually performing correctly in practice.

The improvement in behavioral performance is also consistent with research demonstrating the value of simulation and case-based assessment for evaluating actual clinical application. Nursing performance in complex clinical situations has been shown to benefit from case-based simulation, particularly when participants must apply rules, prioritize information, and make decisions under conditions resembling actual practice (13). In resuscitation contexts, simulation provides opportunities to practice nontechnical skills such as leadership, situational awareness, role delegation, closed-loop communication, and team coordination, all of which can influence CPR quality. Aser et al. reported improvements in the quality of CPR among healthcare providers in critical care units following a structured training program, supporting the view that educational interventions can translate into higher-quality clinical performance (19). Similarly, code refresher training has been used to strengthen preparedness for in-hospital cardiac arrest during periods of healthcare system strain, highlighting the importance of repeated and context-sensitive training for maintaining readiness (17). The present study extends these findings by demonstrating that a comprehensive training program can produce marked behavioral improvement when assessed over a three-month follow-up period rather than only immediately after course completion.

The result-level findings provide further evidence of the practical value of the intervention. The 43.2% reduction in medical error rates following training indicates that improvements at the reaction, learning, and behavior levels may have translated into safer and more standardized clinical

practice. This is important because the ultimate purpose of CPR education is not merely to increase test scores but to improve emergency care and reduce preventable harm. In complex resuscitation environments, errors may arise from delayed recognition, incorrect sequencing of actions, poor communication, failure to follow established algorithms, inappropriate equipment use, or inadequate coordination among team members. Structured education may reduce these errors by reinforcing protocols and providing repeated opportunities to identify and correct mistakes before they occur in real clinical situations. Experiences with resuscitation quality improvement programs have similarly suggested that repeated competency assessment and feedback can strengthen performance and reduce deviations from recommended practice (18). Furthermore, the use of technologies such as capnography during resuscitation illustrates how modern CPR increasingly depends on clinicians' ability to correctly integrate monitoring information into decision-making, reinforcing the need for advanced and practice-oriented training (4). Thus, the reduction in errors observed in the present study may reflect improved procedural accuracy, greater adherence to protocols, and more effective coordination during emergency response.

The organizational findings are also consistent with the broader concept that improvements in individual performance can contribute to institutional outcomes. Kirkpatrick's fourth level is often the most difficult to assess because organizational results are influenced by many factors beyond training, including staffing, equipment availability, clinical workload, leadership, and hospital systems. Nevertheless, the observed reduction in medical errors, together with improvements in response-related indicators and resuscitation performance, suggests that the intervention may have had effects beyond individual competence. This interpretation is compatible with the logic of multilevel training evaluation, in which changes in learning and behavior are expected to contribute progressively to measurable organizational outcomes (20). Applications of the Kirkpatrick framework in other educational settings have likewise emphasized that the most meaningful evaluation occurs when training is linked to observable changes in practice and performance rather than being judged only through participant opinion (22, 24). The

present findings therefore support the use of Kirkpatrick's framework in healthcare environments where administrators require evidence that investment in staff education is associated with improvements in service quality and patient safety.

Another important aspect of the findings concerns the relationship between knowledge, confidence, and adherence to CPR guidelines. Previous studies have demonstrated that nurses and other healthcare providers may possess uneven levels of CPR knowledge and may not consistently follow advanced life support protocols during actual emergencies (2, 3). Knowledge gaps among staff nurses have also been reported in hospital settings, further emphasizing the need for continuing CPR education (1). The present study suggests that intensive, structured training can address at least some of these deficiencies by simultaneously improving theoretical knowledge and observable performance. Attitudes and perceived preparedness may also play an important role. Healthcare professionals' attitudes toward CPR situations have been associated with several experiential and contextual factors, suggesting that confidence, prior exposure, and perceived readiness may influence willingness and effectiveness during resuscitation events (16). Although the present study did not focus exclusively on attitudes, the high satisfaction score and strong behavioral improvement may indicate increased engagement and readiness among trained nurses. This possibility is particularly relevant in emergency and intensive care settings, where hesitation or uncertainty can contribute to delayed intervention.

The findings also support the use of multimodal educational design rather than reliance on a single teaching method. The intervention combined theoretical instruction, practical workshops, simulation, case analysis, and crisis-management exercises, allowing participants to engage with CPR content through multiple learning pathways. This approach is consistent with evidence that diverse educational methods can strengthen different dimensions of CPR competence (8). Multimodal training has also been used successfully across intensive care units to prepare staff for complex and rapidly evolving clinical processes (11). Similarly, the effectiveness of video self-instruction for CPR retention suggests that reinforcement through multiple formats can help maintain knowledge and procedural skills

beyond the initial learning period (15). These findings imply that the strong learning and behavioral improvements observed in the present study may be attributable not simply to the duration of training but to the integration of different instructional strategies, each targeting a distinct component of competence.

Overall, the study provides evidence that Kirkpatrick's Four-Level Model is an appropriate framework for evaluating CPR training among nursing staff because it captures a sequence of outcomes that are highly relevant to clinical education. The high reaction score demonstrated participant acceptance, the substantial increase in cognitive scores indicated effective learning, the improvement in behavioral performance demonstrated transfer of learning to practice, and the reduction in medical errors provided evidence of broader organizational benefit. Previous applications of Kirkpatrick's model in educational programs have supported its usefulness for assessing multidimensional outcomes (22-24). Although one of the older references included in the conceptual literature addresses outcomes in a substantially different research context, it nevertheless reflects the broader historical concern with evaluating consequences beyond immediate responses and recognizing that interventions may have effects at multiple levels (21). In the clinical setting examined here, the convergence of improvements across the four Kirkpatrick levels strengthens the interpretation that the training program was effective and that comprehensive evaluation provides more meaningful evidence than isolated post-test measures.

The study has several limitations that should be considered when interpreting the findings. First, the research was conducted in only three public hospitals in the Al-Rusafa sector of Baghdad, which may limit the generalizability of the results to other hospitals, healthcare sectors, or regions of Iraq with different organizational resources and staffing structures. Second, although the sample size was sufficient for the planned analyses, a larger multicenter sample would provide stronger evidence regarding the stability of the observed effects. Third, behavioral performance was monitored for three months, which may not be long enough to determine the long-term retention of CPR competence. Fourth, organizational outcomes such as medical error rates and resuscitation success may be influenced by factors other than training,

including staffing ratios, equipment availability, workload, patient severity, and institutional emergency systems. Finally, blinding of participants to group assignment was not feasible because of the nature of the educational intervention.

Future research should replicate the study across a larger number of hospitals and include healthcare institutions from different Iraqi governorates to improve external validity. Longer follow-up periods, such as six or twelve months, should be used to examine whether improvements in knowledge and behavioral performance are retained over time. Future studies may also compare different educational strategies, including high-fidelity simulation, video-assisted self-learning, spaced refresher training, blended learning, and conventional instructor-led programs. Additional research should incorporate more patient-centered outcomes, including return of spontaneous circulation, survival to hospital discharge, neurological outcomes, and time to first effective compression or defibrillation. Qualitative interviews with nurses and supervisors could also help explain the organizational, psychological, and environmental factors that facilitate or hinder the transfer of CPR training into routine clinical practice.

In practice, healthcare institutions should establish structured and recurring CPR training programs rather than relying on isolated or irregular educational sessions. Training should combine theoretical instruction with supervised skills practice, realistic simulation, team-based scenarios, and structured debriefing. Hospitals should also implement periodic competency reassessment to identify skill deterioration and provide targeted refresher training. Nursing managers should integrate CPR performance indicators into continuing professional development and quality-improvement systems, while ensuring that emergency equipment, staffing, and institutional protocols support the application of acquired skills. The Kirkpatrick model can be incorporated into hospital training policy as a practical framework for evaluating participant satisfaction, knowledge and skills, behavioral transfer, and organizational results, thereby enabling administrators to determine whether educational investments produce meaningful improvements in clinical performance and patient safety.

Authors' Contributions

All authors contributed substantially to the study and to manuscript development, and all approved the final version.

Declaration

The authors declare that artificial intelligence tools were used only to assist with language editing, translation, and improvement of the manuscript's readability. All conceptualization, study design, data collection, data analysis, interpretation of findings, and final approval of the manuscript were performed by the authors. The authors take full responsibility for the accuracy, integrity, and originality of the content.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

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Ethics Considerations

The study placed a high emphasis on ethical considerations. Informed consent obtained from all participants, ensuring they are fully aware of the nature of the study and their role in it. Confidentiality strictly maintained, with data anonymized to protect individual privacy. The study adhered to the ethical guidelines for research with human subjects as outlined in the Declaration of Helsinki.

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