

Rapid Cycle Deliberate Practice for Pediatric Intern Resuscitation Skills

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Abstract

Introduction: For pediatric interns, it takes deliberate practice to translate the knowledge of what to do in emergencies into the procedural and communication skills required of a team member or team leader. This curriculum taught interns through simulations with rapid cycle deliberate practice (RCDP). This method focused on teaching time-sensitive team-based activities in simulation. The RCDP structure alternated practice with immediate expert feedback. This alternating pattern gave the learner chances to practice the correct way to perform these skills. **Methods:** The curriculum was developed iteratively based on common gaps in intern skills and knowledge; it was well suited for groups of four to six interns and to be given by one or two instructors over a 6-hour period of time. After an initial warm-up case, a series of simulations used RCDP to move interns through cases focusing on management of respiratory distress, upper airway obstruction, shock, intubation, complications of intubation, and pulseless arrest. Feedback was interspersed throughout the experience with detailed explanations provided as the interns required them to complete the simulations. **Results:** This technique was well received by a group of 81 interns who provided positive feedback on the sessions. In particular, when asked if the course “improved my teamwork and leadership skills” they agreed with a mean score of 4.9 out of 5. **Discussion:** This curriculum taught and integrated the procedural skills, communication skills, and teamwork needed to participate in pediatric resuscitations. The methods described in this curriculum improved confidence of pediatric interns and merits further study.

Keywords:

Simulation, Resuscitation, Rapid Cycle Deliberate Practice, RCDP, Physician, Pediatric Emergency Medicine, Flipped Classroom

Educational Objectives

By the end of this session, learners will be able to:

1. Maintain an open airway in a child in respiratory distress.
2. Prepare for and coordinate intubation of a child.
3. Perform needle thoracentesis when emergently needed for tension pneumothorax.
4. Coordinate CPR.
5. Use the defibrillator.
6. Use choreographies to support a child in acute undifferentiated distress.
7. Apply crisis resource management skills as outlined in the teaching guide to improve teamwork and leadership during the care of patients who require time-sensitive team interventions.

Introduction

In our hospital as in many other hospitals, interns are the first responders to acute decompensations on the inpatient floor. The types of patients that most often trigger emergent care have respiratory, cardiovascular, and/or neurologic deterioration.^{1,2} Rarely, they are called to patients in full cardiorespiratory arrest. Caring for ill patients even for a few minutes while critical care specialists are getting to the room requires pediatric interns to combine procedural skills, communication skills, and medical knowledge to care for the patient with a team-based approach.³

Simulation-based medical education works well; for pediatric resuscitation skills, rapid cycle deliberate practice (RCDP) works particularly well.^{4,5} This is a method which focuses on developing mastery of a time-sensitive, team-based skill. As the name suggests, RCDP relies on deliberate practice, meaning that the learners have specific goals that they are focused on while performing the skill, followed by immediate expert feedback provided with adequate time to repeat the performance until a level of mastery is achieved.⁶ This technique uses a gold standard choreography to help the learners achieve specific time and performance goals.⁵ Furthermore, action-linked phrases

Citation:

Lemke DS. Rapid cycle deliberate practice for pediatric intern resuscitation skills. *MedEdPORTAL*. 2020;16:11020. https://doi.org/10.15766/mep_2374-8265.11020

such as, “The patient has no pulse, I am starting compressions,” are taught to the learners to increase the automaticity of critical actions.⁷ These techniques have shown improved posttraining performance.^{4,5}

Some RCDP curricula that have been published focus on cardiopulmonary arrest scenarios,⁸ the neonatal resuscitation program,⁹ and intubation.¹⁰ Multiple simulation-based curricula which use uninterrupted simulation scenarios with postevent debriefing are published for shock,¹¹⁻¹³ bronchiolitis,¹⁴ or pediatric cardiac cases.^{15,16} There are groups of cases aimed to improve critical communication skills during resuscitations.^{17,18} However, this was the first RCDP-based resuscitation-based curriculum that taught and integrated procedural skills, communication skills, and resuscitation knowledge using a team-based choreography for the most common causes of pediatric deterioration.

Methods

Development: Curriculum

Originally, resuscitation skills at our institution were taught with a series of lectures and hands-on skills stations. Since RCDP had been used with success for some upper-level resident education at our institution, it made sense to use this technique for the introductory course (Appendices A and B). In a similar way to how we developed the resident level course, the learning objectives of the intern course were divided up into three groups of RCDP rounds: upper airway and oxygen; positive pressure ventilation, intubation, and needle decompression; and pulseless arrest. These scenarios were outlined in Appendix C.

The final case from Appendix C has been adapted and shortened to serve as a pretraining needs-assessment case. This was also outlined in Appendix B. This served to provide a warm-up exercise for the participants. The instructor can assess the needs of the day’s learner group.

As these cases were used, interns would routinely ask questions about the same material. These questions and the responses were documented as the mini-lectures listed in Appendix D. To aid with the mini-lectures, visual aids have been developed that were compiled in Appendix E.

Development: Learner Groups

Our interns had all been certified in pediatric advanced life support (PALS) as part of orientation before their clinical duties started. Interns were assigned to a 1-month rotation that included various skills needed before starting their second year. These skills included not only resuscitation, but also diabetes

management, asthma, and various procedures. Each month of internship groups of four to five interns came to the simulation center for 1 day during this rotation. This curriculum needed to serve interns in June, as well as July, and everything in between.

Development: Instructor Training

Instructors were familiar with simulation training, mannequin use, and common debriefing techniques. In addition, instructors were experienced with RCDP. For instructors new to RCDP, our simulation center has developed a half-day workshop to develop the skills needed. This separate course established a theoretical understanding of RCDP, tips on how and when to intervene in an ongoing scenario, and guidance on how to advance teams through a sequence. While this course taught instructors how to work with learners using RCDP, practicing with the scenarios multiple times is essential. RCDP simulation emphasizes choreography and scripted communication. While experts will likely vary on what they consider to be the gold standard of choreography, teaching teams to follow agreed upon best-practice choreographies and scripts gets them to a level where improvisations on these scripts can further improve care. As a result, each instructor needed to know the scripts and choreographies well. Having two or more instructors or more was helpful to provide peer mentoring through the process of learning how to use the curriculum.

Equipment/Environment

We ran this course in our simulation center, but it could be run with a portable simulation setup, and we used a high-fidelity infant mannequin, SimBaby (Laerdal) along with a standard pediatric resuscitation crash cart in a room that was similar to a regular patient care room. This room included a crib, monitor, air, oxygen, and suction on the wall which were used during the simulations. The crash cart was stocked with all needed equipment and medications (see Appendix A for detailed contents that were used), and came with a defibrillator.

Implementation: Introductions and Orientation

In its entirety, this curriculum ran for a 6-hour period. As an alternative, the three sections of the curriculum could be divided into separate experiences of about 1.5-2 hours each. Six hours allowed for completion with time for breaks and lunch. Each day started with meeting the interns and establishing three things: a safe learning environment through discussion of confidentiality, the fiction contract, and the basic assumption. To ensure a safe learning environment, the interns were assured that the focus of the course was to provide a formative experience and therefore no evaluation of their performances would be given to their supervisors. They in turn would maintain the performance of their

peers as confidential. For the fictional contract, learners were asked to focus on the parts of the simulated experience that were real rather than on how it was different from real life. Finally, the basic assumption was for learners to assume that any mistakes that were made during the simulations were not reflective of something inherently wrong with the learner or the instructor, but rather an opportunity to learn.¹⁹

After establishing the three frameworks, the interns were shown the detailed operation of the mannequin and allowed to find any equipment they might need. The structure of the day's activity was provided and interns were oriented to the simulation center's layout. Finally, they were asked to pretend to be working on one of our hospital floors and that they would hear a call for help that would mark the beginning of each simulation. At that signal, learners were to have one intern go into the room check what was needed. If needed, they were to call for help. Once that person called for help, the remaining interns were instructed to wait an additional 10 seconds before entering the room to simulate how long it would take to gather equipment and people on a typical hospital ward. They were reminded to act as interns and to help each other as needed both with specific tasks as well as thinking through the problem. Scripting for this briefing session was included in Appendix D.

Implementation: Needs Assessment Case

The first case of the day was used as a needs assessment for the team. This case was limited to 5 minutes and consisted of a parent calling for help after their infant child had collapsed and was in cardiac arrest caused by ventricular fibrillation of an unknown etiology (Appendix B). At the end of 5 minutes, the simulation was halted. A short debriefing session was used to highlight things that were done well and improvements to work on. This plus-delta debriefing highlighted areas that would become a focus of the instructor for the remainder of the day. No specific script for this debriefing was used, but it started with reactions from the learners simply asking how they felt in one or two words, then a clinical summary to clarify what happened, and finally a plus-delta debriefing. The group, including instructors, would generate a list of things that went well and the areas that need to be changed. After summaries of any learning points, the team participated in the first RCDP simulation.

Implementation: RCDP Rounds

While the needs-assessment case was uninterrupted for 5 minutes followed by debriefing, the simulation structure changed to RCDP for the remainder of the day. The details of the RCDP scenario rounds were in Appendix C. Each round of RCDP

simulation built on the previous round. At the beginning of each round's description was a list of objectives that were added to the previous round's objectives. Also listed were the setup, initial vital signs, scripts for a parent confederate, and expected actions of learners. All simulations were set on the hospital floor and a call for help from the parent confederate triggered the first responder followed by the remaining interns once more help was requested.

Instead of an uninterrupted simulation followed by postevent debriefing, these rounds of simulation were conducted using RCDP techniques.^{7,20} Multiple types of feedback were provided interspersed with the interns performing their roles in the simulation:

1. Ongoing coaching, without pausing: feedback was provided when needed to correct or praise the performance of a single individual such as rate of compressions by the compressor, or team lead communications (e.g., assigning roles, sharing mental model, asking for closed loop communication, etc.).
2. Pause and restart: feedback was provided and the same scenario was restarted to give the team a chance to practice from the beginning of the round.
3. Pause and rewind: feedback was provided and a key time period was repeated (e.g., compressor switch with pulse and rhythm check, shared mental model). This was also used to give each individual a chance to perform a skill in each role after one configuration of the team did it well.
4. Stop, praise, and round up: feedback was provided, team members were rotated, and the next round was started.

While many of the pauses were initiated by the instructor, the interns were empowered to pause the action and ask for help as needed. After questions and feedback, the lead instructor decided whether rewinding or restarting was called for. The scenarios in Appendix C formed the structure of the day, but interspersed within simulation were opportunities to provide immediate feedback and repetitive practice for the interns. The most commonly used mini-lectures were described in Appendix D and each mini-lecture was tied to a specific scenario where it most commonly was required. Of note, the team often performed the entire round of a simulation correctly, and the instructor still repeated the same scenario with interns playing the same role to provide additional practice. This repetitive practice of perfect performance allowed the interns to solidify their skills through motor memory. To maintain the morale of the team, the instructor also served as a cheerleader of the team providing positive feedback with every pause in the action.

At the start of each new round, the residents were asked to rotate their roles to experience each position throughout the day. At times, the same case (or parts of the case) would be run repeatedly to allow each learner to participate in each role around the bed. In Appendix C, the expected actions were divided into hard stops (i.e., those actions which must be performed a given way before moving on) and soft stops (i.e., those actions which allow for variability in performance). Hard stops were highlighted in bold. For these actions, if they were not done by the team member they had a chance to repeat the action correctly. Some of the actions were labeled as soft stops. For these, if the team was doing well overall and there was time to spend on these finer points, the team would be asked to repeat these aspects.

The first part of each course focused on the technical skills of upper respiratory management and fluid resuscitation. The middle section of the course focused on the choreography of intubation and responding to a sudden decompensation after intubation caused by a tension pneumothorax. The final section of the curriculum centered on cardiopulmonary arrest and performing CPR while getting to the first pulse and rhythm check as fast as possible. Throughout the day, the team worked on closed loop communication and mental modeling.

Assessment

To evaluate the course, learners filled out a Likert-based questionnaire which reflected the objectives listed above (Appendix F). This questionnaire was the standard form our center used. Study data were collected and managed using research electronic data capture (REDCap) tools hosted at Texas Children's Hospital. REDCap is a secure, web-based software platform designed to support data capture for research studies, providing: (1) an intuitive interface for validated data capture; (2) audit trails for tracking data manipulation and export procedures; (3) automated export procedures for seamless data downloads to common statistical packages; and (4) procedures for data integration and interoperability with external sources.^{21,22} Data generated from these questionnaires were analyzed using means and standard deviations.

Results

Eighty-one learners in 2018 participated in 21 sessions and filled out the REDCap surveys. All of these were physician interns in the pediatric programs at Texas Children's Hospital/Baylor College of Medicine and all were PALS-certified prior to attending the course. When asked to complete the voluntary survey, not all residents responded to all questions resulting in some questions having fewer responses.

Table. Course Evaluations of Intern Confidence^a

Statement	M	SD	N
The session improved my skill in airway management.	4.9	.3	78
The session improved my preparation for intubation of the non-neonate.	4.8	.5	78
The session improved my skill in needle thoracentesis for tension pneumothorax.	4.7	.5	81
The session improved my skill in CPR.	4.9	.3	80
The session improved my skill in the use of the defibrillator.	4.9	.5	81
The session improved my teamwork and leadership skills.	4.9	.3	80

^aRated on a 5-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*).

As shown in the Table, the self-reported responses to all six Likert-scale items (1 = *strongly disagree*, 5 = *strongly agree*) had mean above 4.5 out of 5. In particular, when asked if the course “improved my teamwork and leadership skills” learners agreed with a mean score of 4.9 out of 5. These were two representative comments from the evaluations:

- “I absolutely loved practicing PALS over and over again. It was extremely useful to know how to open things and to know where things are and how actually to execute a code, as opposed to just saying the words out loud.”
- “Sim day [...] was awesome! I learned a lot and I especially appreciated switching roles during the mock code and the repetition. Also, it was a lot of fun, so thank you for a great day!”

Discussion

There have been challenges along the way of implementing this curriculum. The RCDP method allows adaptation to different levels of team experience. This was particularly relevant when teaching teams at the beginning of the year versus the end of the year. However, dealing with a variety of experience levels within a team remained difficult. There have been days when one of the interns had a strong interest in critical care fellowships or emergency medicine fellowship and other interns were heading into fields that were unlikely to require resuscitation skills. Balancing the needs of each type of resident was challenging. Pushing the team to handle more difficult scenarios when the more experienced intern was in charge helped challenge them appropriately, while providing ongoing coaching to the less experienced intern as they led the session helped mitigate the situation.

While the interns typically came to the simulation session as a group of four to six, there have been times due to illness or the vagaries of the schedule that fewer residents have been assigned. This curriculum did not work well with fewer than four, worked best with six learners, and could even be used with as

many as eight with adapted expectations. When only two or three participants were present, shifting this experience to focus on individual skills stations was required. Similarly, two instructors (or one instructor and one assistant) were usually assigned to the day. This worked well, but if a single instructor was very familiar with the material and controlling the mannequin, it was possible to still run the cases.

Early during the development of the course, after several rounds of practice teams often completed tasks (such as administering epinephrine) at a rate much faster than expected; most of the time this was because they had completed the task before starting and did not put everything back. One common event was leaving a syringe with epinephrine in the slot where it is stored in the crash cart. The solution for this particular challenge was to make sure that teams could not skip steps even if it was the fourth or fifth time through the skill. For example, emptying or refilling all vials and putting away the syringe, the needle, and the epinephrine back into the original packaging in the correct location in the crash cart helped maintain a realistic pace of completion.

While the results of the posttraining surveys were encouraging, they were limited by this being taught at a single institution and by mostly one instructor. Also, the survey was a measure of the confidence of the interns immediately after the session. Alternative and more robust (but more difficult to obtain) evaluations would be to measure the medical knowledge of participants before and after training, or to measure the performance of the team in a simulated environment. This survey reflected a single point in time immediately after the training session, and did not include surveys at a later time. These improvements of analysis of the curriculum are one direction of future research for this project. Another direction would be to move this curriculum into an interprofessional direction. Finally, this education could be split up into multiple sessions, each of which would be shorter but offered more frequently than a single time during the intern year.

One strength of this method was that it allowed teams to focus on the basics before progressing to skills that were less likely to be required in actual resuscitations. This allowed for the curriculum level to adapt to the level of the learner. "Practice does not make perfect, perfect practice makes perfect," is an idea that my middle school piano teacher drilled into me. This RCDP curriculum allowed for the chance to get it perfect. This curriculum was an opportunity for interns who cognitively understood the steps necessary to practice the technical skills of resuscitation alongside the communication skills to organize

and be part of a team. It allowed interns not just to practice, but to practice resuscitation near perfectly.

Appendices

- A. Supply List.docx
- B. Assessment Scenario.docx
- C. RCDP Scenarios.docx
- D. Instructor Scripts and Lectures.docx
- E. Visual Aids.pdf
- F. Evaluation.docx

All appendices are peer reviewed as integral parts of the Original Publication.

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Acknowledgments

Dr. Martin Lorin, Emeritus Professor of Pediatrics at Baylor College of Medicine, developed the course on which this version was based and provided edits to this manuscript.

Dr. Cara Doughty and her simulation center team at Texas Children's Hospital provided time, resources, and space to make this course possible as well as provided advice and edits during the writing process.

Disclosures

None to report.

Funding/Support

None to report.

Ethical Approval

Reported as not applicable.

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- Received:** December 16, 2019
Accepted: July 2, 2020
Published: November 19, 2020