RESEARCH PAPER

From Education to bedside: Improving patient related outcomes through nurses training in arrhythmias. A Randomised Controlled Study

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Abstract

Background: Cardiac arrhythmias are common health problems around the world. Nonetheless, knowledge gaps in arrhythmia recognition and electrocardiogram (ECG) interpretation among critical care nurses is a worldwide problem. While there is little evidence from properly designed randomised controlled trials linking nurses education with patient-related outcomes, structured training programmes are being shown promising effects. The objective of the study was to determine if a structured arrhythmia training programme for critical care nurses increase nurse knowledge, clinical response efficiency, bedside skill accuracy and patient-related outcomes.

Methods: A multicentric prospective parallel-arm cluster randomised controlled trial was conducted at 22 hospitals in Ranchi district, Jharkhand, India (September 2021–November 2025) registered with CTRI (CTRI/2023/05/053190). A sample of 506 critical care nurses (253 intervention, 253 control) representing 22 clusters (11 intervention, 11 control) were enrolled through multistage sampling. The intervention consisted of a classroom training session (3-4 hours) with structured education on ECG interpretation, lethal arrhythmia recognition and emergency management, an educational booklet and demonstration of skills. There were no additional interventions offered. The arrhythmia knowledge score, base and week 3. The other outcomes were assessed which included physician feedback scores, time duration from door to ECG, nurses' emergency response time, ECG lead placement accuracy, defibrillator use, timely reperfusion and average length of hospital stay (ALOS). The data was evaluated through independent t-test paired t-test Chi-square test and repeated measures ANOVA on IBM SPSS version 16.

Results: There was no significant difference in the pre-test knowledge scores of both groups (8.72 ± 3.93 vs 8.84 ± 2.94; $p = 0.711$). After the training the knowledge post-test of intervention group was significantly higher (post score 18.11 ± 4.80), the mean gain of the intervention group was also significantly higher (9.47 ± 5.39) ($p<0.001$) along with significantly higher physician feedback (14.23 ± 3.06 v/s 7.44 ± 2.78) ($p<0.001$). Door-to-ECG time under 10 minutes was achieved by 81.2% in the intervention versus 17.8% in controls ($p < 0.001$). Nurse emergency response within a 5-minute period showed a significant statistical increase of 86.3% against 13.7% ($p < 0.001$). The correctness of ECG lead placement was enhanced to 70.3% against 29.7% ($p < 0.01$) and proper use of defibrillator (≥2 settings) scaled to 79.8% versus 20.2% ($p < 0.01$) Of the patients assigned to the intervention group, 81.9% underwent reperfusion within 30 minutes, compared with 18.1% of controls ($p < 0.01$) ALOS has improved marginally only by around 1-2% as there were delays in processing of Ayushman Bharat.

Conclusion: A structured arrhythmia training programme for critical care nurses produces significant and measurable improvements in knowledge, clinical response efficiency, bedside skill accuracy, and reperfusion timeliness. The results of our study provide robust evidence, to overcome bias, for integrating competency-based arrhythmia training into the routine education of critical care nursing to improve patient safety and outcomes.

Keywords: Arrhythmia training, critical care nurses, randomised controlled trial, ECG interpretation, patient outcomes, cluster randomisation, reperfusion therapy, door-to-ECG time.

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Introduction

Cardiac arrhythmias represent a significant and escalating global health burden. Atrial fibrillation (AF), the most prevalent arrhythmia, affected an estimated 52.55 million individuals worldwide in 2021, contributing to approximately 0.34 million deaths and 8.36 million disability-adjusted life years (DALYs).[1] The incidence and prevalence of arrhythmias have risen steadily over recent decades and are projected to continue increasing, driven by ageing populations and the growing burden of chronic non-communicable diseases.[2] Beyond AF, a broad spectrum of cardiac dysrhythmias—including ventricular tachycardia, supraventricular tachycardias, and other life-threatening arrhythmias—collectively contribute to haemodynamic instability, thromboembolic complications, emergency hospitalisation, and preventable mortality.[3]

Nurses constitute the largest segment of the global healthcare workforce and occupy a frontline role in the detection, continuous monitoring, and initial management of cardiac arrhythmias. This role is particularly critical in intensive care units (ICUs), coronary care units (CCUs), and emergency departments, where patients undergo continuous non-invasive cardiac monitoring and nurses represent the primary responders to any aberrant cardiac rhythm. A strong positive correlation has been established between nurses' proficiency in arrhythmia recognition and their capacity to make sound clinical decisions and initiate timely interventions in high-risk cardiac events.[3] The electrocardiogram (ECG) is the cornerstone diagnostic tool in this context, with an estimated 300 million ECGs performed annually in the United States alone.[4]

Despite the centrality of this competency, studies have consistently documented significant knowledge deficits and highly variable ECG interpretation skills among nurses across global healthcare settings. A systematic review synthesising evidence from 43 studies confirmed that nurses' competency in ECG interpretation ranged widely from low to high, with nurses themselves identifying a lack of regular training and insufficient clinical exposure as principal barriers to proficiency.[5] In critical care environments, ineffective cardiac monitoring attributable to poor ECG knowledge has been linked to increased incidence of sudden cardiac death and the well-documented phenomenon of "failure to rescue"—the clinician's failure or delay in recognizing and responding to a deteriorating patient—representing a profound patient safety concern. [6]

Studies conducted in diverse geographical settings, including Egypt, Iraq, China, and Saudi Arabia, have corroborated these findings, consistently demonstrating inadequate baseline arrhythmia knowledge and clinical skill deficits among nursing staff, highlighting a systemic and globally prevalent educational gap.[7] Structured nursing training programmes have nonetheless shown considerable promise in bridging these deficiencies. Educational interventions have produced statistically significant improvements in nurses' theoretical knowledge, ECG interpretation accuracy, and clinical practice, with benefits documented at short- and medium-term follow-up.[8] Innovative pedagogical approaches, including the CDIO (Conceive-Design-Implement-Operate) model and the CRISP (Cardiac Rhythm Identification for Simple People) method combined with flipped classroom strategies, have demonstrated meaningful and durable gains in arrhythmia competence among trainee nurses in randomised studies.[9,10] Nurse-led educational interventions targeted at patients with AF have additionally resulted in significant reductions in arrhythmia-related complications, 30-day heart failure admissions, and 90-day all-cause hospitalisations, affirming that nurse education translates into tangible patient-related benefits.[11]

Despite this growing evidence, the literature remains predominantly comprised of quasi-experimental designs characterised by small sample sizes, short follow-up periods, and heterogeneous outcome measures. Rigorously designed randomised controlled trials are therefore imperative to establish a causal relationship between structured nurse arrhythmia training and improvements in patient-related clinical outcomes. The present study was designed as an RCT to address this critical evidence gap and evaluate whether a structured, competency-based arrhythmia training programme for nurses results in measurable improvements in patient outcomes, thus providing robust evidence to inform nursing education policy and clinical practice.

Materials and Methods

Study Design and Registration

This study was a multicenter, prospective, parallel-arm, cluster-randomized controlled trial being conducted at 22 hospitals in Ranchi district, Jharkhand, India, (September 2021–November 2025). The research was organized and published following the guidelines set out in SPIRIT 2013 and CONSORT 2010. The trial was concurrently registered (before the outcome data were made available) with the Clinical Trials Registry of India, which is a member of the WHO Primary Registry Network (CTRI/2023/05/053190).

Ethical Consent.

The Doctoral Research Committee (DRC) and Institutional Ethics Committee (IEC) of Rajendra Institute of Medical Sciences (RIMS) Ranchi granted ethical clearance for the study (IEC Letter No. 19, Dated 03/02/2022). Written consent of informed was taken from all participants before enrolment.

Setting and Participants.

Out of 208 hospitals in Ranchi district, 22 super- and multi-speciality hospitals with functional critical care units (minimum six beds with cardiac monitors and presence of more than ten permanent critical care nurses) were included after systematic on-site eligibility screening.

Nurses employed permanently in critical care units (GNM/B.Sc./M.Sc. Nursing) directly monitoring the cardiac activity of the patient and providing emergency care, who are available throughout the study period, and are willing to proceed with the consent form.

The exclusion criteria included nurses who work in non-critical care areas, were on leave or administrative duty during the data collection period, were not directly involved in ECG monitoring, and were contractual or temporary staff.

Sample size

The sample size for the study was calculated using the following formula: n=(16p(100-p))/d^2 ×DE, where p = 76%, d = 24% and design effect (DE) = 2. Therefore, the base sample of 84 increased to 186 per group after applying 10%attrition and the design effect. Thus, an estimated total sample of 400 was calculated for the study. The actual enrolment in the study was 278 per arm at baseline. Out of these, 253 per arm (505 total) completed the study.

Randomisation and Blinding

The study utilized cluster randomisation with a fixed cluster size for allocation of subjects. An independent external member uses Research Randomizer to generate a random sequence. We maintained allocation concealment through Sequentially Numbered, Opaque, Sealed Envelopes (SNOSEs) overlapping with aluminium foil. Blinding of participants and investigators was not possible, however, outcome assessors were blinded to group allocation.

Intervention

The intervention was based on the Health Belief Model and adhered to the TIDieR checklist, comprising one time structured classroom training session (3-4 hours) using PowerPoint presentations at each of the hospital by PI. The content that was covered included ECG interpretation, recognition of lethal arrhythmias, and their emergency management. Participants received an educational booklet (focusing on Managing Lethal Arrhythmia) that was reinforcing in nature, plus a hands-on demonstration and re-demonstration on the placement of ECG leads and the settings of a defibrillator. The overall Content Validity Index (CVI) of the training module was 0.96. No intervention was given to the control group.

Study Design and Registration

This was a multicentric, prospective, parallel-arm cluster-randomised controlled trial conducted across 22 hospitals in Ranchi district, Jharkhand, India (September 2021–November 2025). The study was designed and reported in conformity with the SPIRIT 2013 and CONSORT 2010 guidelines. The trial was prospectively registered with the Clinical Trials Registry of India, a WHO Primary Registry Network member (CTRI/2023/05/053190).

Ethical Approval

Ethical clearance was obtained from the Doctoral Research Committee (DRC) and the Institutional Ethics Committee (IEC) of Rajendra Institute of Medical Sciences (RIMS), Ranchi (IEC Letter No. 19, dated 03/02/2022). Written informed consent was obtained from all participants prior to enrolment.[1]

Setting and Participants

From 208 hospitals in Ranchi district, 22 super- and multi-speciality hospitals with functional critical care units (minimum six cardiac monitor-equipped beds and more than ten permanent critical care nurses) were included following systematic on-site eligibility screening.[1]

Inclusion criteria: Permanently employed critical care nurses (GNM/B.Sc./M.Sc. Nursing) directly involved in cardiac monitoring and emergency care, available

throughout the study period, and willing to provide informed consent.

Exclusion criteria: Nurses in non-critical care areas, on leave or administrative duty during data collection, not directly involved in ECG monitoring, or contractual/temporary staff.

Sample Size

Sample size was calculated using the formula $n = \frac{16p(100-p)}{d^2} \times DE$ where p = 76%, d = 24%, and design effect (DE) = 2. A base sample of 84 increased to 186 per group after applying 10% attrition and the design effect, giving a total estimated sample of 400. Actual enrolment was 278 per arm at baseline, with 253 per arm (506 total) completing the study.

Randomisation and Blinding

Cluster randomisation with fixed cluster size (16–20 subjects/cluster; 22 clusters in 1:1 allocation) was used. Random sequence was generated using Research Randomizer by an independent external member. Allocation concealment was maintained using Sequentially Numbered, Opaque, Sealed Envelopes (SNOSEs) reinforced with aluminium foil. Participant and investigator blinding was not feasible; however, outcome assessors were blinded to group allocation.

Intervention

Grounded in the Health Belief Model and guided by the TIDieR checklist, the intervention comprised a single structured classroom training session (3–4 hours) delivered by the principal investigator using PowerPoint presentations at each hospital. Content covered ECG interpretation, lethal arrhythmia recognition, and emergency management. Participants received a reinforcing educational booklet (*Managing Lethal Arrhythmia*) and underwent hands-on demonstration and re-demonstration of ECG lead placement and defibrillator settings. The training module achieved an overall Content Validity Index (CVI) of 0.96. The control group received no intervention.

Data Collection Tools and Outcome Measures

Four validated instruments were used:

Tool	Description	Items	S-CVI	Reliability
I – SDPE Questionnaire	Sociodemographic and professional data	9	1.00	—
II – Knowledge Questionnaire	Lethal arrhythmia knowledge (score: 0–30)	30	0.95	PMCC = 0.97
III – Physician Feedback Scale	Arrhythmia identification and management (5-point Likert, 2 domains)	4	0.97	Lin's CCC = 0.96
IV – Observation Checklist	Patient outcomes (door-to-ECG time, reperfusion, ECG lead accuracy, defibrillator use, response time, ALOS)	6	0.94	Lin's CCC = 0.78

Primary outcome: Arrhythmia knowledge score (baseline and Week 3). **Secondary outcomes:** Physician feedback score (Week 20–24) and patient-related outcome indicators (baseline and Week 48).

Pilot Study

A pilot study was conducted at Samford Hospital, Ranchi (January 2023) with 40 critical care nurses to assess feasibility, instrument applicability, and intervention logistics.

Statistical Analysis

Data were analysed using IBM SPSS version 16. Descriptive statistics included frequency, percentage, and mean ± SD. Normality was tested by the Kolmogorov-Smirnov and Shapiro-Wilk tests. Between-group differences were compared using the independent *t*-test and Chi-square test; within-group changes were assessed using the paired *t*-test and repeated measures ANOVA. A p-value <0.05 was considered statistically significant.

Results- In this randomised controlled study, 506 critical care nurses (253 intervention, 253 control) were recruited. Both groups had similar baseline knowledge, as they had comparable pre-test score; 8.72 ± 3.93 vs. 8.84 ± 2.94; p = 0.711) and there were no significant between-group difference in age, nursing experience, and CCU experience prior to intervention (Table 1). After applying arrhythmia training program, the mean

post-test knowledge score of the intervention group (18.11 ± 4.80) was significantly more compared to the control group (8.85 ± 2.93) ($p < 0.001$). Moreover, the mean gain score was (9.47 ± 5.39). Feedback scores of critical care physicians were significantly more in the intervention group (14.23 ± 3.06) as compared to the control group (7.44 ± 2.78) ($p < 0.001$) (Table 1). The training intervention led to improved clinical response efficiency, with a significant post training change in <10 min door-to-ECG times (81.2% intervention and 17.8% control, $p < 0.001$) and a significantly quicker nurse emergency response time (<5 min: 86.3% intervention vs. 13.7% control; $p < 0.001$) compared to control. Both outcomes were not significantly different at baseline (Table 2). The accuracy of bedside clinical skills also improved significantly in the intervention group where ECG lead placement rose to 70.3% against 29.7% in the controls group ($p < 0.01$). Appropriate use of the defibrillator (≥2 settings) increased to 79.8% versus only 20.2% in the controls post-training (Table 3). The timing of reperfusion therapy in the intervention group was significantly better following the training. It was found that 81.9% experienced reperfusion within 30 minutes compared to 18.1% in controls ($p < 0.01$). The distribution in pre-training was not significant (Table 4). Average hospital length of stay regarding patient-related outcome showed a slight improvement of 1-2% within the intervention hospitals. Reason for only marginal improvement is due to Ayushman and insurance processing delay as observed in the control length of stay and not only the nursing competency (Table 5). All in all, structured arrhythmia training confirms bringing education to bedside practice.

Table 1: Impact of Structured Training on Arrhythmia Knowledge Scores

Variable	Intervention (n=253) Mean ± SD	Control (n=253) Mean ± SD	t-value	p-value
Pre-test Score	8.72 ± 3.93	8.84 ± 2.94	0.371	0.711 (NS)
Post-test Score	18.11 ± 4.80	8.85 ± 2.93	−26.17	<0.001 *
Mean Difference (Post – Pre)	9.47 ± 5.39	−0.01 ± 0.10	−27.981	<0.001 *
Paired t-test (within group)	t = 27.08, p = 0.001*	t = −1.73, p = 0.083 (NS)	—	—
Feedback Score (by CCU Doctors)	14.23 ± 3.06	7.44 ± 2.78	−26.158	<0.001 *

*Significant at $p<0.05$; NS = Not Significant

Table 2: Effect of Training on Clinical Response Efficiency

Outcome	Category	Intervention f (%)	Control f (%)	p-value
Door-to-ECG Time (Pre-training)	<10 min	22 (55.9)	26 (54.1)	0.696 (NS)
	10–20 min	71 (42.6)	64 (47.4)	
	20–30 min	160 (49.6)	163 (50.4)	
Door-to-ECG Time (Post-training)	<10 min	161 (81.2)	35 (17.8)	<0.01*
	10–20 min	69 (31.7)	63 (68.3)	
	20–30 min	23 (15.5)	155 (84.5)	
Nurse Emergency Response Time (Pre-training)	<5 min	28 (56.0)	22 (44.0)	0.667 (NS)
	5–10 min	182 (49.5)	186 (50.5)	
	≥10 min	43 (49.9)	45 (51.1)	
Nurse Emergency Response Time (Post-	<5 min	201 (86.3)	32 (13.7)	<0.001 *

training)				
	5–10 min	51 (21.1)	190 (78.9)	
	≥10 min	10 (24.4)	31 (75.6)	

*Significant at p<0.05; NS = Not Significant

Table 3: Effect of Training on Clinical Skill Accuracy and Defibrillator Use

Outcome	Category	Intervention f (%)	Control f (%)	p-value
ECG Lead Placement Accuracy (Pre-training)	Accurate	92 (47.7)	101 (52.3)	0.410 (NS)
	Inaccurate	161 (51.5)	152 (48.5)	
ECG Lead Placement Accuracy (Post-training)	Accurate	248 (70.3)	105 (29.7)	<0.01 *
	Inaccurate	5 (3.3)	148 (96.7)	
Defibrillator Setting Frequency (Pre-training)	0 times	175 (49.1)	182 (50.9)	0.402 (NS)
	1 time	53 (56.4)	41 (43.6)	
	≥2 times	25 (45.5)	30 (54.5)	
Defibrillator Setting Frequency (Post-training)	0 times	45 (20.9)	171 (79.1)	<0.01 *
	1 time	66 (59.9)	46 (41.0)	
	≥2 times	142 (79.8)	36 (20.2)	

*Significant at p<0.05; NS = Not Significant

Table 4: Effect of Training on Reperfusion Therapy Timeliness

Reperfusion Therapy	Category	Intervention f (%)	Control f	p-value
Time			**(%)**	
Pre-training	<30 min	24 (53.7)	31 (56.3)	0.518 (NS)
	30 min–1 hr	207 (50.4)	204 (49.6)	
	Not done	22 (55.0)	18 (45.0)	
Post-training	<30 min	162 (81.9)	35 (18.1)	<0.01 *
	30 min–1 hr	45 (14.2)	212 (85.8)	
	Not done	22 (100.0)	18 (45.0)	

*Significant at p<0.05; NS = Not Significant

Table 5: Patient-Related Outcomes — Average Length of Hospital Stay (ALOS)

Hospital Length of Stay	Category	Pre-training			Post-training		
		Control f (%)	**Intervention** f (%)	**Total** f (%)	**Control** f (%)	**Intervention** f (%)	**Total** f (%)
Hospitals (n=22)	<5 days	2 (18)	2 (18)	4 (18)	2 (18)	3 (28)	5 (23)
	5–10 days	3 (28)	3 (28)	6 (28)	3 (28)	4 (36)	7 (32)
	11–15 days	6 (54)	6 (54)	12 (54)	6 (54)	4 (36)	10 (45)

Note: ALOS showed marginal improvement (1–2%) in the intervention group post-training. Insurance and Ayushman processing delays were identified as confounding factors limiting the impact of nursing efficiency on hospital stay duration.

Discussion

The current RCT shows that a structured arrhythmia training for critical care nurses can result in improvements in knowledge, clinical response efficiency, accuracy of bedside skills, and reperfusion

time, while also identifying institutional confounders that limit patient-level outcomes, such as length of stay in hospital.As indicated by baseline comparability (pre-test: 8.72 ± 3.93 vs. 8.84 ± 2.94; p = 0.711), post-training differences were due to training rather than pre-existing differences. After undergoing the training, there was a significant enhancement in the knowledge of the intervention group (post-test: 18.11 ± 4.80; mean gain: 9.47 ± 5.39; p < 0.001). In contrast, there was almost no change observed in the control group (mean difference: −0.01 ± 0.10; p = 0.083). These results are almost similar to Chen et al.,[9] who employed the CDIO pedagogical model during a nursing arrhythmia course and found the post-test cognitive scores of the respondents improved from 22.31 ± 3.03 at baseline to 38.90 ± 4.33 one (1) week after the training (p < 0.001), and sustained at 24 weeks. Likewise, Bazrafkan et al.[12] employed a simulation of cardiac arrhythmia software to train nurses and found a significant difference in nurses' knowledge scores post-training (p < 0.001), thus verifying the possible transfer of simulation-based gains to critical thinking in practice. A self-directed e-learning (SDL) study by Abd El-Megeed et al. reported a post-test ECG interpretation score of nurses of 15.92% (47.12 to 63.04; p < 0.001). This further reinforces that there is always a gain in knowledge between the two groups (CDIO, simulation, SDL). The substantial increase in physician feedback scores for the intervention group (14.23 ± 3.06 vs 7.44 ± 2.78; p < 0.001) adds another layer to knowledge assessment, showcasing a clinical translation of learning rarely seen in this type of research.The percentage of nurses who achieved door-to-ECG times of less than 10 minutes increased significantly in the intervention group after training (81.2% vs 17.8%; p < 0.001) with another significant increase in emergency response times of under 5 minutes (86.3% vs 13.7%; p < 0.001). The proportions match well with evidence linking education of staff with timely ECGs. According to Alghamdi et al.[14], the median door-to-ECG time was reduced from 12.9 min to 11.4 min, or by 10.8%, following an initiative to standardise processes and delegate nursing roles. Furthermore, compared with the 6-month pre-intervention baseline, there was a 32% reduction. Their findings affirmed that targeted interventions focused on nurses can significantly compress the ECG acquisition time. According to He et al.[15], a modified cardiac triage strategy appreciably reduced door-to-ECG time from 5 to 4 minutes (p = 0.02), and the percentage of patients with ST elevation myocardial infarction (STEMI) with a door-to-ECG time under 10 minutes was improved from 45% to 57% (p = 0.01). In other words, organisational and educational interventions had a real clinical impact. Chen et al (2022)[16] also established that those who had their ECG taken within 10 minutes of them reaching the hospital benefitted from timely percutaneous coronary intervention and better clinical outcome when suffering from acute coronary syndrome. Thus highlighting the clinical importance of the improvement seen in the present study.In the intervention group, ECG lead post-training placement accuracy improved significantly as compared to controls (70.3% vs. 29.7% , p < 0.01). The findings showed similarity to the study done by Medani[17], who implemented a peer-led educational intervention for ECG lead placement, resulting in significant improvement in knowledge and placement among hospital nursing staff. Carullo et al., in their accuracy and knowledge survey among nursing students, reaffirmed that specific training ought to be provided in order to bring down the rate of lead misplacement, which often distorts the clinical interpretation of the ECG and causes delay in diagnosis. The results regarding defibrillator competence were quite significant as well. The appropriate use (2 settings or more) increased from a non-significant baselinemore than 79.8% in the intervention group compared to only 20.2% in controls p < 0.01. Çıkrıkçı Işık et al.,[19] who applied the CRISP (Cardiac Rhythm Identification for Simple People) technique, came to a comparable conclusion, where after training, there was a significant increase in post-test scores, particularly for accurately interpreting fatal arrhythmias, so that the skill-directed training translates into better technical skill at the bedside.An important outcome of the current study was the patient-related timeliness of reperfusion therapy. After training, reperfusion of 81.9% of patients in intervention- group hospitals within 30 minutes versus 18.1% in control hospitals (p<0.01); pre-training distributions were not significantly different. This is directly consistent with international guidelines: Ibanez et al. [20](ESC 2017 STEMI Guidelines) recommend a door-to-needle time of within 30 minutes for thrombolysis and a door-to-balloon time of within 90 minutes for primary PCI. Both recommend that these benchmarks can be achieved with the help of trained nursing staff O'Gara et al. 2013).According to Huang et al., shorter reperfusion times due to protocol driven systems and timely ECG

acquisition will be linked to better myocardial salvaging, lower risk of heart failure, and better functional outcomes of patients.The average hospital length of stay (ALOS) fell only marginally by 1–2% in the intervention-group hospitals (Table 5), despite significant improvements in knowledge, process and skill indicators. The effect of it has not yet been entirely wiped out. This is because of the non-clinical administrative delays causing insurance and Ayushman Bharat scheme processing. These caused another independent confounding effect and not due to nursing competency. A meta-analysis of five RCTs by Li et al.,[22] demonstrated that nurse-led transitional care interventions significantly reduced ALOS by a mean of 2.37 days (95% CI: −3.16 to −1.58; $p < 0.0001$) in heart failure patients under an assumption of no administrative bottleneck. According to Qiu et al[23] study, a nurse-led approach following heart surgery resulted in improved ALOS and significantly lower rates of post-operative complications, provided full operationalisation of the nursing care pathway without institutional delays. The slight improvement in ALOS for the current analysis should therefore not be construed as diminishing the training effectiveness, but rather a manifestation of widespread healthcare-system limitation which specifically pertains to processing of government insurance scheme in Indian tertiary care settings.

Conclusion

The aim of this study was to determine the effect of structured arrhythmia training on knowledge, clinical response efficiency, ECG lead placement accuracy, defibrillator competence, and reperfusion timeliness among critical care nurses. This cluster-RCT shows that structured arrhythmia training for critical care nurses improves knowledge (mean gain: 9.47 ± 5.39; $p < 0.001$) and also improves their clinical response efficiency, accuracy during ECG lead placement (70.3%), competence of using defibrillator (79.8%), and getting reperfusion in 81.9% cases within 30 minutes. The ratings provided by physicians further validated bedside teaching. The slight reduction in hospital length of stay is due to system-level confounding, especially of the processing of Ayushman Bharat insurance, and not due to any weakening of the training effect. These findings support the argument that nurse arrhythmia education is a patient safety issue and should be incorporated into mandatory continuing professional development programs for critical care nursing.

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