Repeated Versus Varied Case Selection in Pediatric Resident Simulation

Nancy M. Tofil, MD, MEd
Dawn Taylor Peterson, PhD
Julie Turner Wheeler, MD
Amber Youngblood, BSN, RN
J. Lynn Zinkan, MPH, BSN, RN
Diego Lara, MD, MPH
Brett Jakaitis, MD
Julia Niebauer, MD
Marjorie Lee White, MD, MPPM, MEd

Abstract

Background Repeated exposure to pediatric emergency scenarios improves technical skills, but it is unclear whether repeated exposure to specific cases affects medical decision making in varied cases.

Objective We sought to determine whether repeated exposure to 1 scenario would translate to improved performance and decision making in varied scenarios.

Methods Senior pediatrics residents participated in 3 scenarios with scripted debriefing. Residents were randomized to repeated practice (RP) scenarios or mixed (MIX) scenarios. RP residents completed pulseless electrical activity (PEA) with different stems (Case 1, 2, 3). MIX residents completed PEA (Case 1), seizure (Case 2), and ventricular tachycardia (Case 3) scenarios. Four months later, participants returned to complete 3 more cases: PEA (Case 4), seizure (Case 5), and critical coarctation (Case 6).

Results Twenty-three residents participated in the study and were randomized to either the RP or the MIX group. The RP group showed statistically significant improvement in time to start chest compressions, whereas the MIX group showed no improvement. Use of a backboard improved significantly in Case 4 for the RP group but not for the MIX group. Similarly, time to check glucose in the seizure scenario was significantly better in the MIX group that had previous exposure to a seizure scenario. No differences in performance were noted between groups in Case 6, which was new to both groups.

Conclusions Results of this study indicate that whereas repeated exposure may improve decision-making skills in similar scenarios, it may not translate to improved medical decision making in other scenarios.

Editor's Note: The online version of this article contains the data recording sheet used in the study.

Nancy M. Tofil, MD, MEd, is Medical Director, Pediatric Simulation Center, Children's of Alabama, and Associate Professor, University of Alabama at Birmingham School of Medicine; **Dawn Taylor Peterson, PhD,** is Director, Simulation Education and Research, Pediatric Simulation Center, Children's of Alabama, and Program Director, Department of Pediatrics, University of Alabama at Birmingham; **Julie Turner Wheeler, MD,** is Family Practice Resident, St. Vincent's Health System; **Amber Youngblood, BSN, RN,** is Nurse Educator, Pediatric Simulation Center, Children's of Alabama; **J. Lynn Zinkan, MPH, BSN, RN,** is Nurse Educator, Pediatric Simulation Center, Children's of Alabama; **Diego Lara, MD, MPH,** is Pediatric Cardiology Fellow, Baylor College of Medicine; **Brett Jakaitis, MD,** is Fellow, Department of Pediatrics, Emory University School of Medicine; **Julia Niebauer, MD,** is Affiliate Assistant Professor, Department of Pediatrics, South Florida College of Medicine; and **Marjorie Lee White, MD, MPPM, MEd,** is Medical Co-Director, Pediatric Simulation Center, Children's of Alabama, and Associate Professor, University of Alabama at Birmingham School of Medicine.

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Corresponding author: Dawn Taylor Peterson, PhD, Department of Pediatrics, University of Alabama at Birmingham, 1600 7th Avenue South, CPP1 Suite 110, Birmingham, AL 35233, dawn.taylorpeterson@childrensal.org

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Introduction

That one learns best by doing is well established, as is the benefit of simulations to the active learning process.[1,2] A recently published meta-analysis of 609 studies showed that using simulation in medical education yields consistently better learning outcomes in regard to knowledge, skills, and behaviors.[3] High-fidelity simulation of clinical scenarios allows repeated practice (RP) within a controlled environment that accommodates educational feedback.[1,2,4]

Repetitive practice as provided by simulation has been shown to increase competence in the performance of many clinical procedures, including endoscopy,[5] thoracentesis,[6] advanced cardiac life support,[7] cardiac auscultation,[8] central line placement,[9] lumbar puncture,[10] and neonatal resuscitation skills.[11] Repeated exposure to simulated cases has been shown to improve performance, but repeating case scenarios decreases the learner's overall breadth of exposure. Repeated practice may be exceptionally useful in fields where a few scenarios make up the majority of emergency situations. We previously demonstrated the utility of this simulation model in training radiology residents and technologists to respond to severe contrast reactions.[12]

Residents have limited time for simulation scenarios due to multiple competing demands such as patient care activities, duty hour limits, and documentation requirements. Given these constraints, designers of the simulation curriculum must consider the tradeoff between what can be learned by repeating a case a number of times versus that of seeing many different cases just once.

This study sought to address whether the exposure attained by case repetition could contribute to improved performance in fields where emergency scenarios are more varied, such as pediatric medicine. Based on previous studies, we hypothesized that pediatrics, internal medicine–pediatrics (medicine-pediatrics), and pediatrics–medical genetics (pediatrics-genetics) residents exposed to repeated scenarios with scripted debriefing would outperform residents exposed to a variety of scenarios on certain performance times.[10,11]

What was known

Simulation improves performance in emergent situations, yet it is not clear whether skills learned in a given scenario are transferrable to other types of cases.

What is new

Residents randomized to a series of 3 repeating scenarios performed better than residents who completed 3 different scenarios.

Limitations

Insufficient sample size and power to detect smaller differences; assessment instrument was not validated.

Bottom line

Scenario-based simulation improves decision-making skills, yet these skills do not appear to be transferrable to other clinical conditions and situations.

Methods

All third-year residents in general pediatrics and all third- and fourth-year residents in medicine-pediatrics and pediatrics-genetics at our institution were invited to participate in the study. All participants were Pediatric Advanced Life Support (PALS)–certified and had completed at least 3 months of neonatal intensive care (2 months if medicine-pediatrics), 2 months of pediatric intensive care (1 month if medicine-pediatrics), and 4 months of emergency medicine (2 months if medicine-pediatrics). Residents were randomized to the RP group, those who repeated the same scenario 3 times in a row during the initial phase of the study, or to the mixed (MIX) group, those who completed 3 different scenarios during the initial phase of the study. Residents participated 1 at a time in each session.

Scenario Development/Study Timing Development

Prior to starting the study, the research team performed 2 pilot sessions with junior pediatrics critical care fellows who closely resembled the residents who would be asked to participate in the study. The pilot sessions were conducted to improve standardization of the study conditions. During the pilot sessions, participants' times to perform critical events were recorded, allowing timekeepers to become familiar with the data recording sheets (provided as online supplemental material). This also allowed the research team to clarify any questions about the timing of key actions. In addition, the scripted debriefing tool was tested during the pilot sessions and adjusted for clarity after feedback from pediatric critical care fellows. Data gathered during the pilot sessions were used for quality control processes only, not for data analyses. The same timing device was used for all sessions. All sessions were videotaped to allow objective resolution of any discrepancy between the 2 observers. Three nurses were trained as confederates (a confederate is a person who knows the background of the scenario and performs the duties of a nurse during the simulation), and 2 of the 3 nurses participated in each session to minimize variability. The confederates played scripted roles during the scenarios and completed only the tasks requested of them by the resident. All cases were programmed to ensure consistency in mannequin changes over time and were performed using the same high-fidelity infant simulator (SimBaby; Laerdal, Wappingers Falls, NY). All simulations were performed at the Pediatric Simulation Center at Children's of Alabama.

During the initial phase of the study, the RP group participated in a pulseless electrical activity (PEA) case 3 times, with a different introductory stem and cause for each scenario. After each case, the resident was debriefed by 1 of 2 supervising physicians trained in critical care or emergency medicine. These 2 individuals also ran the simulator during the case. Each resident always had the same physician debriefing them for each set of 3 cases; there may have been a different individual debriefing for the first set of cases versus the second set. The purpose of the scripted debriefing was to discuss the pathophysiology involved in the case, the possible treatment modalities, the tasks that were done appropriately, and the attributes of the case that could have been performed better.

The MIX group participated in 3 different cases during the initial phase of the study. The initial scenario consisted of the same PEA case as performed by the RP group. The MIX group also participated in cases involving a seizure with apnea and pulseless ventricular tachycardia. The order of the scenarios was fixed and did not vary from 1 participant to another. The group was debriefed after each scenario by 1 of the critical care physicians, just as with the

RP group. The PEA scenario that was completed by the MIX group had the same scripted debriefing as the RP group to minimize variability.

Approximately 4 months after the initial session, residents returned to the simulation center for follow-up sessions consisting of 3 more scenarios. Both RP and MIX residents participated in the same 3 scenarios during this phase of the study. The follow-up scenarios included PEA, seizure, and shock in a 1-week-old infant. All of the cases in the follow-up sessions had stems and causes that were different from those of cases in the initial phase of the study. All participants regardless of randomization were debriefed using the same script. The debriefing time was not recorded, as all sessions were limited to 1 hour.

Every scenario lasted 6 minutes. If participants failed to perform an action in the 6 minutes, it was recorded as not completed. Resident performance in both groups was evaluated using a time-to-event checklist; 2 trained observers in another room completed the checklist while watching a live video feed. One observer called time to certain predetermined actions on the resident's part (for example, time to check for a pulse), and the other observer recorded the time on preprinted time sheets. After each session, the participant completed an anonymous evaluation sheet, assessing the simulation effectiveness and updating the rotation they had completed (eg, if they had completed another month in the intensive care unit since the first phase of the study).

The study was approved by the Institutional Review Board at the University of Alabama at Birmingham.

Statistics

Individual initial and follow-up times were compared using a paired *t* test. Normally distributed continuous data between groups were analyzed using an unpaired *t* test, and categorical data were analyzed using a χ^2 test. Non-normally distributed continuous data were analyzed using a nonparametric test (Mann-Whitney *U* test). All tests were 2-tailed. SPSS version 11.5 software (IBM Corp, Armonk, NY) was used for analysis.

Results

Twenty-four residents (100% of senior residents) participated in the initial set of scenarios, and 23 returned for 4-month follow-up testing. Fifteen pediatrics residents, 8 medicine-pediatrics residents, and 1 pediatrics-genetics resident participated in the first phase of the study. The 1 resident who did not return was a pediatrics resident in the MIX group. There were no statistically significant differences between groups in regard to age, sex, or program.

The RP group showed a statistically significant improvement in the time to start chest compressions between the first and fourth PEA cases (45 ± 32 seconds versus 23 ± 30 seconds, respectively; $P = .03$), whereas the MIX group showed no significant improvement between the first and fourth PEA cases (32 ± 12 versus 34 ± 26, respectively; $P = .84$). None of the participants in either group used a backboard for chest compressions in the first session. However, use of the backboard improved significantly between PEA cases 1 and 4 for the RP ($P = .01$) but not for the MIX group. Backboard use also increased for PEA Cases 1 and 2 for the RP residents ($P = .001$). Correct identification of PEA improved for both groups between PEA Case 1 and Case 4 (TABLE). In all instances of incorrect rhythm identification, sinus bradycardia was designated instead of PEA.

Time to check glucose was significantly faster in MIX residents, who had previous exposure to a seizure scenario (51 ± 51 seconds in RP versus 38 ± 99 seconds in MIX; $P = .05$). In addition, times to check other electrolytes such as calcium and potassium in the MIX group were not different from those in the RP group (134 ± 98 seconds in RP versus 79 ± 50 seconds in MIX; $P = .12$). No differences were noted between groups in the performance of Case 6, which was new to both groups in the follow-up phase of the study. Variables studied included time to check for pulse, to assess breathing, to apply oxygen, to administer fluid, and to give antibiotics or to intubate (provided as online supplemental material).

Discussion

Our results indicate that repeating simulated scenarios enhances certain measures of resident performance compared to single exposure. Previous studies evaluating residents' performance in pediatric cardiac emergencies have demonstrated that recognition and interpretation of rhythm and appropriate adherence to PALS protocols remain difficult tasks for pediatrics residents, despite undergoing required training.[13,14] This may be partly attributed to the well-established phenomenon of decay in knowledge of and skills in resuscitation that occurs over time.[15–18] The results of our study are encouraging in that, despite a 4-month interval between intervention and follow up, performance of critical tasks by the RP group showed significant improvement, such as time to chest compressions, use of backboard, and identification of the correct rhythm. The time difference in chest compressions was 11 seconds, which can be very important to a pulseless patient. In addition, the backboard, which improves the effectiveness of chest compressions, was used more than 6 times more often in the RP group.

The improved performance of the RP group compared to that of the MIX group in the repeated PEA case did not extend to the seizure and neonatal shock cases to which

TABLE Performance of Critical Actions in PEA Scenarios

Critical Action	PEA 1	PEA 2	PEA 4	*P* value (1 vs 2)	*P* value (1 vs 4)
Time to chest compressions					
RP	45 ± 32	26 ± 5	23 ± 30	.06	.03
MIX	32 ± 12	NA	34 ± 26	NA	.84
Time to assess breathing					
RP	13 ± 11	12 ± 5	10 ± 4	.66	.39
MIX	15 ± 9	NA	12 ± 3	NA	.33
Time to start bag-valve-mask					
RP	21 ± 11	12 ± 5	17 ± 8	.44	.15
MIX	26 ± 16	NA	15 ± 7	NA	.05
Time to check pulse					
RP	33 ± 36	17 ± 6	16 ± 6	.13	.17
MIX	29 ± 30	NA	16 ± 7	NA	.09
Time to give epinephrine					
RP	86 ± 37	69 ± 34	56 ± 45	.22	.11
MIX	65 ± 40	NA	62 ± 41	NA	.62
Backboard use					
RP	0/12	8/12 (66)	7/12 (58)	.001	.002
MIX	0/11	NA	1/11 (9)	NA	.17
Rhythm identification					
RP	7/12 (58)	12/12 (100)	12/12 (100)	.08	.07
MIX	6/11 (55)	NA	10/11 (91)	NA	.07

Abbreviations: PEA, pulseless electrical activity; RP, repeated practice group; MIX, 3 different cases at intervention phase; NA, not applicable.
Note: Data are seconds ± SD or rate of completion of tasks with absolute numbers and percentage in parentheses.

the RP group was newly exposed, despite the decision-making practice provided to the RP group by repetition of the PEA scenario. The MIX group was also not statistically different from the RP group in time to measure blood glucose during the seizure case. As a power calculation was not done prior to the study, it is possible that the lack of association in some of the comparisons is due to an insufficient number of subjects. Alternatively, the lack of improvements may be a true finding and reflect the need for residents to repeat specific scenarios in order to show sustained improvements at 4 months. The differences observed in this study can be used to perform a power calculation to determine number of subjects to avoid a type II error in the next investigation.

Data are emerging as to the value of repeated cases versus varied case selection. In the field of psychology, extensive evidence exists for the value of consistent training to learn automatic behaviors.[19–21] Previous studies have evaluated the use of simulation to improve nontechnical skills, such as task management, situation awareness, team training, and decision making.[22–25] However, the methods in those studies did not include repetition of cases. The improved levels of performance of both the RP and the MIX groups in scenarios to which they were exposed more than once demonstrate that RP does indeed enhance medical decision making, much as it has already been shown to improve competence in technical and procedural skills.[5–9]

In addition to the lack of a sample size calculation prior to beginning our study, there are other limitations to our study. The study involved a convenience sample of senior residents, and different performance results would be expected if novices had been included as participants. A third limitation is our relatively brief follow up. One would like to see how the decision-making skills attained through repeated cases withstand the test of time, as previous studies have demonstrated that technical skills deteriorate as time passes.[18–21] Our postsurvey asked about the realism, effectiveness, and learning but did not undergo validity testing. Finally, we do not know if between the first and follow-up phases, any of our participants had experience with a child with PEA, seizures, or critical coarctation, which could have affected their performance.

Much work remains to be done, as it is yet unclear what combination of repeated versus varied scenarios is most effective in pediatrics residency training. More studies are needed to better define the learning outcomes and the proper emphasis of repeating scenarios versus exposure to new cases. Broadening this research to include multiple institutions would increase the sample size and provide additional data points for analysis. A longitudinal study beginning with interns could allow more occasions for deliberate practice of decision making and more room to further explore the most appropriate proportion of repeated cases versus varied cases.

Conclusion

Our study found that repetition of exposure does improve some measure of performance in the repeated scenarios but decreases other measures of performance in unexposed cases. These results add to existing data regarding improved competence as a result of simulation in medical education.

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