

Improving the Performance of Residents in Pediatric Resuscitation with Frequent Simulated Codes

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Abstract

Aim. Exposure to real codes during pediatric residency training is scarce. Consequently, experiencing mock codes scenarios can provide an opportunity to increase residents' confidence and knowledge in managing pediatric emergencies. **Hypothesis.** Pediatric senior residents perform better as code team leaders if they are exposed to frequent mock codes. **Material and Methods.** Forty-three pediatric senior residents (postgraduate year [PGY] two and three) participated in the study. Team leader performance was assessed utilizing the Team Emergency Assessment Measure (TEAM) scoring. Residents' team leadership performance was assessed before and 6 months after the implementation of weekly mock codes. **Results.** Pediatric residents' team leadership performance in mock codes improved after exposure to weekly practice mock code sessions (71.93 ± 18.50 vs 81.44 ± 11.84 , $P=0.01$). **Conclusion.** Increasing the frequency of mock code sessions during residency training led to an improvement in code team leadership performance in pediatric senior residents.

Keywords

mock codes, pediatrics, resuscitation, pediatrics residents

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Introduction

All pediatricians, irrespective of the career path they choose, may come across life threatening pediatric emergencies and should receive the training necessary to deal with such emergencies. Pediatric residents are required by the Accreditation Council for Graduate Medical Education to be certified in specific core competencies with resuscitation skills accounting for a significant portion of these requirements.¹ However, resuscitation algorithms are complex and the retention of residents' resuscitation knowledge and clinical performance skills may be negatively affected if not put to use on a regular basis. Newer trends limiting resident inpatient duty hours together with more supervision by fellows and in house attending physicians, have had a negative impact on pediatric residents' opportunities to acquire the basic resuscitation skills needed in pediatric emergencies. The majority of the residents' resuscitation knowledge and skills is acquired and reinforced while rotating in the neonatal intensive care unit (NICU), pediatric intensive care unit (PICU), and the pediatric emergency room (ER).

Many studies in the literature have reported on different ways to improve residents' resuscitation training by redesigning their code team structures, implementing new mock code curriculums, or using new simulation technologies.²⁻⁴ Pediatric residency training programs use mock code sessions with simulated emergency case scenarios to help maintain and improve residents' resuscitation skills. These teaching sessions help prepare residents for real life emergencies. During a mock code session, residents gain knowledge and experience in the different roles within the resuscitation team such as code team leader, airway management, chest compression, defibrillator use, and intravenous/intraosseous line placement. They also learn to work as part of a team

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using effective communication skills. Mock code sessions usually last 20 to 30 minutes and include management of a given emergency case scenario followed by a short debriefing session to discuss the strengths and weaknesses of the resuscitation efforts.

Human factors, defined as the inter-relationship between humans, their tools, and their environment, have been looked at for their role in resuscitation.^{5,6} The “big five model,” which was initially proposed by Tupes et al in 1961 and later extended by Goldberg, lays out personality traits required to be an effective leader.^{7,8} Working with this model, Judge et al showed that an extraversion personality trait correlated well with better leadership skills.⁹ The model was later expanded by others to assess its applicability to teamwork. The core components were listed as team leadership, mutual performance, back up behavior, adaptability, and team orientation. Teamwork has been shown to offer greater innovation and efficiency when well directed by an effective team leader. This is especially true when trying to save lives in a complex and chaotic setting like an emergency room. Team traits, such as shared mental models, closed loop communication, and mutual trust are able to further strengthen the effectiveness of a team.¹⁰

The role of a code team leader is to orchestrate the entire code team’s activities by giving continuous instructions to the code team members, so as to have them complete the necessary tasks correctly during the code. The team leader should focus on giving instructions to the code team members and whenever possible, should not participate in team members’ activities such as airway management, chest compressions, etc. Sherman et al conducted a survey in a tertiary hospital pediatric ER to measure barriers and best practices within a resuscitation team as perceived by the different staff members. They reported communication, especially closed-loop communication and deficiencies in team leader qualities to be the greatest barriers to quality resuscitation.¹¹ Poor leadership skills can have a negative impact on the performance of other code team members. Marsch et al studied the influence of leadership during cardiopulmonary resuscitation (CPR) and found that an absence of leadership behavior and explicit task distribution was associated with poor team performance outcome in simulation-based scenarios.¹² In an observational study Cooper et al found that a team leader who was more hands-on, as opposed to taking a coordinating role, affected the team performance negatively.¹³

We believe that frequent practice and teaching sessions can help health care providers to perform better as code team leaders. In various studies where the code

team also included nurses and medical students, teaching team leadership led to an improvement in overall resuscitation performance.^{14,15} Our pediatric residents had previously given us feedback following their monthly practice mock code sessions that these sessions increased their knowledge and confidence as a code team leader. In this study, we were interested in testing the impact of increasing the frequency of mock codes from monthly to weekly on senior residents’ code team leadership performance. For this, we compared residents’ scores at baseline and 6 months after the implementation of weekly mock codes. Our hypothesis was that pediatric senior residents would perform better as code team leaders if they participate in weekly practice mock codes, as compared to monthly mock codes during their training.

Material and Methods

The study was approved by our Institutional Review Board (IRB# 798406-1). Forty-three pediatric senior residents (14 PGY2 and 29 PGY3) were recruited from our residency program between January 2016 and June 2016. Written consent was not required as these mock code sessions were part of our residents’ resuscitation teaching sessions. Our pediatric residents were undergoing monthly mock code sessions prior to the onset of the study period while on their inpatient rotations. Residents were informed of a code situation through the floor’s overhead paging system and were unaware of the clinical scenario until arriving at the scene. The monthly mock code sessions were run by a PICU attending and chief residents. Senior residents were assigned as code team leaders to manage the entire code team for a specific clinical scenario. Mock codes would last 30 minutes, with 20 minutes allotted for case management and 10 minutes for debriefing and feedback on their performance.

At the start of the study, before the implementation of weekly mock codes, the Team Emergency Assessment Measure (TEAM) scoring tool was used to evaluate the senior resident acting as the team leader during a code scenario involving a case of supraventricular tachycardia (SVT). They were assessed in 11 different areas, which involved leadership performance, team dynamics and how efficient the team members worked together during the resuscitation effort. (Figure 1) Each area was scored using a Likert scale where 0 on the scale indicates poor performance and 4 indicates best performance. The overall assessment score for the resuscitation effort was calculated based on all these scores. The minimum overall score is 0 and the maximum total is 44.¹⁶ Additionally, each resident received a checkpoint for successfully completing each one of nine management

Introduction												
Never/Hardly Ever	Seldom	About as often as not	Often	Always/Nearly always								
0	1	2	3	4								
Leadership			0	1	2	3	4					
1. The team leader let the team know what was expected of them through direction and command			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
2. The team leader maintained a global perspective			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
Team Work			0	1	2	3	4					
3. The team communicated effectively			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
4. The team worked together to complete tasks in a timely manner			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
5. The team acted with composure and control			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
6. The team morale was positive			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
7. The team adapted to changing situations			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
8. The team monitored and reassessed the situation			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
9. The team anticipated potential actions			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
Task Management			0	1	2	3	4					
10. The team prioritized tasks			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
11. The team followed approved standards/guidelines			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
Overall			1	2	3	4	5	6	7	8	9	10
12. On a scale of 1-10, give your global rating of the team's performance			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Figure 1. TEAM scoring tool (Adapted from “Rating medical emergency teamwork performance: Development of the Team Emergency Assessment Measure (TEAM)” by Cooper et al.¹⁶ Resuscitation 81:446-452.).

steps in the supra ventricular (SVT) clinical scenario we used from the American Heart Association (AHA), pediatric advanced life support (PALS) course curriculum.¹⁷

Six months after the implementation of the weekly mock codes, all 43 residents were retested using the same clinical scenario of SVT and TEAM scoring system. The testing sessions focused on assessing non-technical skills, such as how well the senior resident

performed as a code team leader, managing the code team by assigning and delegating tasks, his/her communication skills and the interaction between the team members. We did not assess the quality of the resuscitation nor the resident’s clinical skill performance. Nurses and ER fellows acted as the code team members during the pre and post testing sessions. The same three evaluators, who were AHA PALS course instructors, scored

Table 1. Demographic data, PGY:Post Graduate Year, IMG: International Medical Graduate, AMG: American Medical Graduate.

Age years (mean, SD)		27.9 ± 4.5
Gender (Female), n (%)		19 (44.1%)
PGY level, n (%)	PGY II:	14 (32.5%)
	PGY III:	29 (67.4%)
IMG/AMG, n		37/6
Time after medical school graduation, n	<2 years	24
	2-5 years	11
	>5 years	8

the residents' performance using the TEAM scoring forms. The mean scores from all three evaluators were calculated for each area the resident was tested on. Chief residents facilitated the testing sessions and conducted a short debrief after each session, allowing time for questions and feedback. TEAM scores given for residents' team leadership performance were compared before and after implementation of weekly mock codes. A paired- and two-tailed student *t*-test was used (IBM SPSS Statistics for Windows, Version 19.0. Armonk, NY: IBM Corp) was used to test differences in TEAM scores between pre and post implementation of weekly mock codes with significance determined by $P < .05$.

Results

Demographic data of the residents are presented in Table 1. The majority of our residents were international medical graduates (IMG) with different levels of medical education and training backgrounds. Fifty-six percent of our residents started their pediatric residency training within 2 years after medical school graduation.

The mean scores given by the three evaluators to each resident tested was calculated and the result compared pre and post intervention (Table 2). Our results showed that increasing the frequency of mock codes from monthly to weekly, improved pediatric senior residents' team leader performance scores. We did not find difference between the PGY2 and PGY3s' mean overall performance scores before and after the intervention. *P* values .54 versus .22, respectively. Residents performed more effectively as code team leaders and the improvement were significant both for the combined overall skill set (sum of scores items 1–11) and for the leadership performance section of the scoring system (Items 1 and 2) (Figure 2). The scores residents received for the teamwork and task management sections were also higher post intervention, but the difference was not statistically significant.

Discussion

Pediatric cardiopulmonary arrests are rare, however pediatric emergencies can occur anywhere and at any time.¹⁸ Therefore, it is important to train pediatric residents for such emergencies. AHA PALS courses emphasize teaching team leader skills as an essential part of resuscitation training.¹⁹ However, these courses are required only every 2 years. This may be too long a period to maintain the knowledge and the skills learned during these courses. In our previous study, we found pediatric residents' code team leadership skills markedly declined within 8 months of their last PALS certification.²⁰

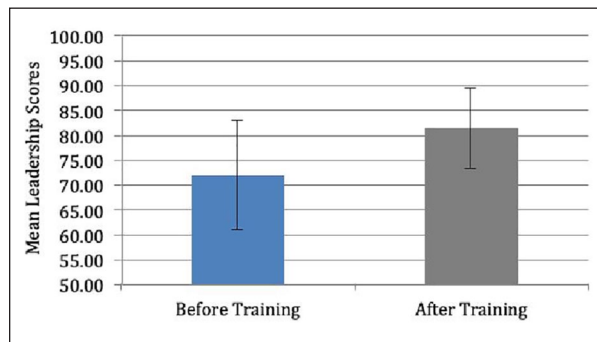
Our results showed that increasing the frequency of mock codes during pediatric residency training from monthly to weekly, improved pediatric senior residents' team leader performance scores. Residents performed more effectively as code team leaders and the improvement was significant both for the leadership and for their overall performance scores during the mock code. Scores were also higher for teamwork and task management although the difference was not statistically significant. Similarly, Settgest et al.²¹ found that internal medicine residents benefitted from exposure to practice code sessions. They implemented monthly educational exercises for 67 residents emphasizing practical skills and equipment usage. They surveyed residents before and after participating in a session and found significant improvement in their comfort level with certain skills as well as their level of comfort being a code leader.²¹

In an effort to improve code team performance, Prince et al implemented a restructuring plan over a 3 month period that included a defined number of code team participants, identification of team members primary responsibilities, and the initiation of team training events and surprise mock codes.²² Results obtained from a survey of code team members during two consecutive years showed significant improvements in team member confidence in the skills for their assigned role and clarity in their role's position. However, team leadership and team communication did not significantly increase.

Pediatric residency training programs are increasingly implementing practice mock code sessions on a regular basis to help residents maintain and improve their resuscitation skills and knowledge and to teach them to perform as effective team leaders. This is crucial because the success of a code is directly related to the knowledge and performance of the code leader.^{20,23} A code team leader orchestrates the code by giving instructions to other code team members, providing guidance and supervision to members of the team and

Table 2. Performance of the residents in each section and overall of TEAM tool before and after intervention, Mean(SD).

	Leadership	Team work	Task management	Overall
Pre-training	71.93 (+18.50)	79.07 (+17.48)	79.30 (+16.36)	76.77 (+15.88)
Post-training	81.44 (+11.84)	84.51 (+10.98)	83.79 (+12.70)	83.25 (+8.71)
P values	.011	.126	.199	.039

**Figure 2.** Mean leadership performance.

ensuring that the necessary tasks are completed correctly during resuscitation. Codes led by strong team leaders were found to be more efficient in completing the necessary tasks with fewer mistakes.^{12,24}

During a code, the most knowledgeable and experienced team member should assume the role of the code team leader. A successful code team leader should communicate effectively and create an environment to allow for all its members to quickly adapt to one another. This is of particular value as staff members called to a code frequently come from different departments. Teams in which members worked in harmony performed the steps in a timely fashion. Experience of team leader and code members has been shown to have a positive impact on code success.^{12,24}

Our study has some limitations. It was conducted at a single academic institution in an urban setting with a significant percentage of IMGs and may not be generalizable to other pediatric residents in training. A multi-center trial including a larger number of pediatric residents would increase the generalizability of our results and may have sufficient power to assess changes in communication skills, which improved in our study but did not reach statistical significance. Also, we did not address all aspects of the resuscitation effort such as the quality of CPR and other interventions observed during the practice codes, which are also vital for a successful resuscitation. Finally, we recognize that conducting weekly practice mock codes is a significant undertaking and may not be practical in all residency-training programs. Still, our results showed that increasing the

frequency of mock codes resulted in improved senior resident performance as a code team leader and consequently a greater chance for a favorable outcome in pediatric emergencies.

Conclusion

In our study we found that weekly practice mock code sessions during residency training were beneficial in improving senior residents' performance as code team leaders when compared to monthly practice mock codes. We add to the existing literature that supports the use of repetitive exposure to emergency mock scenarios as an effective means to reinforce the knowledge and skills learned in official mandatory resuscitation courses. More so, in pediatrics given the scarcity of real codes, it is important that training programs develop and implement curricula to regularly reinforce these resuscitation skills and knowledge. Although we did not test our residents' confidence level as code team leaders, we believe that frequent mock code sessions can have a positive impact on residents' confidence level by increasing their exposure and familiarity with a code scenario. Additional studies are needed to help us assess the relative benefit from different types of training curricula on resident preparedness in pediatric codes.

Authors' Note

Sule Doymaz is also affiliated with SUNY Downstate Health Sciences University, Brooklyn, NY, USA.

Author Contributions

SD, MR and CG: contributions to conception and design, and/or acquisition of data, and/or analysis and interpretation of data.

SD, MR and CG: drafting the article or revising it critically for important intellectual content.

SD, MR and CG: final approval of the version to be submitted and any revised version.

Declaration of Conflicting Interests

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