Section: Paediatrics

Original Research Article

SIMULATION-BASED TRAINING ENHANCING PAEDIATRIC CRITICAL CARE SKILLS AMONG POSTGRADUATE MEDICAL TRAINEES

Ashwani Kumar Mishra[1], Nukala Chaitanya Krishna[2], Rama Krishna Paramhamsa[3], Sandeep Ganni[4]

[1]Fellow, Paediatric Critical Care (Simulation), GSL Medical College, Rajahmundry, Andhra Pradesh, India.
[2]Assistant Professor, Department of Paediatrics, GSL Medical College, Rajahmundry, Andhra Pradesh, India
[3]Professor and Head, Department of Paediatrics, GSL Medical College, Rajahmundry, Andhra Pradesh, India
[4]Director, Simulation Laboratory & GSL Medical College, Rajahmundry, Andhra Pradesh, India

Received : 15/05/2026
Received in revised form : 24/06/2026
Accepted : 08/07/2026

Keywords:
Simulation-based training, Paediatric critical care, Chest compression fraction, Intubation time, Postgraduate medical education.

Corresponding Author:
Dr. Ashwani Kumar Mishra,
Email: ashwanikumarmishra29@gmail.com

DOI: 10.47009/jamp.2026.8.4.45

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2026; 8 (4); 245-248

ABSTRACT

Background: Postgraduate paediatric trainees are frequently required to recognise and manage rare but life-threatening critical illnesses in children, situations for which conventional didactic teaching provides limited hands-on preparation. Simulation-based education allows trainees to acquire and rehearse such high-stakes skills repeatedly in a controlled, patient-safe environment. The objective of this study was to evaluate the impact of a structured paediatric critical care simulation training programme on chest compression fraction (CCF) and time taken for intubation among postgraduate paediatric trainees, and to assess associated changes in technical execution and situational awareness. **Materials and Methods:** A prospective observational study was conducted in the simulation laboratory of a tertiary care teaching hospital. Forty postgraduate paediatric residents and fellows were enrolled after obtaining valid informed consent and were randomly divided into four teams of ten participants each. Participants underwent training across eight high-risk paediatric emergency scenarios using high-fidelity mannequins, with structured debriefing and peer-led reflection after each session. CCF and time to intubation were recorded during a standardised cardiac arrest scenario before and after the workshop, and were compared using a paired t-test. **Results:** The mean CCF improved from 70% before training to 82.5% after training ($p < 0.001$). The mean time taken for intubation reduced from 135.75 seconds to 51.25 seconds ($p < 0.001$). All four teams showed consistent improvement across both metrics. Team C achieved the highest post-training CCF and shortest post-training intubation time, while the largest absolute reduction in intubation time was observed in Team B. Participants also reported improved confidence, teamwork, leadership, and closed-loop communication after the workshop. **Conclusion:** A structured, scenario-based paediatric critical care simulation module significantly improves technical performance metrics and non-technical teamwork skills among postgraduate trainees. Incorporating simulation into routine paediatric postgraduate curricula may enhance preparedness for high-risk paediatric emergencies and improve overall clinical outcomes.

INTRODUCTION

Critically ill children present a complex array of diagnostic and therapeutic challenges that demand rapid recognition, structured decision-making, and coordinated team response.[1] Because true paediatric emergencies such as cardiac arrest, status epilepticus, and septic shock are comparatively infrequent in routine clinical postings, postgraduate trainees often complete their training with limited first-hand exposure to these high-stakes events.[2] Conventional didactic teaching, while important for the acquisition of theoretical knowledge, does not by itself allow trainees to rehearse the psychomotor and cognitive skills required to manage acute deterioration in a child.

Simulation-based education has emerged as a transformative pedagogical approach that enables

ISSN (O): 2687-5365; ISSN (P): 2753-6556

learners to develop and refine clinical competencies in a safe, controlled environment without risk to real patients.[3] High-fidelity mannequin-based simulation, in particular, permits repeated deliberate practice of critical procedures such as chest compressions and endotracheal intubation, with objective measurement of performance metrics including chest compression fraction (CCF) and time to intubation, both of which are recognised determinants of outcome in paediatric cardiopulmonary resuscitation.[4] Beyond technical skill acquisition, simulation training also creates a structured opportunity to practise non-technical competencies such as team leadership, role allocation, and closed-loop communication, which are equally critical to effective resuscitation performance.[5]

Several international programmes have demonstrated that mannequin-based simulation curricula improve procedural performance and confidence among paediatric trainees, and structured debriefing following simulated scenarios has been shown to consolidate learning and translate into longer-term skill retention.[5] However, locally developed data describing the impact of an existing simulation curriculum on objective performance metrics among postgraduate paediatric trainees in Indian teaching hospitals remain limited. The present study was therefore undertaken to evaluate the impact of a structured paediatric critical care simulation training programme, comprising eight high-risk paediatric emergency scenarios, on chest compression fraction and time to intubation among postgraduate paediatric residents and fellows at a tertiary care hospital simulation laboratory.

MATERIALS AND METHODS

This prospective observational study was conducted in the simulation laboratory of GSL Medical College, a tertiary care teaching hospital, to assess the impact of an existing simulation-based training programme on the clinical performance of paediatric residents and fellows. Following institutional approval, a total of 40 postgraduate paediatric trainees were enrolled after obtaining valid informed consent and were randomly divided into four teams of ten participants each (Team A, Team B, Team C, and Team D).

The training curriculum was developed by a multidisciplinary team comprising paediatricians, intensivists, and simulation educators, and covered eight high-risk paediatric emergencies: septic shock, acute severe asthma, status epilepticus, supraventricular tachycardia, polytrauma, cardiac arrest, croup, and sick newborn resuscitation. [Table 1] High-fidelity mannequins were used to simulate realistic clinical environments for each scenario.

Prior to the workshop, participants completed a validated pre-test and performed a standardised cardiac arrest scenario, during which chest compression fraction (CCF) and time to intubation were recorded by trained simulation faculty using scenario-recording software integrated with the mannequin system. Following the simulation training, each session concluded with structured debriefing and peer-led reflection to reinforce both technical skills and non-technical skills such as communication, leadership, and teamwork. Post-training assessment included a validated post-test and a repeat of the identical cardiac arrest scenario to measure change in performance metrics.

Team-wise mean CCF (%) and time to intubation (seconds) were recorded before and after the workshop. Descriptive statistics (mean) were computed for each team, and paired comparison of pre- and post-training values was performed for CCF and time to intubation using a paired t-test, with a p-value of less than 0.05 considered statistically significant.

Table 1: Paediatric critical care scenarios included in the simulation curriculum

S. No.	Scenario	Primary Skill Assessed
1	Septic shock	Fluid resuscitation, early recognition, escalation
2	Acute severe asthma	Bronchodilator therapy, escalation of respiratory support
3	Status epilepticus	Airway protection, stepwise anticonvulsant therapy
4	Supraventricular tachycardia	Rhythm recognition, vagal manoeuvres, cardioversion
5	Polytrauma	Primary survey, haemorrhage control, team coordination
6	Cardiac arrest	Chest compression fraction, defibrillation, intubation
7	Croup	Airway assessment, nebulised therapy, escalation triggers
8	Sick newborn resuscitation	Neonatal airway management, thermoregulation, team roles

RESULTS

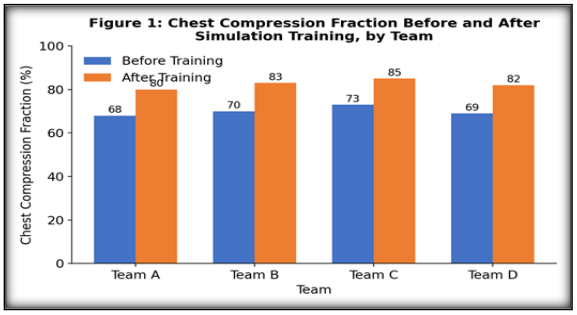
Forty postgraduate paediatric trainees, divided into four teams of ten, completed the pre- and post-training assessments. All 40 participants completed both the pre-workshop and post-workshop cardiac arrest scenarios, with no dropouts recorded during the study period.

Chest compression fraction improved consistently across all four teams following simulation training. [Table 2] The mean CCF across teams increased from 70% before training to 82.5% after training, and this improvement was statistically significant ($p < 0.001$). Team C recorded both the highest pre-training CCF (73%) and the highest post-training CCF (85%), while Team A recorded the lowest pre-training CCF (68%), improving to 80% after training.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Table 2: Chest compression fraction (CCF) before and after simulation training

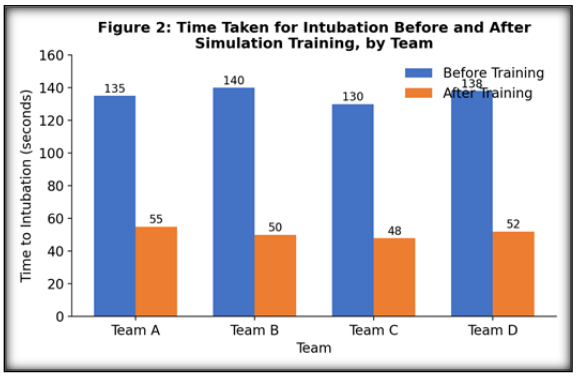
Team	CCF Before (%)	CCF After (%)
Team A	68	80
Team B	70	83
Team C	73	85
Team D	69	82
Mean	70	82.5
p < 0.001		



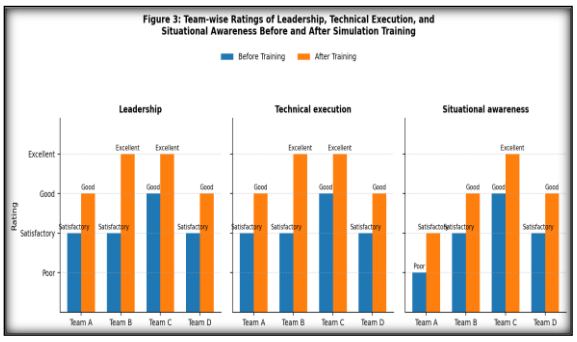
Time taken for intubation reduced substantially in every team following the workshop. [Table 3] The mean intubation time across teams fell from 135.75 seconds before training to 51.25 seconds after training, a reduction that was statistically significant ($p < 0.001$). Team C achieved the shortest post-training intubation time (48 seconds), while Team B, which had the longest pre-training intubation time (140 seconds), showed the largest absolute reduction (90 seconds).

Table 3: Time taken for intubation before and after simulation training

Team	Time Before (sec)	Time After (sec)
Team A	135	55
Team B	140	50
Team C	130	48
Team D	138	52
Mean	135.75	51.25
p < 0.001		



Beyond the two objective performance metrics, participants across all teams demonstrated qualitatively better team leadership, more efficient technical execution, and improved situational awareness during the post-training cardiac arrest scenario. Post-workshop feedback from participants indicated improved confidence and perceived teamwork compared with the pre-workshop baseline.



Ratings reflect structured faculty observation during the pre- and post-training cardiac arrest scenario, recorded on a four-point descriptive scale (Poor, Satisfactory, Good, Excellent).

DISCUSSION

The present study demonstrates that a structured, scenario-based simulation curriculum produces a substantial and statistically significant improvement in two objective markers of resuscitation performance, chest compression fraction and time to intubation, among postgraduate paediatric trainees. The magnitude of improvement in CCF (from a mean of 70% to 82.5%) and in intubation time (from a mean of 135.75 seconds to 51.25 seconds) is consistent with the wider literature demonstrating that repeated deliberate practice on high-fidelity mannequins, supported by structured debriefing, meaningfully improves resuscitation skill acquisition.[6,7]

Chest compression fraction is a well-recognised determinant of return of spontaneous circulation and survival following cardiac arrest, and even modest improvements are considered clinically meaningful.[4] The consistent gains observed across all four teams in this study, rather than in isolated individuals, suggest that the improvement reflects a genuine curriculum effect rather than the performance of a few high-achieving participants. Similarly, the marked reduction in time to intubation across all teams is consistent with reports that repeated simulation practice using high-fidelity

ISSN (O): 2687-5365; ISSN (P): 2753-6556

mannequins shortens procedural time and improves first-attempt success in paediatric intubation.[8]

Simulation-based training provides an invaluable opportunity to practise the recognition and management of rare but life-threatening paediatric conditions without risk to patients. This approach also fosters essential non-technical skills such as team dynamics, leadership, and closed-loop communication, which were qualitatively observed to improve in this study alongside the objective performance metrics.[5,9] The inclusion of structured debriefing and peer-led reflection after every scenario is likely to have contributed meaningfully to this dual improvement in technical and non-technical performance, consistent with evidence that debriefing is one of the most influential components of simulation-based learning.[9]

The implementation of this simulation module demonstrated encouraging learner engagement and skill acquisition across a broad range of high-risk paediatric emergencies. Coverage of eight distinct scenarios, spanning respiratory, cardiovascular, neurological, traumatic, and neonatal emergencies, allowed trainees to build a versatile skill set applicable across the spectrum of paediatric critical illness, rather than proficiency limited to a single clinical presentation. Some limitations of this study should be acknowledged. This was a single-centre study conducted over a limited period with a relatively small sample of 40 participants, and the findings may not be directly generalisable to institutions with different curricula, faculty expertise, or simulation resources. Performance was assessed immediately after training, and the study did not evaluate longer-term skill retention or translation of simulated performance into real clinical outcomes. Additionally, the analysis was restricted to two objective metrics; non-technical skills such as leadership and communication were reported descriptively rather than through a validated structured scoring instrument.

CONCLUSION

A structured paediatric critical care simulation module can significantly enhance the training experience for postgraduate paediatric trainees, producing measurable improvement in chest compression fraction and time to intubation, alongside qualitative gains in team leadership and communication. By integrating simulation into regular paediatric postgraduate education, training institutions can better prepare healthcare providers to respond effectively to paediatric emergencies and improve overall clinical outcomes. Future directions should include structured outcome assessment using validated non-technical skills instruments, objective performance metrics across a wider range of scenarios, and longitudinal evaluation of skill retention beyond the immediate post-training period.

REFERENCES

1. Tofil NM, Benner KW, Worthington MA, Zinkan JL, White ML. Pediatric intensive care simulation course: A new paradigm in teaching. J Grad Med Educ. 2011;3(1):81-87.
2. Mannarino CN, Galler R, Montgomery K, Hinkle M, Hall M. Pathophysiology for the Pediatric Critical Care Fellow: Three Representative Simulation Cases. MedEdPORTAL. 2020;16:10914.
3. Issenberg SB, McGaghie WC, Petrusa ER, Lee Gordon D, Scalese RJ. Features and uses of high-fidelity medical simulations that lead to effective learning: a BEME systematic review. Med Teach. 2005;27(1):10-28.
4. Sutton RM, Case E, Brown SP, et al. A quantitative analysis of out-of-hospital pediatric and adolescent resuscitation quality - A report from the ROC epistry-cardiac arrest. Resuscitation. 2015;93:150-157.
5. Cheng A, Eppich W, Grant V, Sherbino J, Zendejas B, Cook DA. Debriefing for technology-enhanced simulation: a systematic review and meta-analysis. Med Educ. 2014;48(7):657-666.
6. Andreatta P, Saxton E, Thompson M, Annich G. Simulation-based mock codes significantly correlate with improved pediatric patient cardiopulmonary arrest survival rates. Pediatr Crit Care Med. 2011;12(1):33-38.
7. Halamek LP, Kaegi DM, Gaba DM, et al. Time for a new paradigm in pediatric medical education: teaching neonatal resuscitation in a simulated delivery room environment. Pediatrics. 2000;106(4):e45.
8. Couto TB, Reis AG, Farhat SC, Carvalho VE, Schvartsman C. Changing the view: impact of simulation-based mastery learning in pediatric tracheal intubation with videolaryngoscopy. J Pediatr (Rio J). 2021;97(1):30-36.
9. Grant DJ, Marriage SC. Training using medical simulation. Arch Dis Child. 2012;97(3):255-259.

ISSN (O): 2687-5365; ISSN (P): 2753-6556