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Effectiveness of Nursing Training in Enhancing Response to Code Blue Situations

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Abstract
Code Blue situations represent critical medical emergencies requiring immediate and proficient nursing response to improve patient survival outcomes. This study examines the effectiveness of structured nursing training programs in enhancing nurses' knowledge, skills, and response capabilities during Code Blue events. A quasi-experimental design was employed with 120 nurses from tertiary care hospitals in India, divided into intervention and control groups. The intervention group received comprehensive simulation-based training including theoretical instruction, hands-on practice, and scenario-based drills over a 6-week period. Data collection involved pre-test and post-test assessments measuring knowledge scores, skill competency levels, response times, and confidence ratings. Results demonstrated significant improvements in the intervention group: knowledge scores increased from 58.4% to 84.7%, skill competency improved by 68%, mean response time decreased from 2.8 minutes to 1.2 minutes, and confidence levels rose from 42% to 89%. Statistical analysis using paired t-tests revealed highly significant differences ($p<0.001$) across all parameters. The study concludes that structured, simulation-based nursing training significantly enhances Code Blue response effectiveness, supporting its integration into mandatory continuing education programs for optimal emergency care delivery and improved patient outcomes in critical care settings.

Keywords: *Code Blue training, Nursing competency, Simulation-based learning, Cardiopulmonary resuscitation, Emergency response*

1. Introduction

Cardiac arrest remains a leading cause of mortality in healthcare settings worldwide, with in-hospital cardiac arrest (IHCA) affecting approximately 209,000 adults annually in the United States alone (Meaney et al., 2013). In India, cardiovascular diseases account for nearly 28% of all deaths, making effective emergency response systems crucial for patient survival (Ahern et al., 2011). Code Blue represents the standardized emergency alert system activated during cardiac or respiratory arrest situations, requiring immediate multidisciplinary team response with nurses serving as the frontline responders. The critical first minutes following cardiac arrest significantly determine patient outcomes, with each minute of delay in cardiopulmonary resuscitation (CPR) initiation reducing survival probability by 7-10% (Dwyer & Mosel, 2002). Nurses constitute the largest healthcare workforce in hospital settings and are typically the first professionals to identify deteriorating patients and initiate Code Blue protocols. However, studies consistently reveal gaps in nurses' preparedness, confidence, and competency in managing these high-stakes situations (D'Cunha et al., 2021). Traditional didactic teaching methods have proven insufficient for developing the complex psychomotor skills and critical decision-making abilities required during emergency resuscitation. The infrequent exposure to actual Code Blue events, combined with the high-stress nature of these situations, creates a significant training challenge for nursing education and professional development programs.

Simulation-based learning has emerged as an effective pedagogical approach for training healthcare professionals in emergency management. The Institute of Medicine has specifically recommended incorporating simulation into healthcare education to enhance patient safety and reduce medical errors (Kohn et al., 2000). Simulation provides a safe, controlled environment where nurses can practice technical skills, develop clinical judgment, and experience realistic Code Blue scenarios without risking patient harm. Recent research indicates that simulation-based CPR training improves not only technical performance but also teamwork, communication, and leadership skills essential for effective emergency response (Cook et al., 2013). Despite growing evidence supporting simulation-based training, many healthcare institutions in India lack structured, evidence-based Code Blue training programs for nursing staff. Resource constraints, limited access to simulation facilities, and absence of standardized training protocols contribute to inconsistent preparedness levels among nurses. This

study addresses this critical gap by systematically evaluating the effectiveness of a comprehensive nursing training program designed to enhance response capabilities during Code Blue situations. Understanding the impact of structured training interventions is essential for developing evidence-based educational strategies that can ultimately improve patient survival rates and outcomes following cardiac arrest events in Indian healthcare settings.

2. Literature Review

The literature on nursing competency in Code Blue situations reveals several critical themes regarding training effectiveness, skill retention, and patient outcomes. Cooper et al. (2010) conducted a landmark study examining nursing students' ability to manage deteriorating patients in simulated environments, finding that simulation significantly enhanced clinical judgment, situation awareness, and appropriate intervention selection. Their research established that experiential learning through simulation provides superior preparation compared to traditional lecture-based approaches for emergency management scenarios. Lindsey and Jenkins (2013) demonstrated through a randomized experimental design that simulation-based education interventions substantially improved nursing students' clinical judgment in rapid response situations. Their study revealed that participants receiving simulation training achieved significantly higher posttest scores (M=90.91, SD=8.73) compared to control groups (M=64.80, SD=19.69), with statistical significance at $p<0.001$ level. This research provided quantitative evidence supporting simulation as an effective intervention for enhancing emergency response capabilities among nurses.

Recent investigations into Code Blue response optimization have focused on response time reduction through systematic training interventions. Huseman (2012) documented improvements in critical performance metrics following implementation of regular code blue drills, with chest compression initiation times improving from 0.867 to 0.214 minutes and time to first defibrillation decreasing from 3.286 to 1 minute. However, the study also identified that these improvements were not consistently maintained three months post-training, highlighting the necessity for periodic refresher training to maintain skill proficiency and ensure sustained performance enhancement. The psychological dimensions of Code Blue preparedness have been explored extensively, with research indicating that confidence and attitude significantly influence nursing performance during emergencies. Sultani (2021) reported a 90% improvement in nurses' self-reported confidence levels following structured educational training using Likert scale assessments. This research underscored the importance of addressing psychological readiness alongside technical skill development in comprehensive training programs. Dwyer and Mosel (2002) further established that nurses' attitudes regarding CPR and emergency response behaviors are shaped by training quality and frequency, supporting the implementation of regular, high-quality training programs.

Liaw et al. (2012) investigated the transfer of simulation learning to actual patient care settings, documenting that nurses who received simulation-based training demonstrated superior abilities in recognizing, responding to, and reporting patient deterioration in clinical practice. Their findings validated the ecological validity of simulation training and its effectiveness in preparing nurses for real-world emergency situations. The study emphasized the importance of debriefing sessions following simulation exercises, which facilitated reflective learning and reinforced key concepts essential for effective Code Blue management. The impact of training modality on learning outcomes has been examined through comparative studies. D'Cunha et al. (2021) conducted a prospective interventional study with 65 nursing students, demonstrating significant knowledge improvement from pretest to posttest (55.69% to 77.33%) following simulation-based drills. Participant feedback revealed that 95.4% of nurses found simulation essential for skill development prior to handling actual patients, and 92.3% identified debriefing as valuable for error analysis and concept reinforcement. These findings supported the integration of simulation-based teaching into nursing curricula for emergency preparedness.

3. Objectives

1. To assess the baseline knowledge and skills of nurses regarding Code Blue protocols and cardiopulmonary resuscitation techniques in tertiary care hospital settings.
2. To evaluate the effectiveness of structured simulation-based training intervention in improving nurses' theoretical knowledge and practical competency in Code Blue management.
3. To measure the impact of training on nurses' response time during simulated Code Blue scenarios and confidence levels in managing cardiac arrest situations.
4. To identify barriers and facilitating factors influencing the implementation and effectiveness of Code Blue training programs in Indian healthcare institutions.

4. Methodology

This study employed a quasi-experimental pretest-posttest control group design to evaluate the

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effectiveness of a structured nursing training program on Code Blue response capabilities across three tertiary care hospitals in central India (January–December 2023), following ethical approval and informed consent. A total of 120 registered nurses from critical care areas were purposively sampled and randomly assigned to intervention (n=60) and control (n=60) groups. Inclusion criteria required at least one year of clinical experience and willingness to complete the training; nurses with recent ACLS certification, planned leave, or physical limitations were excluded. The intervention comprised a 6-week program: Week 1 covered theoretical foundations through lectures; Weeks 2–3 involved hands-on skills stations; Weeks 4–5 included high-fidelity simulation scenarios; Week 6 focused on integrated practice and competency assessment. Sessions lasted 3 hours with up to 12 participants per batch, facilitated by AHA-certified instructors. The control group received routine education. Data were collected pre- and post-intervention using validated questionnaires and checklists for knowledge, skills, response time, and confidence. Statistical analyses included paired and independent t-tests, ANCOVA, chi-square tests, and Pearson correlation, with significance at $p<0.05$. Quality measures included standardized protocols, assessor blinding, and pilot testing.

5. Results & Discussion

Table 1: Demographic Characteristics of Study Participants (N=120)

Characteristic	Intervention Group (n=60)	Control Group (n=60)	p-value
Age (years) Mean ± SD	28.4 ± 4.2	27.8 ± 4.6	0.453
Gender (Female) n (%)	48 (80%)	52 (86.7%)	0.338
Years of Experience Mean ± SD	4.6 ± 2.8	4.3 ± 2.5	0.541
Educational Qualification			
Diploma in Nursing	18 (30%)	22 (36.7%)	0.624
B.Sc. Nursing	35 (58.3%)	32 (53.3%)	
M.Sc. Nursing	7 (11.7%)	6 (10%)	
Department			
ICU	24 (40%)	23 (38.3%)	0.891
Emergency	18 (30%)	20 (33.3%)	
Medical-Surgical	18 (30%)	17 (28.4%)	

Table 1 demonstrates demographic characteristics of study participants showing homogeneity between intervention and control groups across all variables. The mean age of participants in the intervention group was 28.4±4.2 years compared to 27.8±4.6 years in the control group, with no statistically significant difference (p=0.453). Gender distribution showed female predominance in both groups, with 80% in intervention and 86.7% in control groups (p=0.338). Clinical experience averaged 4.6±2.8 years for intervention group and 4.3±2.5 years for control group, indicating comparable baseline clinical exposure (p=0.541). Educational qualifications were similarly distributed with majority holding B.Sc. Nursing degrees in both groups. Department-wise distribution across ICU, Emergency, and Medical-Surgical units showed no significant differences (p=0.891), confirming successful randomization and comparable baseline characteristics essential for valid comparison of training intervention effects.

Table 2: Pre-test and Post-test Knowledge Scores Comparison (N=120)

Group	Pre-test Mean ± SD	Post-test Mean ± SD	Mean Difference	t-value	p-value	Cohen's d
Intervention (n=60)	11.68 ± 2.94 (58.4%)	16.94 ± 1.87 (84.7%)	5.26 ± 2.12	19.23	<0.001	2.08
Control (n=60)	11.45 ± 3.12 (57.3%)	12.18 ± 2.98 (60.9%)	0.73 ± 1.86	3.04	0.004	0.27
Between-group difference at post-test			4.76	10.47	<0.001	1.91

Table 2 presents the comparison of knowledge scores between intervention and control groups at pre-test and post-test phases. The maximum possible score was 20 points. At baseline, both groups demonstrated comparable knowledge levels with intervention group scoring 11.68±2.94 (58.4%) and control group scoring 11.45±3.12 (57.3%), with no significant difference (p=0.721). Following the 6-week training intervention, the intervention group showed remarkable improvement with post-test scores

increasing to 16.94±1.87 (84.7%), representing a mean improvement of 5.26 points or 26.3 percentage points. This improvement was highly statistically significant (t=19.23, p<0.001) with a large effect size (Cohen's d=2.08). The control group showed minimal improvement from baseline to post-test (mean difference 0.73 points), likely attributable to routine clinical exposure and test familiarity. Between-group comparison at post-test revealed a significant difference of 4.76 points (t=10.47, p<0.001) with large effect size (Cohen's d=1.91), demonstrating the substantial impact of structured training intervention on nurses' theoretical knowledge regarding Code Blue management.

Table 3: Skill Competency Assessment Scores (N=120)

Skill Component	Intervention Group Pre-test Mean ± SD	Intervention Group Post-test Mean ± SD	Control Group Pre-test Mean ± SD	Control Group Post-test Mean ± SD	F-value (ANCOVA)	p-value
Chest Compressions Technique (0-5)	2.4 ± 0.8	4.6 ± 0.5	2.3 ± 0.9	2.6 ± 0.8	187.34	<0.001
Airway Management (0-5)	2.1 ± 0.9	4.4 ± 0.6	2.0 ± 0.8	2.3 ± 0.9	165.28	<0.001
Defibrillator Use (0-5)	1.8 ± 0.7	4.5 ± 0.6	1.7 ± 0.8	2.0 ± 0.7	198.45	<0.001
Medication Administration (0-5)	2.3 ± 0.8	4.3 ± 0.7	2.2 ± 0.9	2.5 ± 0.8	142.67	<0.001
Team Communication (0-5)	2.2 ± 0.9	4.5 ± 0.6	2.1 ± 0.8	2.4 ± 0.9	171.89	<0.001
Overall Competency (0-25)	10.8 ± 3.2 (43.2%)	22.3 ± 2.1 (89.2%)	10.3 ± 3.4 (41.2%)	11.8 ± 3.5 (47.2%)	215.73	<0.001

Table 3 demonstrates skill competency assessment across five critical components of Code Blue management using a standardized 25-point checklist. At baseline, both groups showed limited proficiency across all skill domains, with overall competency scores around 41-43%. The intervention group exhibited substantial improvements in all skill components following training. Chest compressions technique scores improved from 2.4±0.8 to 4.6±0.5, representing 91.7% improvement. Airway management skills increased from 2.1±0.9 to 4.4±0.6, showing 109.5% enhancement. Defibrillator use demonstrated the most dramatic improvement from 1.8±0.7 to 4.5±0.6, marking 150% increase. Medication administration and team communication skills also showed significant improvements of 87% and 104.5% respectively. Overall competency scores in the intervention group increased from 10.8±3.2 (43.2%) to 22.3±2.1 (89.2%), representing an improvement of 106.5% or 46 percentage points. Analysis of covariance controlling for baseline differences revealed highly significant differences between groups across all skill components (p<0.001), confirming the effectiveness of hands-on simulation-based training in developing practical Code Blue management competencies.

Table 4: Code Blue Response Time Measurements (N=120)

Response Time Component (minutes)	Intervention Group Pre-test Mean ± SD	Intervention Group Post-test Mean ± SD	Control Group Pre-test Mean ± SD	Control Group Post-test Mean ± SD	Mean Difference (Post-test)	t-value	p-value
Recognition to Activation	0.95 ± 0.28	0.32 ± 0.12	0.92 ± 0.31	0.86 ± 0.27	0.54	13.87	<0.001
Activation to Scene Arrival	0.88 ± 0.24	0.41 ± 0.15	0.85 ± 0.26	0.79 ± 0.23	0.38	10.23	<0.001

Scene Arrival to CPR Initiation	0.97 ± 0.32	0.47 ± 0.18	0.94 ± 0.29	0.88 ± 0.28	0.41	8.96	<0.001
Total Response Time	2.80 ± 0.64	1.20 ± 0.31	2.71 ± 0.68	2.53 ± 0.59	1.33	13.42	<0.001
Time to First Defibrillation	3.45 ± 0.87	1.65 ± 0.42	3.38 ± 0.92	3.21 ± 0.84	1.56	11.78	<0.001

Table 4 presents response time measurements across various components of Code Blue management during standardized simulation scenarios. Response times were measured in minutes from scenario initiation to specific action completion. At baseline, both groups demonstrated comparable response times across all components with no significant differences. The intervention group showed substantial reduction in all response time components following training. Recognition to activation time decreased by 66.3% from 0.95±0.28 to 0.32±0.12 minutes, indicating enhanced patient assessment and emergency recognition skills. Activation to scene arrival improved by 53.4%, and scene arrival to CPR initiation decreased by 51.5%, demonstrating improved preparation and efficiency. Total response time from patient deterioration recognition to CPR initiation showed remarkable improvement, decreasing from 2.80±0.64 minutes to 1.20±0.31 minutes, representing a 57.1% reduction or 1.6 minutes faster response. Time to first defibrillation improved from 3.45±0.87 to 1.65±0.42 minutes, a 52.2% reduction. Control group showed minimal changes in response times with slight improvements likely due to practice effects. Between-group comparisons at post-test revealed highly significant differences across all response components ($p<0.001$), demonstrating that structured training significantly enhances speed and efficiency of Code Blue response, critical factors directly influencing patient survival outcomes

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Table 5: Confidence Level Assessment (N=120)

Confidence Domain (Scale 1-5)	**Intervention Group Pre-test Mean ± SD**	**Intervention Group Post-test Mean ± SD**	**Control Group Pre-test Mean ± SD**	**Control Group Post-test Mean ± SD**	**Percentage Increase (Intervention)**	**t-value**	**p-value**
Recognizing Cardiac Arrest	2.3 ± 0.8	4.5 ± 0.6	2.2 ± 0.9	2.4 ± 0.8	95.7%	17.89	<0.001
Performing CPR	2.1 ± 0.9	4.6 ± 0.5	2.0 ± 0.8	2.3 ± 0.9	119.0%	19.34	<0.001
Operating Defibrillator	1.8 ± 0.7	4.4 ± 0.7	1.7 ± 0.6	2.0 ± 0.7	144.4%	18.67	<0.001
Administering Emergency Medications	2.2 ± 0.8	4.3 ± 0.6	2.1 ± 0.8	2.3 ± 0.8	95.5%	16.23	<0.001
Leading Code Blue Team	1.6 ± 0.7	4.0 ± 0.8	1.5 ± 0.6	1.7 ± 0.7	150.0%	15.78	<0.001
Documenting Code Blue Events	2.5 ± 0.9	4.4 ± 0.6	2.4 ± 0.9	2.6 ± 0.9	76.0%	14.56	<0.001
Overall Confidence Score (6-30)	12.5 ± 3.8 (41.7%)	26.2 ± 2.9 (87.3%)	12.0 ± 3.6 (40.0%)	13.3 ± 3.9 (44.3%)	109.6%	20.45	<0.001

Table 5 presents confidence level assessment across six critical domains of Code Blue management using a 5-point Likert scale where 1 indicates "not at all confident" and 5 indicates "extremely confident." At baseline, both groups demonstrated low confidence levels across all domains with overall confidence scores around 40-42% of maximum possible score. The intervention group exhibited remarkable improvements in confidence levels across all domains following the training intervention. Confidence in

recognizing cardiac arrest increased from 2.3±0.8 to 4.5±0.6, representing 95.7% improvement. Performing CPR confidence showed 119% increase, while operating defibrillator demonstrated the most substantial improvement of 144.4%, indicating that hands-on practice significantly reduced apprehension regarding equipment use. Confidence in administering emergency medications improved by 95.5%, and leading Code Blue teams showed 150% enhancement, suggesting that simulation scenarios effectively developed leadership competencies. Overall confidence scores increased from 12.5±3.8 (41.7%) to 26.2±2.9 (87.3%), representing a 109.6% improvement. Control group showed minimal confidence changes with slight increases likely attributable to continued clinical exposure. Between-group comparisons revealed highly significant differences ($p<0.001$) across all confidence domains, confirming that comprehensive training substantially enhances nurses' self-efficacy and psychological preparedness for Code Blue situations.

Table 6: Training Program Satisfaction and Perceived Effectiveness (N=60)

Feedback Parameter	Strongly Agree n (%)	Agree n (%)	Neutral n (%)	Disagree n (%)	Strongly Disagree n (%)	Mean Score (1-5)
Training improved my Code Blue knowledge	52 (86.7%)	7 (11.7%)	1 (1.6%)	0 (0%)	0 (0%)	4.85 ± 0.41
Simulation scenarios were realistic	48 (80.0%)	10 (16.7%)	2 (3.3%)	0 (0%)	0 (0%)	4.77 ± 0.51
Hands-on practice was valuable	55 (91.7%)	5 (8.3%)	0 (0%)	0 (0%)	0 (0%)	4.92 ± 0.28
Debriefing sessions enhanced learning	50 (83.3%)	8 (13.3%)	2 (3.4%)	0 (0%)	0 (0%)	4.80 ± 0.48
Training increased my confidence	53 (88.3%)	6 (10.0%)	1 (1.7%)	0 (0%)	0 (0%)	4.87 ± 0.39
I feel prepared to manage Code Blue	46 (76.7%)	12 (20.0%)	2 (3.3%)	0 (0%)	0 (0%)	4.73 ± 0.52
Training should be mandatory for all nurses	57 (95.0%)	3 (5.0%)	0 (0%)	0 (0%)	0 (0%)	4.95 ± 0.22
Training duration was appropriate	42 (70.0%)	15 (25.0%)	3 (5.0%)	0 (0%)	0 (0%)	4.65 ± 0.58
Instructors were knowledgeable and supportive	54 (90.0%)	6 (10.0%)	0 (0%)	0 (0%)	0 (0%)	4.90 ± 0.30
Overall training satisfaction	51 (85.0%)	8 (13.3%)	1 (1.7%)	0 (0%)	0 (0%)	4.83 ± 0.42

Table 6 presents satisfaction and perceived effectiveness data from participants in the intervention group using a 5-point Likert scale feedback questionnaire. Results demonstrate overwhelmingly positive responses across all evaluation parameters. Regarding knowledge improvement, 86.7% of participants strongly agreed that training enhanced their Code Blue knowledge with a mean score of 4.85±0.41. The realism of simulation scenarios received strong endorsement with 80% strongly agreeing and mean score of 4.77±0.51, validating the fidelity of training scenarios. Hands-on practice was most highly valued with 91.7% strongly agreeing about its importance (mean 4.92±0.28), emphasizing the critical role of practical skill development. Debriefing sessions were recognized as enhancing learning by 83.3% of participants with mean score 4.80±0.48, supporting the educational value of structured reflection and feedback. Confidence improvement was strongly endorsed by 88.3% participants (mean 4.87±0.39), aligning with objective confidence score improvements shown in Table 5. Preparedness to manage Code Blue situations received 76.7% strong agreement (mean 4.73±0.52), indicating successful achievement of training objectives. Remarkably, 95% of participants strongly agreed that such training should be mandatory for all nurses (mean 4.95±0.22), demonstrating recognition of its essential value. Instructor quality received 90% strong agreement (mean 4.90±0.30), validating the training delivery approach. Overall training satisfaction achieved 85% strong agreement with mean score of 4.83±0.42, confirming that participants found the comprehensive training program highly valuable, relevant, and effective in preparing them for real-world Code Blue management responsibilities.

6. Conclusion

This study conclusively demonstrates that structured, simulation-based training interventions significantly and substantially enhance nursing competency across all critical dimensions of Code Blue response. The intervention group exhibited marked improvements in theoretical knowledge (26.3 percentage point increase), practical skills (46 percentage point

increase), response time (57.1% reduction), and confidence levels (109.6% improvement), all with large effect sizes and high statistical significance. These findings provide compelling evidence supporting the integration of comprehensive simulation-based Code Blue training as a mandatory component of nursing professional development programs in Indian healthcare institutions. The overwhelming participant satisfaction and endorsement of the training approach validates simulation-based learning as an effective, acceptable, and valued educational modality for emergency preparedness. Given the critical importance of rapid, proficient nursing response in determining patient survival following cardiac arrest, investment in quality Code Blue training programs represents not merely an educational priority but a patient safety imperative. Healthcare institutions should prioritize resource allocation toward simulation facilities, equipment, and trained instructors to ensure all nurses working in inpatient settings receive regular, evidence-based Code Blue training with periodic refresher courses to maintain competency.

Future research should investigate long-term effectiveness, skill retention patterns, cost-effectiveness, and most importantly, the impact of enhanced training on actual patient outcomes following real Code Blue events. Studies examining optimal training frequency, duration, and format will help refine training programs for maximum effectiveness and efficiency. Multi-site studies across diverse healthcare settings would enhance generalizability and identify context-specific factors influencing training effectiveness. Despite these areas for further investigation, the present study provides substantial evidence that comprehensive simulation-based training effectively prepares nurses to respond competently, confidently, and rapidly during Code Blue situations, ultimately contributing to improved patient survival and outcomes in cardiac arrest emergencies.

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