

Simulation Training to Maintain Neonatal Resuscitation and Pediatric Sedation Skills for Emergency Medicine Faculty

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ABSTRACT

Background: Neonatal resuscitations and significant adverse cardiorespiratory events during pediatric sedations are infrequent. Thus, it is challenging to maintain the skills necessary to manage patients experiencing these events. As the pediatric emergency medicine specialty expands, exposure of general emergency medicine physicians to these potentially critical patients may become even more limited. As such, effective training strategies need to be developed. Simulation provides the opportunity to experience a rare event in a safe learning environment, and has shown efficacy in skill acquisition for medical students and residents. Less is known regarding its use for faculty-level learners.

Objectives: To assess the acceptability, efficacy, and feasibility of a simulation-based educational intervention for emergency medicine faculty on their knowledge, comfort, and perceived competence in neonatal resuscitation and pediatric sedation skills.

Methods: Eighteen academic emergency medicine faculty participated in a 4-hour educational intervention with high-fidelity simulation sessions focused on neonatal resuscitation (precipitous delivery of a depressed newborn) and adverse events associated with pediatric sedation (laryngospasm and hypoventilation). Faculty also practiced umbilical vein catheterization, video laryngoscopy skills, and reviewed supplies stocked in our pediatric resuscitation cart. A pre- and postintervention evaluation was completed consisting of knowledge and attitude questions. Paired *t* test analysis was used to detect statistically significant change ($P \leq 0.05$).

Results: Results were obtained from 17 faculty members. Simulation training was well accepted pre- and postintervention, and simulation was effective with statistically significant improvement in both knowledge and attitude. This type of event was feasible with 83% of emergency medicine faculty participating.

Conclusion: Emergency medicine faculty have limited opportunities to manage neonatal resuscitations and adverse events in pediatric sedations. Simulation training appears to be an effective educational modality to help maintain these important skills.

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INTRODUCTION

Survey data has shown that nearly half of US emergency departments (EDs) provide care to fewer than 10 pediatric patients per day.¹ With such a paucity of young patients, maintenance of pediatric clinical skills can be challenging for emergency physicians at these centers. Even among academic centers with higher volumes, additional factors frequently limit the emergency medicine (EM) physician's exposure to pediatric patients. Subspecialty workforce analysis indicates that the majority of pediatric EM subspecialists practice in medical school hospitals, effectively reducing the pediatric volume for the general EM physicians at these same institutions.² Furthermore, given the relative rarity of events requiring resuscitation in the pediatric population, erosion of skills necessary to recognize and manage potentially critical situations is a concern. In their 2009 joint policy statement, the American College of Emergency Physicians and the American Academy of Pediatrics recommended monitoring skills for all ED physicians with baseline and periodic competency evaluations. In addition to this oversight, the statement acknowledges a need for continuing education and iden-

tified patient simulation as a suggested mechanism to maintain proficiencies.³

Simulation-based training has been shown to be an effective tool that provides a controlled learning environment in which to practice a wide range of clinical scenarios.⁴⁻⁹ Recognizing this potential, residency programs have integrated simulation into their curriculum as an adjunct to live patient encounters with

encouraging results.¹⁰⁻¹⁷ Similarly, simulation exercises have been used for attending-level education by several specialties.^{12,18}

While simulation-based learning has been employed successfully for EM resident and non-EM faculty training, its utility and acceptance among EM faculty has yet to be assessed. In particular, there has not been an evaluation of this training modality as a method for general EM physicians to maintain pediatric critical care skills. Two ED-based scenarios requiring seldom-used clinical skills are neonatal resuscitation and the management of adverse events associated with procedural sedation. Given the rarity of these scenarios, simulation may provide an ideal method to achieve and maintain the requisite decision-making and procedural competencies. With this background, we have undertaken an investigation with the objective to design and assess the efficacy, acceptability, and feasibility of a simulation-based educational intervention for general EM faculty. Our specific aim is to assess changes in their knowledge, comfort, and perceived competence in neonatal resuscitation and adverse events associated with pediatric sedation.

METHODS

Study Design, Setting, and Population

This was a prospective cohort study of academic general EM faculty who participated in a simulation-based educational workshop emphasizing neonatal resuscitation and management of adverse events associated with pediatric sedations. In addition to serving as the intervention for our present investigation, the workshop curriculum was developed for ongoing departmental faculty education. The investigation occurred in the University of Wisconsin Health Simulation Center, a 6400 square foot state-of-the-art center with dedicated space and high-fidelity equipment for simulation, skills, debriefing, and lectures. The site's Institutional Review Board exempted this study, and all participants consented to the use of their data.

Study Protocol

Prior to the workshop, participants completed a closed-book pre-test and survey consisting of 11 medical knowledge and 10 attitude questions. Test questions were based on intervention content and developed by Pediatric EM-boarded study faculty. Following completion of the pretest, educational materials pertinent to neonatal resuscitation and pediatric procedural sedation were provided for review prior to the training session.¹⁹⁻²¹

The intervention curriculum began with two 30-minute didactic conferences. The first provided an update on Pediatric Advanced Life Support and Neonatal Resuscitation Program (NRP). The second lecture reviewed concepts in pediatric sedation including a discussion of adverse events. Faculty was then divided into groups to take part in 3 simulation-based stations: sedation, neonatal resuscitation, and skills.

The sedation scenario utilized the SimBaby simulator

(Laerdal Medical, Wappingers Falls, New York) and presented a 2-year-old child requiring procedural sedation for fracture reduction who developed laryngospasm and upper airway obstruction. The scenario was developed and led by the study site's pediatric critical care faculty. The learning objectives were: (1) perform a comprehensive pre-sedation assessment and consent, (2) conduct a sedation using appropriate medications and monitoring, (3) recognize and respond appropriately to the adverse event.

The neonatal resuscitation scenario utilized the SimNewB simulator (Laerdal Medical, Wappingers Falls, New York) and presented a precipitous ED delivery of a limp and cyanotic newborn. The case was developed and led by study site's neonatology faculty. The learning objectives were to appropriately perform a neonatal resuscitation consistent with NRP guidelines and demonstrate appropriate skills such as use of T-connector to deliver mask ventilation, endotracheal intubation, and insertion of an umbilical catheter.

The third station provided an opportunity for faculty to practice critical skills for neonatal resuscitation and pediatric airway support. Participants received instruction from pediatric EM faculty and used lower-fidelity mannequins to practice umbilical line insertion as well as video laryngoscopy utilizing a GlideScope (Verathon Inc, Bothell, Washington) for pediatric/neonatal intubation. This session concluded with a review of the contents of the pediatric ED resuscitation cart.

Upon conclusion of all training sessions, faculty gathered for a final debriefing and question-answer period. Participants then completed a postintervention questionnaire consisting of the same 11 medical knowledge and 13 attitude questions as well as a written evaluation of the educational activity.

Data Analysis

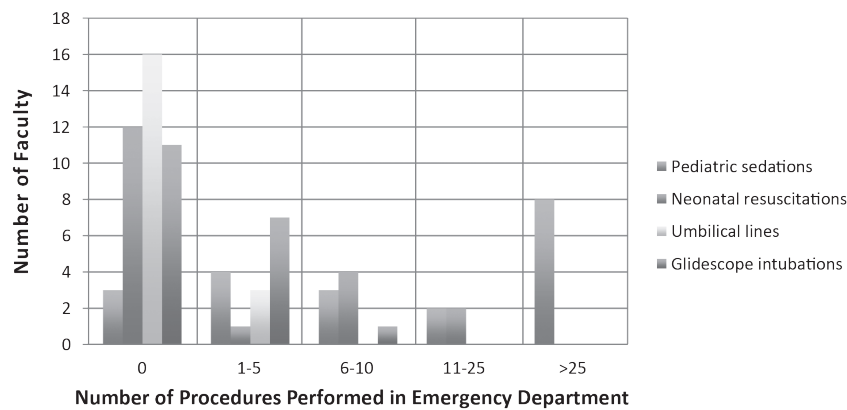
Results of the pre/posttests were blinded via assignment of a unique identifier for each participant. The primary outcome measure was the change in score for both medical knowledge and attitude questions between pre- and postintervention. Pre- and postintervention attitude questions were scored on a 5-point Likert scale. Paired *t* tests were used to compare differences between pre- and posttest scores and further assess effectiveness of the intervention. All calculations were conducted using SAS 9.3 for Windows (SAS Institute Inc, Cary, North Carolina).

RESULTS

Faculty Experience

There were 18 participants in the study, with complete data collected on 17 faculty. Average years removed from residency for the cohort was 4.3 (range 0.5 to 22). Background experience for selected skills performed by faculty after completion of residency training is shown in the Figure. Over half the faculty previously had performed at least 11 pediatric sedations with approximately

Figure. Emergency Medicine Faculty Post-Residency Clinical Experience



40% reporting greater than 25. The majority of faculty (65%) had yet to participate in a neonatal resuscitation and 90% had never placed an umbilical line. Similarly, exposure to pediatric video laryngoscopy was minimal with 60% of faculty yet to utilize in practice and greater than 90% having performed the procedure 5 or fewer times.

Medical Knowledge and Attitude

Overall, knowledge scores improved 29% from pre- to postintervention (Table). The largest improvements were noted for questions relating to umbilical vessel anatomy and chest compression: ventilation rates (350% and 115% increase in correct answers, respectively).

Pre-intervention attitude questions demonstrated the lowest comfort with neonatal resuscitation skills. The lowest mean scores were for umbilical line placement competence (2.18), followed by neonatal resuscitation comfort (2.59), and competence (3.06). Postintervention scores on all 3 NRP-related skills increased significantly, particularly for umbilical line placement (70% change, $P < 0.0001$). Furthermore, 90% of participants felt more comfortable with umbilical line placement and 53% with neonatal resuscitation following the simulations. Pre-intervention knowledge scores for pediatric sedations and airway management were generally higher, particularly with respect to competence in performing pediatric sedations (3.88). Pre-intervention competence scores for airway management skills including use of video laryngoscopy (3.71) and other pediatric airway equipment (3.71) were also high among faculty. Following the educational curriculum, all sedation and airway-related scores demonstrated statistically significant increases. This was most notable for competence with the GlideScope, which showed a 15.6% positive change ($P = 0.0002$).

Acceptability and Feasibility

Eighty-three percent of eligible faculty participated in the study. Prior to the intervention, faculty strongly agreed that simulation is a good way to update pediatric critical care skills (4.59). This was unchanged following the curriculum (4.71, $P = 0.16$). The simulation exercises were associated with a level of anxiety among participants, which was similar before (3.65) and after (3.76) the exercises ($P = 0.69$). The workshop required 21 billable hours of simulation center time including set-up, room use for didactic sessions, scenario administration, and take-down for a total cost of \$2985.

The endeavor also required approximately 6 hours of faculty time, including review of reading material, completing the written tests, and workshop participation.

DISCUSSION

Maintaining skills necessary to expertly manage the wide range of critical scenarios encountered in the Emergency Department is a daunting challenge. Given the relative rarity of neonatal clinical encounters, it is not surprising there is unease with NRP-based procedures among EM physicians. Similar to our academic faculty, Kester-Greene and Lee reported lower confidence in neonatal-related competencies among community ED physicians and suggested simulation exercises to enhance skills and comfort.²² Our results support this educational modality as evidenced by significant postintervention improvements for all neonatal-based knowledge and attitude scores. Such large improvements likely reflect both a general discomfort with neonates pre-intervention as well as improved knowledge and confidence attained via practiced skills.

Pediatric sedations occur daily in many EDs and physicians must be vigilant to detect and manage complications. Not surprisingly, compared to the neonatal-based scenarios, our general EM faculty had both greater pre-intervention experience and comfort with airway management (Table). Despite these high pre-intervention scores, all improved significantly following the intervention, demonstrating the efficacy of simulation-based learning to supplement faculty prior experience and reinforce skills necessary for competence in pediatric sedations and airway management.

The popularity of simulation may be related to the intrinsic hands-on nature of the learning environment such that trainees perceive they are engaged in real-life clinical situations. While operating in a controlled setting, instructors and students can examine how the learners react in specific clinical scenarios. However, despite impressive advances in simulation fidelity,

Table. Comparison of Pre/Post Simulation-Based Educational Intervention on Knowledge and Attitude

	Pre-intervention Average	Post-intervention Average	% Change	P Value
Medical Knowledge Aggregate Test Score (11 questions)	6.83/11	10/11	28.9%	<0.0001
Attitude Questions*				
I feel comfortable in managing adverse events that occur in pediatric sedations	3.41	3.88	13.8%	0.0068
I feel competent in performing emergent pediatric sedations	3.88	4.12	5.9%	0.0413
I feel comfortable in performing emergent neonatal resuscitations	2.59	3.41	31.7%	0.0061
I feel competent in performing emergent neonatal resuscitations	3.06	3.65	19.3%	0.0036
I feel competent in performing umbilical lines	2.18	3.71	70.2%	<0.0001
I feel competent in performing pediatric airway techniques using a GlideScope	3.71	4.29	15.6%	0.0002
I feel competent in handling and identifying pediatric airway equipment in the ED	3.71	4.24	14.3%	0.0149
Participating in this workshop with my colleagues will be (was) anxiety provoking	3.65	3.76	3.0%	0.6959
Simulation is a good way to update my pediatric critical care skills	4.59	4.71	2.6%	0.1635

* On a 5-point Likert scale, with 5 indicating "strongly agree" and 1 indicating "strongly disagree."
Statistically significant change ($p \leq 0.05$) in bold.

many nuances of the clinical experience cannot be recreated. This limitation makes full engagement in the exercise difficult for some, and identifying acceptance of simulation is an important component to assessing its usefulness. Furthermore, direct costs for Simulation Center use, as well as indirect costs associated with faculty time must be factored as potential barriers to its utility.

While medical student and resident trainee acceptance appears to be high, it is possible that faculty with "real-world" experience may resist the simulated environment. However, despite being reported as somewhat anxiety provoking, our findings demonstrate that both pre- and postworkshop acceptance among our faculty was quite high. One study participant noted the most useful aspects of the experience was "having experts available to ask questions that you can't ask in other forums, feeling safe asking questions and getting exposure to pediatric equipment." Thus, it appears that even seasoned emergency medicine faculty members are accepting of the simulation experience for updating pediatric critical care proficiencies.

Academic EM faculty time is frequently divided among myriad commitments. To overcome inherent time constraints, we specifically scheduled the workshop during a departmental retreat, allowing us to capture 83% of faculty. The program costs were covered by departmental funds allocated for the annual retreat, indicating that even during fiscally tight times, appropriate budgeting can help offset the price of educational innovation. At an expense of \$165 per participant, this may represent a small investment to an institution striving to provide the highest quality of care to its youngest patients. Still, we recognize time and financial resources vary widely and will need to be addressed individually by each institution. However, our approach indicates that when an appropriate departmental leadership and faculty commitment are available, simulation exercises to reinforce pediatric and neonatal critical care proficiencies have high acceptance and feasibility.

Limitations

Our workshop evaluated faculty at a single tertiary care academic center, and our findings may not be generalizable other institutions. Given our single study site, our sample size is relatively small and represents a convenience sample of participants. Our data may be affected due to 1 study participant not completing a pretest, and only answering the posttest questions and evaluation. Despite our data trends demonstrating improvement in comfort and competence in performing pediatric procedures and managing pediatric sedations, the responses to our questions were self-reported by the participants, which may not accurately measure the participants' actual competency.

There were 2 interventions between the pretest and posttest: suggested readings and the simulated cases. It is unclear which intervention had the greatest direct effect on the improvement in scores of the knowledge questions. The knowledge-based posttest questions were identical to the pretest questions. Thus, participants may have made mental note of the questions while reviewing the suggested reading materials, such that they highlighted content germane to the questions or independently found the answers to the questions after turning in the pretest. Of note, faculty did not receive feedback on pretest performance so as to not unduly influence postintervention performance. Additionally, faculty submitted pretest answers well before the intervention/posttest timeframe to minimize the effect of prior familiarity with the knowledge-based questions.

The study participants completed the knowledge-based questions, survey questions, and course evaluation immediately following the simulation workshop. To better assess the long-term effect of this workshop on clinician knowledge and attitude, follow-up survey with knowledge and attitudinal questions would be helpful. Collection of such retention data was not feasible during the timeframe of the current investigation, but is planned for in future iterations of the curriculum. It is also unclear what the

actual effect of this simulation-based training is to patient care and outcomes. Comparing outcomes of critically ill neonates, pediatric sedations, and pediatric procedures in the ED before and after the workshop could better measure the effectiveness of this simulation-based training.

CONCLUSION

General EM faculty have limited opportunities to manage neonatal resuscitations and adverse events associated with pediatric sedations. This study suggests that simulation-based training is an acceptable, effective, and feasible method to educate faculty-level learners. A simulation-based workshop in neonatal and pediatric critical care skills appears to be helpful in improving knowledge, comfort and perceived competence of general EM faculty in the face of expanding pediatric EM coverage.

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