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A High-Fidelity Simulation Boot Camp for Pediatric Cardiac Critical Care Nurse Practitioners

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Abstract

Context: Failure to recognize and manage complications in a postoperative child with congenital heart disease (CHD) can be fatal. The goal in managing these complex patients is to quickly identify and treat an acute event and prevent morbidity and mortality. Growing numbers of pediatric nurse practitioners (PNPs) are being utilized as front line providers in pediatric intensive care units (PICUs), with an increased responsibility for management of these complex patients; however, experience of PNPs in this setting is variable and little research has been conducted on the post-graduate educational programs used to train such providers.

Description: This multi-centered, prospective pre/post interventional simulation pilot study was conducted at The Johns Hopkins Medicine Simulation Center and was designed for the advanced practice nurse. The curriculum was mixed instruction of didactic, case studies, and hands-on high-fidelity simulation, which were based on high complexity cases and the eight CHD benchmark procedures. An expert opinion survey was conducted to guide the development of the curriculum. The aims of this project include: (1) increase the PNPs knowledge of the etiology of low cardiac output (2) reduce the time to identify and implement appropriate treatment for an acute deterioration through the use of high-fidelity simulation scenarios; (3) evaluate the PNPs' confidence and satisfaction with the simulation based training.

Evaluation: There were 30 participants from 13 cardiac centers from the US and Canada. Knowledge was assessed with a pre/post- test format (max score 100). A paired-sample t-test was conducted and a statistically significant increase in the post-test scores was detected (pre-test: 36.8 ± 14.3; post-test: 56.0 ± 15.8; p <0.0001). Confidence and satisfaction were evaluated utilizing an instrument developed by the NLN. Participants responded to questions using a five-point Likert scale, with higher scores indicating higher levels of quality. The participants reported a high level of satisfaction (M= 4.68, SD 0.30) and confidence (M=4.75, SD 0.31) with the simulation experience. Time to recognize and treat an acute deterioration was evaluated utilizing selected high-fidelity simulation. There was an overall improvement in median time, but statistical significance was not achieved based on the small number of groups. The proportion of tasks completed was statistically significant.

Discussion: Simulation boot camps have been conducted for physician training and have been shown to be an effective strategy for educating critical care providers. This was a novel approach to educate nurse practitioners from multiple academic centers. In order to cover multiple, high complexity cases, we employed Rapid Cycle Deliberate Practice (RCDP) for selected high fidelity simulation scenarios.. There was an overall improvement in knowledge and the PNPs reported satisfaction and confidence in the simulation experience.

Objectives

The Institutional Review Board (IRB) at the Johns Hopkins University approved this prospective pre/post interventional pilot study. A simulation based educational training "boot camp" was designed for acute care pediatric nurse practitioners involved in the care of postoperative CHD patients. This one-day boot camp was designed for PNPs from multiple large academic centers from the United States and Canada.

The aims of the project include:

(1) Increase the PNPs **knowledge** of the etiology of low cardiac output in the postoperative CHD patient.

(2) Reduce the time to identify and implement appropriate treatment **(performance)** for an acute deterioration through the use of high-fidelity simulation scenarios.

(3) Evaluate the PNPs **confidence and satisfaction** with the simulation based training.

Methods

Curriculum Development

To determine the best management practices and develop the curriculum for the boot camp, we created a survey to gain expert opinion. A secondary IRB approval was obtained from Johns Hopkins, and a web-based survey was created. We identified a subset of experts from the U.S. who were registered with the Pediatric Cardiac Intensive Care Society and were from top-performing centers according to the *US News and World Report*. The aim of this secondary study was to delineate consensus of expert opinion on key teaching points with regard to the early identification and management of lesion-specific complications in the postoperative CHD patient.

Educational methods utilized during the boot camp

Session	Didactic (min)	Task Training (min)	High fidelity Simulation (min)	Participants (n)
Norwood BT Shunt –over-circulation			45	30
Postoperative Glenn with Hypoxia			45	30
Cardiac Case Review[b]	90			30
ECHO Basics	45			30
ECMO with VT			45	30
Tamponade[c]			45	30
AVC with Pulmonary Hypertension			45	30
Central line placement with ultrasound		45		30
EKG/Pacer		45		30
Total time	135 (30%)	90 (20%)	225 (50%)	

Composition of different teaching methods for each session by time (min).
[a]Small group didactic session
[b]Case review included: Hypoplastic left heart syndrome (HLHS) post Norwood procedure with a clotted BT-shunt; HLHS with LCO post Norwood procedure; tetralogy of fallot (TOF) with junctional ectopic tachycardia (JET); Glenn and Fontan cardiopulmonary interactions and effects on PVR; coarctation of the aorta and complications; pulmonary artery (PA) band for D-TGA in the context of preparation of the left ventricle (LV) and ventricular septal defect (VSD) for over-circulation
[c]Truncus arteriosus repair (type 1a) with right ventricle (RV)-PA conduit with VSD closure and construction of neoaorta

The curriculum was a mixture of didactic instruction, case studies, and hands-on high-fidelity simulations, which were based on high-complexity cases, the eight CHD benchmark procedures, and a mix of lesion-specific postoperative complications. The boot camp took place over one day and included 8 hours of training in total. The participants were divided into smaller groups of 3-6 for individualized instruction. The participants rotated through a mix of task training, case study lecture, and high-fidelity simulation scenarios.

Measurement

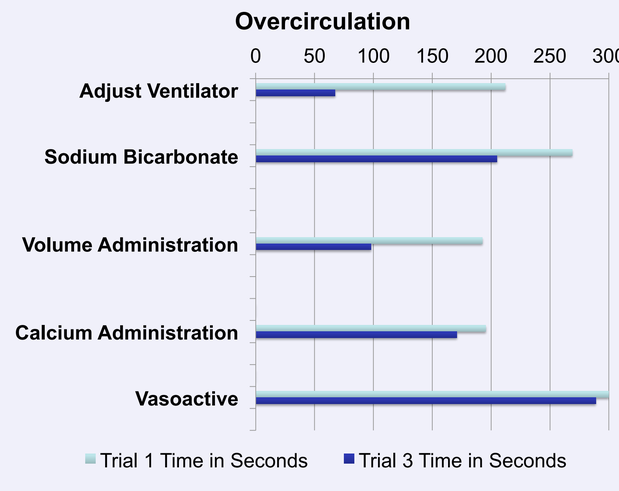
Knowledge: Pre-test/post-test format composed of multiple-choice questions (MCQ).

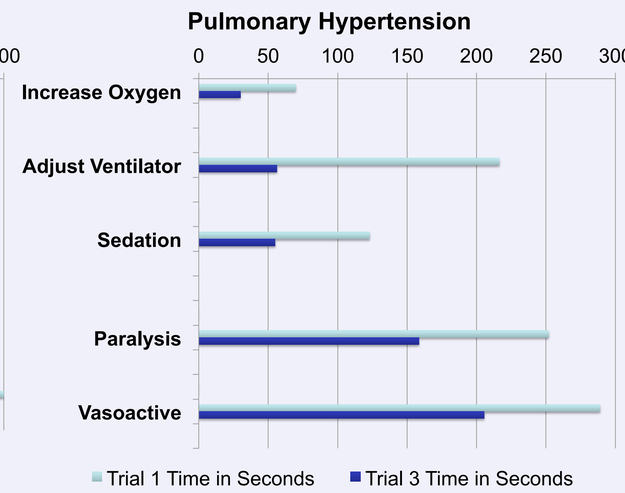
Performance: Evaluation of 1st to 3rd RCDP simulation scenario.

Confidence and Satisfaction: Evaluated by using a validated tool

Results

Knowledge: Post-test mean scores improved by 19%. A paired-sample t-test revealed a statistically significant increase in the post-test scores (pre-test: 36.8 ± 14.3; post-test: 56.0 ± 15.8; p <0.0001). **Performance:** A Wilcoxon signed rank test was used to assess time differences between the first 5-minute simulation and the last 5-minute evaluation. We found no statistical difference in the delta in time for the two related to the small number of groups. However, median times to implement appropriate intervention improved across the scenarios. Notably, there was a significant increase in the proportion of clinically time sensitive tasks completed within five minutes, [PRE: 60% (30/50) vs 86% (43/50), p=0.003]. After our simulation curriculum with RCDP methodology, a significantly higher proportion of participants met the goals than had at baseline testing.





Confidence: We evaluated the participants' confidence and satisfaction after the education session by using the *Student Satisfaction and Self-Confidence in Learning* tool. This validated, 13-item instrument was "designed to measure student satisfaction (five items) with the simulation activity and self-confidence in learning (eight items) using a five-point Likert scale"(20), in which higher scores indicate higher levels of quality. Results are shown as mean ± standard deviation. The participants reported a high level of satisfaction (4.7 ± 0.30) and confidence (4.8 ± 0.3) with the simulation experience.

Conclusions

This novel pediatric cardiac nurse practitioner-specific boot camp pilot utilized a curriculum that was based on expert opinion and supporting literature. The outcomes were positive, showing an overall increase in knowledge and self-reported confidence and satisfaction with the educational experience. Performance time in the RCDP simulation scenarios improved from the first to the last 5-minute implementation. However, our pilot study was not powered to detect statistical significance for median time to accomplish *a priori*–determined vital tasks. The overall expert-designated tasks-to-complete improved from the first to the last RCDP trial. Therefore, RCDP may be an effective educational method for training PNPs in high-risk, time-to-task scenarios.

Simulation boot camps have been conducted for physician training and have been shown to be an effective strategy for educating critical care providers in high-stakes scenarios. This pilot, cardiac-specific, simulation-based PNP training program provided multimodal education for rapid identification and management of the most common pediatric postoperative cardiac emergencies, for which improvement in time-to-task can be life-saving. This program was feasible and well received by the participants. With the increased push for advanced practice nurses in the critical care setting, simulation-based education training is an effective tool for teaching complicated skills. Additional understanding of the known complications associated with CHD surgery and methods to effectively train providers on the early recognition and treatment of these acute events might help to reduce FTR in this vulnerable population. Future simulation training for PNPs should include traditional simulation methods and RCDP education as a means to teach high-risk scenarios in which time to recognize and treat a complication or change is critical.

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