

ORIGINAL RESEARCH

CPR / LIFE SUPPORT

The impact of simulation-based training on the knowledge and skills of postgraduate medical students in the management of cardiac arrest

Archita Patil¹, Sandeep Kadam², Pradhan Monnaiah³, Sanket patil⁴, Srishti Sethiya⁵, Srashti Singh⁶

Author affiliations:

1. Archita Patil, Dept of Anesthesiology, D. Y. Patil Medical College, Kolhapur, India; E-mail: drarchitapatil@gmail.com
2. Sandeep Kadam, Dept of Anesthesiology, D. Y. Patil Medical College, Kolhapur, India; E-mail: kadamsandeeps@gmail.com
3. Pradhan Monnaiah K., Dept of Anesthesiology, D. Y. Patil Medical College, Kolhapur, India; E-mail: pradhanmonnaiahk@gmail.com
4. Sanket Patil, Simulation and Skills Centre, D. Y. Patil Medical College, Kolhapur, India; E-mail: sanket.patil@dypatil.edu
5. Srishti Sethiya, Dept of Anesthesiology, D. Y. Patil Medical College, Kolhapur, India; E-mail: srishtisetiya7@gmail.com
6. Srashti Singh, Dept of Anesthesiology, D. Y. Patil Medical College, Kolhapur, India; E-mail: Srashtisingh28@gmail.com

Correspondence: Dr. Archita Patil; E-mail: drarchitapatil@gmail.com; Phone: +91-9326853458

ABSTRACT

Background: Use of simulation as a teaching learning method is said to improve the learners' skills and clinical decision making in a risk-free environment. The effectiveness of simulation in imparting protocol-based training of a critical situation like cardiac arrest to postgraduate students, needs to be evaluated. We aimed to train students in a simulation-based training session for Advanced Cardiac Life Support (ACLS) in the management of in-hospital cardiac arrest, and assess the effect on the pre-training efficacy.

Methodology: Thirty post-graduate students were subjected to a pre-test in knowledge and skills regarding ACLS, followed by a didactic lecture and a training session on a high-fidelity mannequin for the same. The assessment was conducted one week later. A self-perception questionnaire from the students was obtained at the end of the whole program. Mean score of knowledge, skill, time to initiating CPR and time to defibrillation in pre-test and post-test were compared using the paired-t test. $P < 0.05$ was considered statistically significant.

Results: There was statistically significant improvement in the post-test knowledge score (13.5 ± 2.87 ; $P < 0.0001$) and skills score (6.066 ± 1.25 ; $P < 0.0001$). Objective improvement was noticed in time to start cardiopulmonary resuscitation (pre-test 60 ± 19.76 sec vs. post-test 26.56 ± 16.07 sec; $P = 0.0001$). Time to defibrillation was markedly reduced (pre-test 118.6 ± 28.28 sec vs. post-test 93 ± 33.38 sec; $P = 0.0022$). Majority of the students strongly agreed that the training session resulted in improved confidence (76.7%), which enhanced clinical decision making in emergency situations (83.3%).

Conclusion: The simulation-based training session significantly increases the knowledge and psychomotor skills of the post-graduate students with enhanced confidence to manage a victim of cardiac arrest as self-judged by the participants.

Abbreviations: ACLS – Advanced Cardiac Life Support; CBME - Competency Based Medical Education CPR - Cardiopulmonary Resuscitation; CVR - Content Validity Ratio

Key words: Simulation Training; Cardiopulmonary Resuscitation

Citation: Patil A, Kadam S, Monnaiah P, Patil S, Sethiya S, Singh S. The impact of simulation-based training on the knowledge and skills of medical postgraduate students in the management of cardiac arrest. *Anaesth. pain intensive care* 2023;27(4):496–501. DOI: [10.35975/apic.v27i4.2258](https://doi.org/10.35975/apic.v27i4.2258)

Received: October 13, 2022; **Reviewed:** June 09, 2023; **Accepted:** June 13, 2023

1. INTRODUCTION

Post-graduate (PG) trainees are required to manage emergencies in treatment areas like wards, intensive care units, operation theatres and casualty departments. Errors in reasoning and clinical decision-making in uncertain situations can lead to an adverse patient outcome, as well as lowered self-esteem and confidence of the trainees. Inadequate hands-on training will not only pose a risk to the patient, but also constitute an ethical dilemma. In such scenarios, simulation-based training provides a solution to train students through repeated learning in a risk-free environment.¹ Simulation based teaching is said to be associated with improved interest in students and better learning outcomes.² We conducted this study to assess the knowledge and skill level of our postgraduate trainees regarding the management of cardiac arrest after a simulated training session, and to compare it with the pre-training levels.

2. METHODOLOGY

This was a prospective observational mixed method (qualitative and quantitative) study conducted at the Simulation and Skills Centre of our Institution. Qualitative study comprised of the feedback from the participants and the quantitative part consisted of the assessment of the knowledge and psychomotor skills.

Thirty PG students across all specialties, in their first year of residency training, were enrolled in the study, after written informed consent and approval from the Institutional Ethics Committee (Letter No. 433/2021/IEC, dated: March 24, 2021). A sample size of thirty was calculated from a pilot study to achieve change in knowledge and skills from this educational method.

The primary objective was to train students to achieve competency in the steps of cardiopulmonary resuscitation and compare their post-training knowledge and skills with that of pre-training level. The secondary objective was to assess students' satisfaction with the training and record their feedback. A pre-test questionnaire, with thirty questions, in the format of multiple-choice questions was formulated to test all cognitive domains. Three teachers and two senior residents from anesthesiology carried out the content validation for this questionnaire. Out of the thirty questions, twenty were approved which had a Content Validity Ratio (CVR) of > 0.8 ; each question was assigned one mark with no negative marking. The maximum marks allotted in the test were 20. Psychomotor skill checklist consisted of seven steps with one point assigned to each step, validated by the same team (Appendix 1). A reaction questionnaire with nine questions on a 5-point Likert scale (ranging from 1 =

strongly disagree to 5 = strongly agree) was also formulated similarly. The parameters rated were overall usefulness of the course, quality of training and assessment and the simulation training experience. A Google form was used to conduct the pre-test for knowledge. Two assessors, other than the investigators, assessed the participants in the pre-test for psychomotor skills demonstration, in the skills of chest compression, airway management, time to start Cardiopulmonary Resuscitation (CPR) and time to first defibrillation on a manikin to record baseline skill scores on the checklist.

This was followed by a training session of six hours, conducted by the investigator and co-investigator. It comprised of a didactic lecture on ACLS according to American Heart Association (AHA) 2020 guidelines, skill stations for demonstration of chest compression & airway management on task trainers followed by hands-on training on a task trainer. A demonstration, hands-on training of ECG interpretation of cardiac arrest rhythms, defibrillation, automated clinical scenarios with physiologically responding mannequin was carried out on a high-fidelity patient simulator (Apollo, CAE Healthcare, Canada).³

One week later, a post-test was conducted for knowledge and skills of recognizing cardiac arrest, performing high quality chest compressions, airway maneuvers and defibrillation. Computer based data from the simulator was also considered. Students' response was registered at the end of the post-test session by an online feedback questionnaire.

Statistical analysis

Mean score of knowledge, skill, time to initiating CPR and time to defibrillation in pre-test and post-test were compared using the paired-t test. $P < 0.05$ was considered statistically significant.

Percentage of students following all points on the checklist in pre and post session was compared by Fisher's test. The reaction questionnaire was analyzed for responses and percentage scores were considered.

3. RESULTS

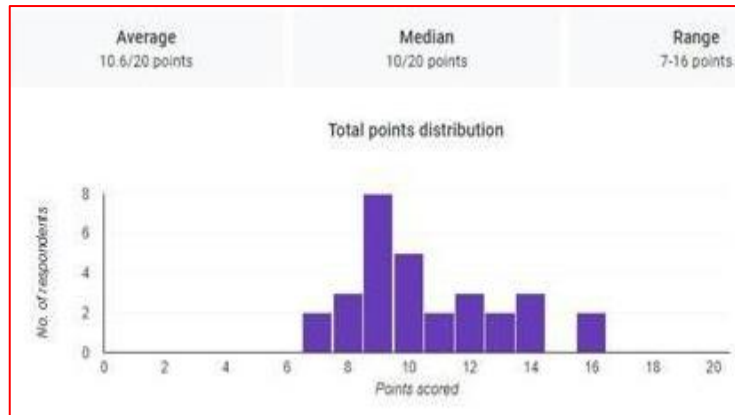
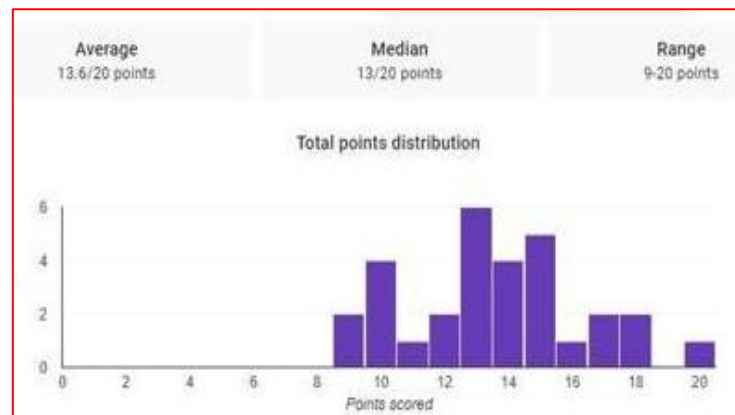
Demographic data shows that the mean age of participants was 27.1 ± 2.39 y and there was no gender difference between the participants (Table 1).

The level of knowledge significantly increased after the training session; e.g., from pre-test score of 10.73 ± 2.42 to post-test score of 13.5 ± 2.87 ($P < 0.0001$), the difference being highly significant. Similarly, the score of skills increased from 3.466 ± 1.56 to 6.066 ± 1.25 ($P < 0.0001$) and the difference was highly significant (Table 2).

Table 1: Demographic data

Parameter	Value
Age (y)	27.1 ± 2.39
Gender	Male 15 (50)
	Female 15 (50)

Data given as mean ± SD or n (%)

**Figure 1: Knowledge pre-test score****Figure 2: Knowledge post-test score.**

The skills required for cardiopulmonary resuscitation showed that 56.66% of students followed all points on checklist and achieved shorter time interval to initiate CPR (26.56 ± 16.07 sec) and defibrillate (93 ± 33.38 sec) in the post test (Table 2) indicating competency in following the cardiac arrest algorithm. Figure 1 shows the comparison of scores in pre- and post-test. Mean scores increased in the post-test for both knowledge and skills significantly indicating improvement after the simulation session.

In the student reaction questionnaire, 90% of the students strongly agreed that simulation is a useful teaching tool to learn skills. Majority of the students (Figure 2) strongly agreed (76.7%) that they felt an increase in their

confidence levels to treat cardiac arrest after this training and could integrate this knowledge in their clinical practice (83.3%) (Table 3).

4. DISCUSSION

Simulation as an educational tool, is widely used in the Western countries not only for training in clinical skills, but also to teach and assess non-technical skills such as situation awareness, task management, clinical decision making and team dynamics.⁴ It helps to address the needs of a restructured medical education system, keeping in mind the needs of 21st century learners and the healthcare system. The Competency Based Medical Education (CBME) curriculum of undergraduate and postgraduate medical education in India designed by the National Medical Council (NMC),⁵ and implemented since August 2019, has highlighted the importance of skills and simulation centers to train and assess students in clinical and communication skills. The high-fidelity

patient simulators have advanced features and interfaces, like reactive eyes, palpable pulses, heart sounds, bilateral breath sounds and bowel sounds etc. A display of ECG rhythms, vital signs like pulse, blood pressure, oxygen saturation and end-tidal CO₂ on a programmable monitor is available. Trainees can perform maneuvers like jaw thrust, perform laryngoscopy and intubate as well as perform chest compressions and defibrillate. It can mimic clinical responsiveness to treatment with oxygen, medications and interventions. Computer based analysis of CPR and defibrillation with a timeline is available.³ High-fidelity simulators help augment the experience of the clinical scenario making it as close as possible to reality. Greater involvement of the participants creates a favorable environment and boosts learning.⁶

During implementation of the ACLS protocol, the trainee integrates the higher levels of cognitive skills like application and analysis along with psychomotor skills of chest compression, airway management and defibrillation.⁷ Non-technical skills, effective communication, team dynamics are essential for better patient outcomes.⁴ Hence, we chose this protocol for our simulation-based study. We evaluated the program by the Kirkpatrick Four Level Model of evaluation.⁸

Level 1, which measures reaction, was obtained from our students in the form of a feedback questionnaire. A

Table 2: Comparison of scores in pre and post test

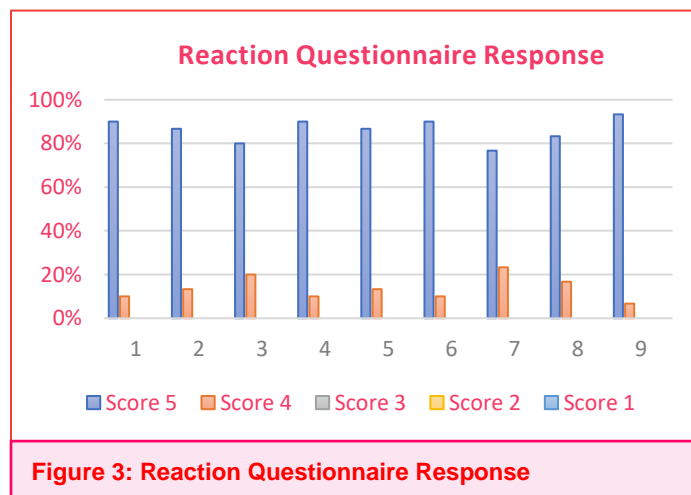
Variable	Maximum score	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	P value
Knowledge	20	10.73 ± 2.42	13.5 ± 2.87	< 0.0001**
Skill	7	3.466 ± 1.56	6.066 ± 1.25	< 0.0001**
Number of participants who followed all steps of checklist		2 (6.66%)	17 (56.66%)	< 0.0001**
Time to initiate CPR (seconds)		60 ± 19.76	26.56 ± 16.07	0.0001**
Time to defibrillation(seconds)		118.6 ± 28	93 ± 33.38	0.0022*

*P < 0.05 considered as significant; * is significant, ** is highly significant*

Table 3: Reaction questionnaire and data for Figure 3; Reaction questionnaire (30 responses)

No	Question	Strongly agree - 5	Agree - 4	Neither agree nor Disagree - 3	Disagree - 2	Strongly Disagree - 1
1	Topic selected was useful to me	90	10	0	0	0
2	Facilitators were supportive in conduct of this session	86.7	13.3	0	0	0
3	The session was well organized	80	20	0	0	0
4	My knowledge increased as a result of this session	90	10	0	0	0
5	My skills increased as a result of this session	86.7	13.3	0	0	0
6	Simulation based teaching is a useful format for learning algorithms	90	10	0	0	0
7	My confidence level to treat cardiac patients has increased as a result of this session	76.7	23.3	0	0	0
8	I can apply the skills learnt in this session in my clinical practice	83.3	16.7	0	0	0
9	I can recommend using such sessions to learn similar topics	93.3	6.7	0	0	0

Data given as percentage (%)

**Figure 3: Reaction Questionnaire Response**

favorable reaction to the training program was received from the students. (Table 3; Figure 3) They perceived it to be engaging, relevant to their clinical practice and were willing to learn similar topics using simulation as the teaching method (93.3%). Majority of the students (76.7%) strongly agreed that they felt confident in comprehension and use of ACLS algorithm in clinical situations. Our results reinforced the study findings of other authors.^{9,10} A study by Shailaja et al. showed a satisfaction of 95% among students for the training program.⁹

Level 2 of the Kirkpatrick Model of Evaluation, which measures change in knowledge, was also assessed in this

study (Figure 1). There was a significant ($P < 0.0001$) improvement in scores of knowledge in the post-test.

From the pre-test (13.5 ± 2.87 vs. 10.73 ± 2.42). Such results were also seen in a study by Shailaja et al.⁹ who noted increase in scores (pre -test 24.22 ± 7 to 47.18 ± 5.6 post-test), which were statistically significant ($P = 0.007$) in a simulation training of anesthesia residents. The skill evaluation also showed improvement in the post-test (Table 2) and students who followed all points on the checklist (Appendix 1) also showed an increase in their skill levels significantly (6.66% vs. 56.66% ; $P = 0.0001$).

The mannequin gives objective computerized data on the rate and efficacy of chest compressions, ventilation, chest compression fraction, time to initiate CPR and defibrillate.³ Training resulted in a shorter time to recognize cardiac arrest, initiate CPR and defibrillate. The protocol was followed accurately by 56.6% of the students during the assessment. Langdorf et al. noted 74% of students perform CPR + defibrillation ≤ 2 min after a high fidelity ACLS training.¹¹ Meta-analysis of studies reporting skill performance at course conclusion demonstrated a moderate benefit for high fidelity manikins when compared with low fidelity manikins [standardized mean difference 0.59; 95% CI 0.13–1.05].¹²

The advent of simulation is resulting in a shift from the traditional apprentice-based system of learning to outcome-based education.¹ Simulation has bridged the gaps in the knowledge and skill levels of healthcare staff, and allowed us to address safety and quality issues for the best outcomes for the patients.^{2,13,14} Technology is improving the potential to deliver better health care and patient outcomes and hence should be used as an educational tool.

5. LIMITATIONS

Small sample size limits the interpretation of the results. Follow up studies are required to measure long term retention of acquired skills (Kirkpatrick level 3). Additional studies are required to document if the training translates to better patient care and reduced medical errors (Kirkpatrick level 4).

6. CONCLUSION

Knowledge, psychomotor skills and confidence level of medical postgraduate students increased after the simulation-based training session in the management of cardiac arrest. Such sessions benefit students as reported in their feedback.

7. Data availability

The numerical data generated during this research is available with the authors.

8. Acknowledgement

We gratefully thank Simulation and Skills Centre, D. Y. Patil Medical College, Kolhapur.

9. Conflict of interest

The study utilized the hospital resources only, and no external or industry funding was involved.

10. Authors' contribution

AP: Concept, Design, Intellectual content, Literature search, Study, Manuscript preparation, Editing, Review, Guarantor_

SK: Design, Intellectual content, Conduct of study, Manuscript editing, review

PM: Intellectual content, literature search, manuscript preparation, editing

SP: Study conduct, Manuscript preparation, review

SS, SSI: Clinical studies, literature search

11. REFERENCES

1. Chacko TV. Simulation-based medical education: Using nest practices and curriculum mapping to maximize educational benefits in the context of shift toward competency-based medical education. *Arch Med Health Sci.* 2017;5:9-15. DOI: [10.4103/2321-4848.208217](https://doi.org/10.4103/2321-4848.208217)
2. So HY, Chen PP, Wong GKC, Chan TTN. Simulation in medical education. *J R Coll Physicians Edinb.* 2019 Mar;49(1):52-57. [PubMed] DOI: [10.4997/JRCPE.2019.112](https://doi.org/10.4997/JRCPE.2019.112)
3. Apollo Adult Patient Simulator. Available from: <https://www.caehealthcare.com/patient-simulation/apollo/>
4. Bhagwat M. Simulation and anaesthesia. *Indian J Anaesth.* 2012 Jan;56(1):14-20. [PubMed] DOI: [10.4103/0019-5049.93338](https://doi.org/10.4103/0019-5049.93338)
5. National Medical council. Competency based undergraduate curriculum for the Indian Medical graduate. Available from: <https://www.nmc.org.in/information-desk/for-colleges/ug-curriculum/>
6. Solymos O, O'Kelly P, Walshe CM. Pilot study comparing simulation-based and didactic lecture-based critical care teaching for final-year medical students. *BMC Anesthesiol.* 2015 Oct 21;15:153. [PubMed] DOI: [10.1186/s12871-015-0109-6](https://doi.org/10.1186/s12871-015-0109-6)
7. Adams NE. Bloom's taxonomy of cognitive learning objectives. *J Med Libr Assoc.* 2015 Jul;103(3):152-3 [PubMed] DOI: [10.3163/1536-5050.103.3.010](https://doi.org/10.3163/1536-5050.103.3.010)
8. Kirkpatrick DL. *Evaluating Training Programs: The Four Levels.* 2nd ed. San Francisco, CA: Berrett-Koehler Publ; 1998.
9. Shailaja S, Hilda SS, Pinto PA, D'Cunha RJ, Mahmood LS, Hegde RB. Evaluation of resident satisfaction and change in knowledge following use of high-fidelity simulation teaching for anaesthesia residents. *Indian J Anaesth.* 2019 Nov;63(11):908-914. [PubMed] DOI: [10.4103/ija.IJA_133_19](https://doi.org/10.4103/ija.IJA_133_19)
10. Bowers KM, Smith J, Robinson M, Kalnow A, Latham R, Little A. The Impact of Advanced Cardiac Life Support Simulation

Training on Medical Student Self-reported Outcomes. *Cureus*. 2020 Mar 6;12(3):e7190. [PubMed] DOI: [10.7759/cureus.7190](https://doi.org/10.7759/cureus.7190)

11. Langdorf MI, Strom SL, Yang L, Canales C, Anderson CL, Amin A, et al. High-fidelity simulation enhances ACLS training. *Teach Learn Med*. 2014;26(3):266-73. [PubMed] DOI: [10.1080/10401334.2014.910466](https://doi.org/10.1080/10401334.2014.910466)

12. Cheng A, Lockey A, Bhanji F, Lin Y, Hunt EA, Lang E. The use of high-fidelity manikins for advanced life support training--A systematic review and meta-analysis. *Resuscitation*. 2015 Aug;93:142-9. [PubMed] DOI: [10.1016/j.resuscitation.2015.04.004](https://doi.org/10.1016/j.resuscitation.2015.04.004)

13. Good JJ, Rabener MJ. ACLS interventional skills: Are we as good as we should be? *JAAPA*. 2021 Apr 1;34(4):40-45. [PubMed] DOI: [10.1097/01.JAA.0000735764.43931.0c](https://doi.org/10.1097/01.JAA.0000735764.43931.0c)

14. Gabbard K, Smith-Steinert RM. Advanced Cardiac Life Support Simulation for Nurse Anesthetists and student Nurse Anesthetists. *Clini Simulation Nurs*. 2021;50:65-73. DOI: [10.1016/j.ecns.2020.06.006](https://doi.org/10.1016/j.ecns.2020.06.006)

Appendix 1: Assessor check list

No.	Skill	Participant number										
		1	2	3	4	5	6	7	8	9	10	
1.	Able to recognize cardiac arrest											
2.	Call for help											
3.	Able to check pulse & respiration											
4.	Was the depth of chest compressions adequate?											
5.	Was the rate of chest compressions, correct?											
6.	Able to perform head tilt/chin lift?											
7.	Able to deliver breath?											
8.	Time to recognize cardiac arrest (min)											
9.	Time to first defibrillation (min)											
Note for examiner: <ul style="list-style-type: none"> • If student performs the step adequately and completely score 1 • If student attempts the step but performs inadequately or incompletely score 0 • If student does not attempt or fails to consider the step score 0 												
Signed (Examiner)..... Date: /...../.....												
Signed (Moderator)..... Date: /..... /.....												