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Evaluation of Team Dynamics and Clinical Preparedness in Pediatric Code Blue through a Structured Simulation Module

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ABSTRACT

Background: Training through simulation is becoming one way to reinforce non-technical competencies, such as teamwork, communication, and leadership, alongside technical skills in code blue management. This study aimed to examine team dynamics among pediatric residents and nursing staff in the pediatric intensive care unit (PICU) following simulation-based systematic training in pediatric Code Blue.

Methods: The quasi-experimental study was conducted in the Department of Paediatrics at Pramukh Swami Medical College and Shree Krishna Hospital, Gujarat, India, between September 2023 and February 2025. Twenty-four participants (Pediatric Junior Residents and PICU nursing staff) were selected through stratified sampling, placed in four interprofessional teams, and trained through a Simulation-Based short-course training module. After two weeks of interaction and practice among team members, groups were systematically evaluated on standardized pediatric Code Blue scenarios.

Results: Out of the total 8 components of team dynamics, assessments showed good performance in mutual respect, role distribution, and proper help-seeking behavior, whereas relative weaknesses were found in communication and leadership. The self-assessment scores were significantly higher than both the mentor and expert ratings ($p<0.05$). Confidence and satisfaction levels were high among all participants, who rated 7 or higher on a 10-point Likert scale.

Conclusion: Pediatric Code Blue simulation training enhances team dynamics, confidence, and clinical preparedness among pediatric healthcare providers. Multi-source evaluation and debriefing play an important role in identifying gaps in areas such as leadership and communication.

Key-words: Code Blue, Clinical preparedness, Inter-professional, Patient safety, Resuscitation, Simulation, Team Dynamics

INTRODUCTION

The application of stimulation-based team training in education has become increasingly effective over the past few decades. Team-based stimulation improved knowledge, skills, and behavioural patterns [1]. In emergency medicine (EM), stimulation-based team training has shown efficacy in trauma and cardiac arrest.

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The purpose of simulation-based training is to enhance the quality of treatment and ensure patient safety, thereby increasing adherence to the principles of the team-based resuscitation strategy [2]. This will help optimise diagnostics and interventions [3]. Optimisation of critical diagnostics and interventions will enhance the patient outcome, such as morbidity and mortality. One of the most significant tools for analyzing and evaluating the outcomes of education and training is the Kirkpatrick Model. It represents the structure for stratifying the impact of the training outcome into four levels. Level 1 includes the participants' initial reaction to the training program; Level 2 refers to individual learning; Level 3 refers to alterations in behavioural patterns post-

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training; and Level 4 indicates various clinical characteristics and patient outcomes [4]. The main focus and the outcome of the simulation-based training include both technical and non-technical skills. Technical skills refer to the appropriate actions from a medical and technical perspective, and non-technical skills refer to the team's decision-making and interaction abilities to manage the team [5]. Simulation-based training can be conducted either in situ or at a simulation centre. Simulation mannequins or actors can be utilised in both settings, and various patient characteristics are included, including voices and reactive pupils. The simulation can be denominated as high fidelity or low fidelity based on complexity [6]. Simulation-based team training has shown significant contributions to learning in trauma training and has enhanced survival to discharge in the implementation of cardiac arrest training [7]. It is crucial to acknowledge that the critical conditions other than trauma and cardiac arrest are presented in the critical care and emergency medicine, which are taught in team training. Multiple tasks, depending on the case, such as chest compressions, are included in cardiac arrest and trauma care, which involves broad multidisciplinary teams. Thus, stimulation training should be emphasised beyond these realms [8]. The study aims to assess the team dynamics and clinical preparedness of healthcare specialists during pediatric Code Blue events through simulation modules for training.

MATERIALS AND METHODS

Study Design- The current quasi-experimental study was conducted in the Department of Pediatrics, Pramukhswami Medical College, and Shree Krishna Hospital, Karamsad, Gujarat. Shree Krishna Hospital is a 1000-bed NABH-accredited multispecialty tertiary care hospital offering affordable and comprehensive healthcare services, including 24 x 7 emergency and intensive care. At the hospital, the Department of Paediatrics now has 96 beds, 14-bed Pediatric Intensive Care Unit (PICU), and Neonatology is an independent department with 20 beds and a DM (Neonatology) program. The institution has a well-equipped Simulation Center with state-of-the-art task trainers and full-body manikins of different fidelity, which aid safe, competency-based training in line with the Competency-Based Medical Education (CBME) curriculum, as required by the National Medical Commission. The study was conducted between September 2023 and February 2025. Between September 2023 and December 2024, a short-course training module was created, ethical committee approval was obtained, and mannequins and consumables were granted. All pediatric residents and nursing staff who volunteered were taken through two structured training sessions in January 2025, before team formation, and received at least 2 weeks of practice. The evaluation was conducted through video-recorded simulation scenarios in February 2025; four teams were assessed in a single session. Study participants were pediatric junior residents (JR 2 and JR3) and PICU nursing staff. Stratified sampling was used to select 24 willing participants to form four teams of six people each: two JR2s, two JR3s, one senior nurse, and one junior nurse.

Inclusion Criteria- All pediatric residents and nursing staff who responded to the Google link to attend the training module.

Exclusion Criteria:

- Nursing staff who declined consent for the video-recorded simulation assessment
- Newly joined first-year resident doctors
- Third year resident doctors who are colleagues of the investigator PG student
- Investigator PG student himself.
- Those who did not complete training

Study tool- The Principal Investigator created a formal, short-course educational program based on the standard Pediatric Advanced Life Support (PALS) principles and the IAP ALS Handbook (2020). A co-investigator conducted training in two sessions, based on participants' availability. Every session included a didactic lecture on the approach to a critically ill child, an 11-minute instructional video on what an ideal code blue response should be, and a printed handout of Chapter 7.2 of the IAP ALS Handbook. They were divided into four interprofessional teams: Team Spade, Heart, Club, and Diamond, each consisting of six individuals (two JR3s, two JR2s, and two nurses). A faculty mentor/senior PICU fellow was assigned to each team to provide direction after training and during practice and assessment preparation. Participants were asked to study relevant chapters from the IAP ALS Handbook (2020) and practice scenarios.

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A practical evaluation was conducted two weeks after training using standard mannequins, equipment, and consumables located at the scenario site, with a simulation-based evaluation. The teams were given one familiar case scenario, which was played in a simulated hospital setting, and video recordings were made. The next step was a debriefing, during which the participants were asked to complete a self-assessment form. Team leaders and mentors who watched videos of other teams then conducted peer evaluations. Lastly, all recordings were evaluated separately by two external expert faculty members who used a standardized expert evaluation form. The evaluation of team dynamics and non-technical skills was informed by baseline preparation, reflections, peer reviews, and expert reviews.

Statistical Analysis- The data was recorded and analyzed in Excel. Baseline characteristics were obtained using descriptive statistics such as Mean, SD, frequency, and Percentage. Further data analysis was performed using the statistical software Stata 18. To establish the relationship between variables, Chi-square and independent-samples t-tests were used. The $p<0.05$ was statistically significant.

Ethical consideration- Before the commencement of data collection, approval was obtained from the Institutional Ethics Committee (IEC/BU/145/Faculty/03/288/2023). The Dean, Pramukhswami Medical College, granted permission, and the Chief Nursing Officer, Shree Krishna Hospital, granted permission for the participation of pediatric resident doctors and nursing staff. The study adhered to Institutional Ethics Committee guidelines, and written informed consent was obtained from all participants after providing a Participant Information Sheet. Study records, including video recordings and evaluation forms, were securely stored and anonymised during analysis.

RESULTS

Baseline details of participants are shown in Table 1. In the present study, the ratio was 3:1, with 18 (75%) of the 24 participants being females and 6 (25%) males. There were 4 resident doctors and 2 nursing staff out of 6, and it is also important to note that the resident doctors and nursing staff were equally distributed across the teams based on their experience, year of residence, or job years.

Table 1: Demographic and professional characteristics of study participants (n=24)

Category	Subcategory	Total numbers	
Nursing staff	Female	08	08
	Male	0	
Resident doctors	Female	10	16
	Male	06	
Experience of nursing staff	Senior nurses (>10 years)	04	08
	Junior nurses (< 2 years)	04	
Year of residency	2rd year residents	08	16
	Exam cleared 3rd year residents	08	

Table 2 indicates the baseline status of all 24 study participants in terms of the pediatric code blue-related training and prior experience of any kind. Fig. 1 and 2 show the confidence and satisfaction levels post-session on a 10-point Likert scale, which were quite high. Of the total participants (n=24), 12 participants reported a confidence level of 9, and an additional 7 reported full confidence (10/10 Likert scale). None of the participants had a level above 7. The level of satisfaction was also 7 or higher among all participants, as shown in Fig. 2.

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Table 2: Baseline status of study participants (Pediatric code Blue-related)

	Sub-category	Team heart (♥) n=6	Team Club (♣) n=6	Team Spade (♠) n=6	Team Diamond (♦) n=6	Total numbers	p-value**
Before E-Sanjeevani Similar online module training received.	JRs	4	4	4	4	16/16	>0.99
	Nurses	2	2	2	2	8/8	
	Total	6	6	6	6	24/24	
Prior Code Blue training was received.	JRs*	4	4	4	4	16/16	>0.99
	Nurses	2	2	2	2	8/8	
	Total	6	6	6	6	24/24	
Prior IAP ALS BLS Course or Institutional ALS BLS training undertaken.	JRs	4	4	4	4	16/16	>0.99
	Nurses	2	2	2	2	8/8	
	Total	6	6	6	6	24/24	
Prior institutional NABH-related modules or handbook training undertaken.	JRs	4	4	4	4	16/16	>0.99
	Nurses	2	2	2	2	8/8	
	Total	6	6	6	6	24/24	
Prior participation in code blue activation in real life.	JRs	3	2	4	3	12/16	0.30
	Nurses	0	1	2	2	5/8	
	Total	3	3	6	5	17/24	

**JRs: Junior Residents, ** Chi-square test, p<0.05 considered significant.*

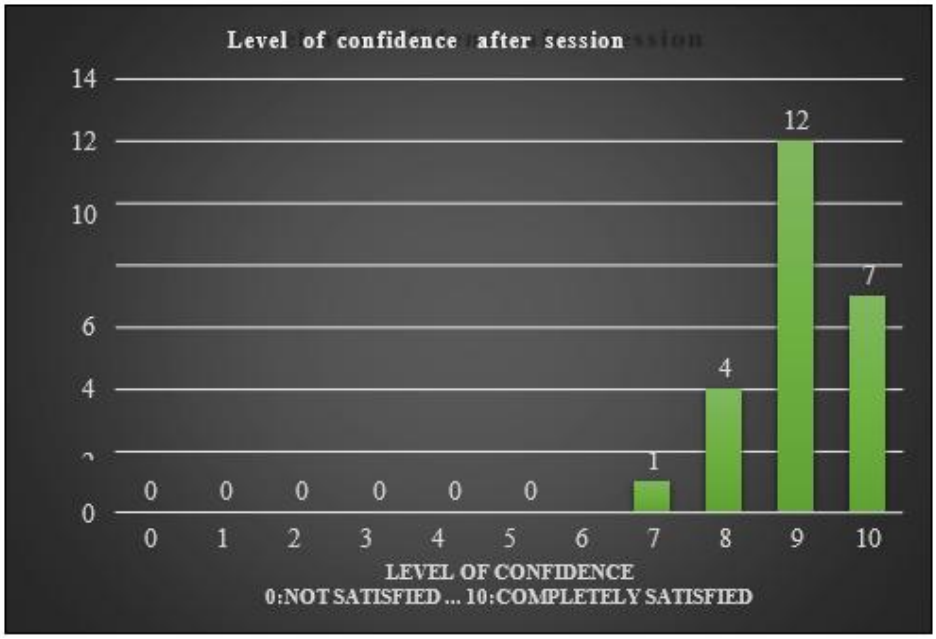

Fig. 1: Level of confidence gain post-session (as per 0,1,2….10 Likert scale)

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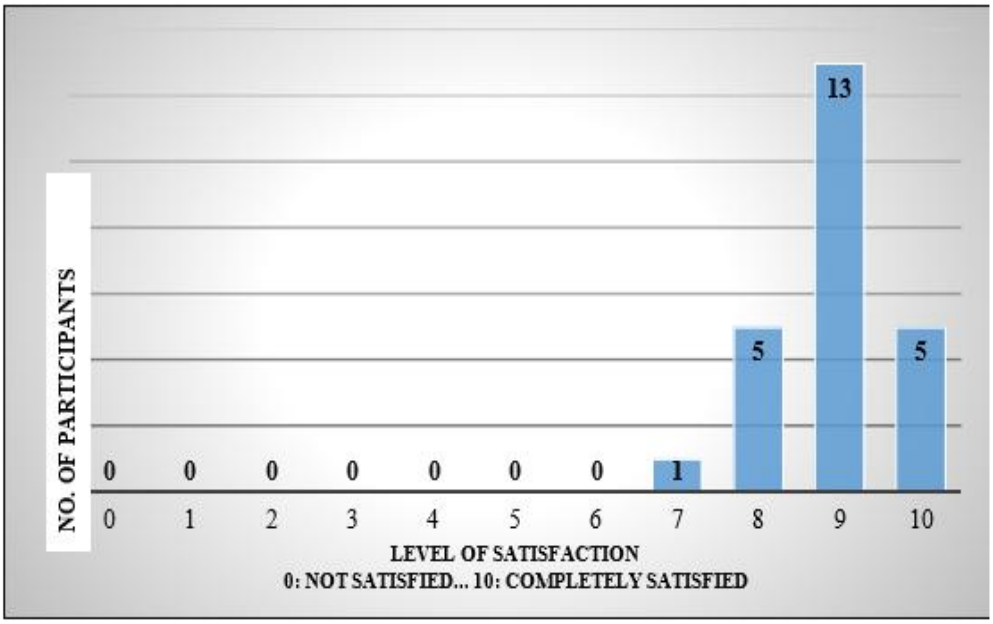

Fig. 2: Level of Satisfaction post-session (as per 0,1,2…10 Likert scale)

Apart from confidence and satisfaction levels, participants evaluated all eight elements of team dynamics using a 0–2 scoring system (Score 0: Not performed; Score 1: Performed improperly or incompletely; Score 2: Performed properly/completely). Fig. 3 presents the scoring distribution for Knowledge Sharing, Mutual Respect, Team Dynamics, and Team Communication across all participants. Fig. 4 illustrates the scoring distribution for External Communication, Role Allocation, Leadership, and Call for Help. A score of 2 was most frequently reported in leadership skills (21 respondents) and role allocation (20 respondents), followed by appropriately calling for help (18 respondents) and external communication (16 respondents). Score 1 was observed in 8 respondents for external communication, 6 for appropriate call for help, and 3 each for role allocation and leadership skills.

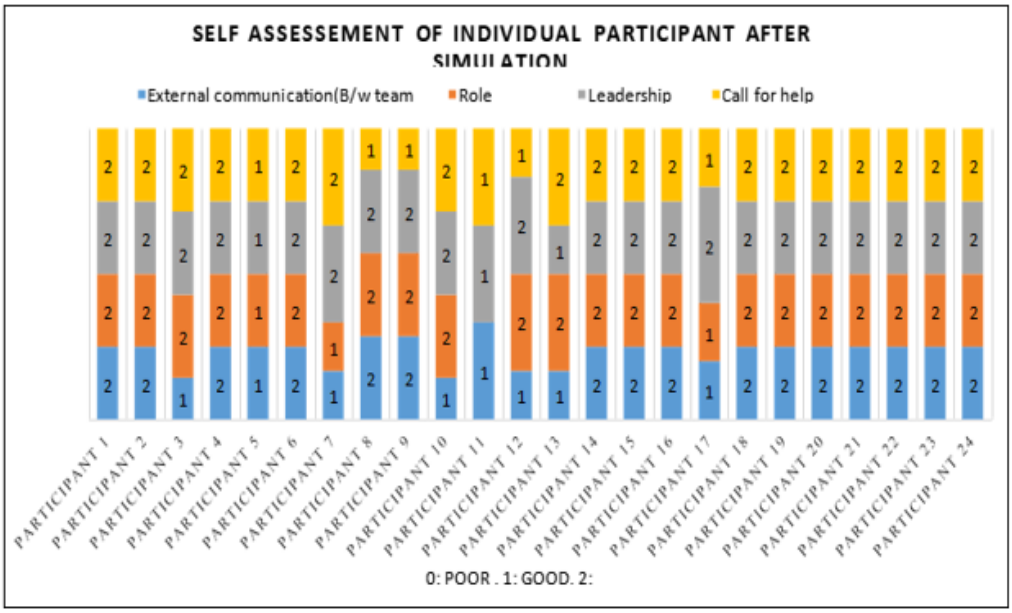

Fig. 3: Self-reported scores by individual participant after simulation scenario for the first 4 components of team dynamics

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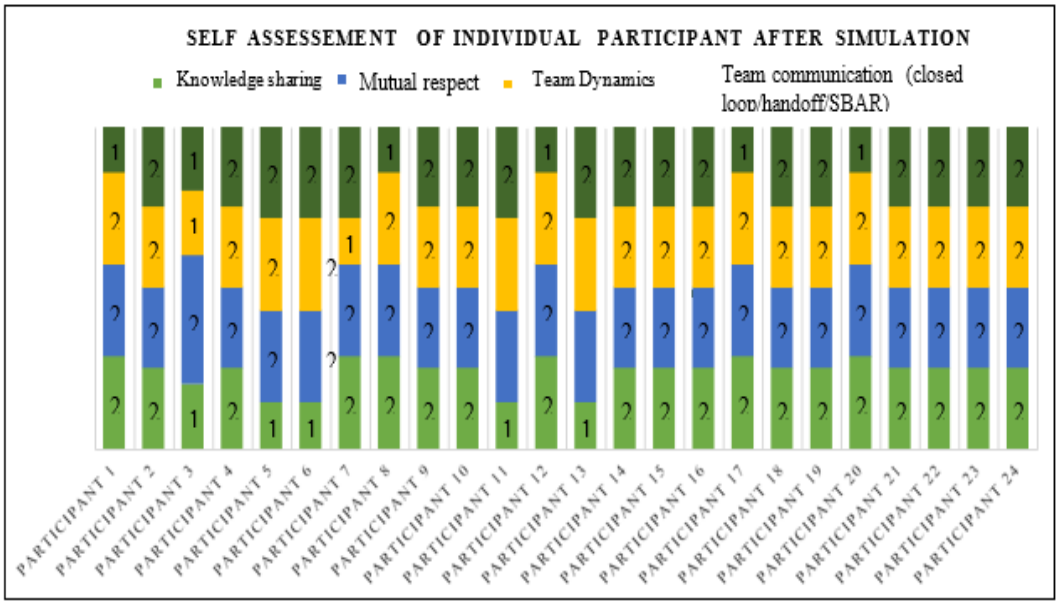

Fig. 4: Self-reported scores by individual participant after simulation scenario for the last 4 components of team dynamics

Table 3 compares self-evaluation scores with leader and mentor evaluations for all eight components of team dynamics. Statistically significant differences were observed in knowledge sharing, team dynamics, and total scores when self-evaluation was compared with mentor evaluation ($p<0.001$ for several components). Team communication showed a significant difference between leaders' self-ratings and self-ratings ($p=0.001$), but not between mentors' self-ratings ($p=0.14$). Mentors rated role allocation ($p=0.015$) and leadership skills ($p=0.004$) significantly lower than participants' self-ratings. No significant differences were observed for mutual respect, external communication, or call for help. Overall scores were significantly lower in both leader and mentor evaluations compared to self-assessment.

Table 3: Comparison of evaluation by team leaders and team mentors with self- evaluation for all 8 components of team dynamics

Component	Self-Evaluation Mean (SD) n=24	Leader Mean (SD) n=12	p-value*	Self-Evaluation Mean (SD) n=24	Mentor Mean (SD) n=12	p-value*
Knowledge Sharing	1.79 (0.41)	1.42 (0.52)	0.02	1.79 (0.41)	0.83 (0.83)	<0.001
Mutual Respect	2 (0)	1.92 (0.29)	0.17	2 (0)	1.83 (0.39)	0.03
Team Dynamics	1.91 (0.28)	1.33 (0.78)	0.002	1.91 (0.28)	1.08 (0.29)	<0.001
Team Communication (Closed loop / Handoff / SBAR)	1.75 (0.44)	1.08 (0.67)	0.001	1.75 (0.44)	1.5 (0.52)	0.14
External Communication (Between Team & Parents)	1.67 (0.48)	1.42 (0.67)	0.20	1.67 (0.48)	1.33 (0.89)	0.14
Role Allocation	1.87 (0.34)	1.75 (0.62)	0.45	1.87 (0.34)	1.5 (0.52)	0.01

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Leadership Skill	1.88 (0.34)	1.75 (0.45)	0.33	1.88 (0.34)	1.33 (0.49)	0.004
Call for Help Appropriately	1.75 (0.44)	1.67 (0.49)	0.62	1.75 (0.44)	1.83 (0.39)	0.59
Total Score (Out of 16)	14.51 (1.84)	12.33 (2.46)	0.005	14.51 (1.84)	11.25 (2.41)	<0.001

**Independent sample t-test, p<0.05 is considered significant.*

Table 4 presents a comparison of expert evaluation with leader and mentor ratings. No statistically significant differences were observed in most components, including knowledge sharing, mutual respect, team dynamics, external communication, role allocation, and call for help. However, leadership skills showed a statistically significant difference between expert and leader evaluations (p=0.003), indicating that leaders overestimated their own leadership performance relative to expert ratings. Total scores did not differ significantly between experts and leaders or mentors.

Table 4: Comparison of evaluation by team leaders and team mentors with evaluation by Experts for all 8 components of team dynamics

Component	**Expert Mean (SD) n=8**	**Mentor Mean (SD) n=12**	**p-value***	**Expert Mean (SD) n=8**	**Leader Mean (SD) n=12**	**p-value***
Knowledge Sharing	1.25	0.83	0.21	1.25	1.42	0.46
	(0.46)	(0.83)		(0.46)	(0.52)	
Mutual Respect	1.75	1.83	0.68	1.75	1.92	0.32
	(0.46)	(0.39)		(0.46)	(0.29)	
Team Dynamics	1	1.08	0.45	1.00	1.33	0.25
	(0)	(0.29)		(0)	(0.78)	
Team Communication	1.12	1.5	0.08	1.12	1.08	0.87
(Closed loop / Handoff/ SBAR)	(0.35)	(0.52)		(0.35)	(0.67)	
External Communication	1	1.33	0.31	1	1.42	0.09
(Between Team & Parents)	(0)	(0.89)		(0)	(0.67)	
Role Allocation	1.88	1.5	0.08	1.88	1.75	0.59
	(0.35)	(0.52)		(0.35)	(0.62)	
Leadership Skill	1.00	1.33	0.16	1	1.75	0.003
	(0.50)	(0.49)		(0.50)	(0.45)	
Call for Help Appropriately	2 (0)	1.83 (0.39)	0.23	2(0)	1.67 (0.49)	0.07
Total Score (Out of 16)	11	11.25	0.78	11	12.33	0.16
	(1.07)	(2.41)		(1.07)	(2.46)	

**Independent sample t-test, p<0.05*

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DISCUSSION

The study revealed that simulation-based team training improves team performance during clinical scenarios. Significant improvements have been seen in communication among participants, in the behaviour of the leaders, and in the allocation of roles. Simulation-based training improves coordination and shared mental models. Task execution has been faster, and procedure errors have been reduced, indicating an improvement in clinical preparedness. Consistent benefits have been observed across professions, including physicians and nurses. More structured simulations enable teamwork more efficiently than the conventional didactic training process [9]. The study revealed that simulation-based training effectively enhances both clinical skills and teamwork during pediatric resuscitation events. The assessments after the training revealed improved adherence due to resuscitation n algorithms and improved initiation, such as airway management and medication delivery. The team demonstrated improved communication quality, with clear leadership and effective roles. Critical errors have been reduced, highlighting the effective clinical preparedness. This intervention strengthens collaboration among nurses, physicians, and respiratory specialists, underscoring the significance of interprofessional training. Improved performance has been observed during the follow-up simulations, highlighting skill retention [10].

Another systematic review demonstrated improved team performance following simulation-based emergency team training among paediatricians across various healthcare settings. Most studies in the literature showed significant improvement in technical skills, including communication, leadership, and situational awareness, during pediatric emergencies. Simulation training was associated with efficient adherence to resuscitation protocols and the prompt execution of critical interventions. Many studies have shown improvement in confidence and self-efficacy among healthcare providers in pediatric care after the training. Improvement in confidence and self-efficacy has been developed. Interprofessional simulation formats may increase collaboration and reduce errors related to teamwork. Some studies also highlight moderate skill of retention, to boost sessions. The review study supported the simulation-based training as an effective strategy to support the dynamics of the pediatric emergency team, highlighting the significance of the standard outcome [11]. Another study found that simulation-based training effectively improves the performance of cardiopulmonary resuscitation (CPR) and team interaction. Better chest compression quality has been noticed among the participants, with improvements in depth and rate, and reduced interruptions. Various simulation sessions provide improved allocation of functions and closed-loop communication among pediatric code teams. High adherence to the Pediatric Advanced Life Support (PALS) guidelines was observed. Awareness of the situation had been enhanced, and the behavioural patterns of leaders also improved. Both technical and non-technical skills have been improved, demonstrating a significant performance benefit. The study has supported the use of simulation as the best tool for education to strengthen pediatric code blue performance [12]. Time constraints affected residents' performance during pediatric mock emergency scenarios. Enhanced cognitive load, under strict time constraints, results in a delay in decision-making and task execution. Certain technical skills, such as the initiation of resuscitation and the administration of medicines, were inconsistent. Certain non-technical skills, such as communication clarity, leadership, and team collaboration, also decreased with increased time pressure. Enhanced deviations from the protocol were observed in the study, including some missed clinical steps [13].

CONCLUSIONS

The study has concluded that structured simulation-based training resulted in uniformly high confidence and satisfaction levels among participants in pediatric code blue protocols and life support measures. Despite strong self-perceived performance across most team dynamics domains, external evaluations revealed significant overestimation in self-assessed knowledge sharing, team dynamics, role allocation, and leadership skills, particularly when compared with mentor and expert ratings. This study showed that a well-structured simulation-based code blue training module greatly enhanced participants' confidence, satisfaction, and overall team performance, with scores for mutual respect, role assignment, and proper help-seeking behaviours remaining high across all teams. Overall, communication processes and leadership competencies

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emerged as the key differentiators between high- and low-performing teams, highlighting critical areas for focused reinforcement in future training programs.

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