

# Neonatal Resuscitation: A Blended Learning Curriculum for Medical and Physician Assistant Students

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## Abstract

**Introduction:** Demonstration of competence in neonatal resuscitation is critical for health care providers who provide newborn care because each year, approximately 400,000 (10%) newborns require resuscitation in delivery rooms across the United States. Therefore, neonatal resuscitation skills certification is provided to graduates entering specific specialties at the beginning of residency and renewed biennially through the American Academy of Pediatrics and the American Heart Association. However, there is no formal curriculum to prepare medical (MD) and physician assistant (PA) students prior to graduation. **Methods:** We developed a neonatal resuscitation curriculum for MD and PA students using a blended learning approach. The curriculum included web-based interactive teaching modules, a demonstration video of a mock neonatal resuscitation, and a neonatal resuscitation simulation. Final-year MD and PA students were evaluated using pre-/posttest, a neonatal resuscitation checklist, and an optional survey on interprofessional communication skills, roles, and responsibility. **Results:** Eighteen health professions learners completed the neonatal resuscitation curriculum. A paired-samples *t* test was conducted to compare pretest and posttest scores. There was a significant difference in pretest ( $M = 61.4, SD = 15.3$ ) and posttest ( $M = 78.6, SD = 8.0$ ) scores,  $t(17) = -4.7, p < .001$ . The mean score on the checklist was 79%. Learners strongly agreed/agreed that the simulation improved skills performance (100%), communication skills (92%), and understanding of roles and responsibilities (83%) during a neonatal resuscitation. **Discussion:** There were improvements in knowledge, procedural, and interprofessional skills in learners who received the neonatal resuscitation curriculum.

## Keywords

Neonatal Resuscitation, Interprofessional Education, Health Professions Learners, Blended Learning, Nurse/Nurse Practitioner, Physician Assistant, Respiratory Therapist, Simulation

## Educational Objectives

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

1. Demonstrate understanding of neonatal resuscitation principles.
2. Perform critical steps in neonatal resuscitation.
3. Recognize the role of an interprofessional team in neonatal resuscitation.

## Introduction

In the United States, approximately 10% of neonates each year require some resuscitation by an interprofessional team of health

care providers at delivery.<sup>1</sup> These providers include physicians, advanced practice professionals, nurses, and other allied health workers. Performing a successful neonatal resuscitation requires knowledge, procedural, and behavioral skills that differ from those needed during pediatric resuscitation.<sup>2</sup> For example, the recommended chest compression-ventilation ratio is 30:2 for lone-rescuer or 15:2 for two-rescuer cardiopulmonary resuscitation in the pediatric age group but is 3:1 in neonatal resuscitation.<sup>2</sup> Also, neonatal resuscitation is performed by a team of health care providers with clearly defined roles. Therefore, the American Academy of Pediatrics and the American Heart Association have designed the Neonatal Resuscitation Program (NRP) to offer certification to health care providers. New graduates in health professions fields who require skills in neonatal resuscitation receive their initial certification at graduation, but studies have shown that despite certification, there is a decline in competence shortly after training.<sup>3</sup> The use of simulation-based training in neonatal resuscitation has been

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shown to improve these skills in health care providers across specialties and professions<sup>4-8</sup> and to decrease skills decay over time.<sup>9</sup>

A review of literature revealed that most neonatal resuscitation training focused on postgraduate trainees. For example, Patricia, Arnold, and Lemke described a curriculum using simulation in the application of rapid cycle deliberate practice to neonatal resuscitation for physicians (attendings, fellows, and residents), nurses, advanced practice providers, and respiratory therapists, all of whom were already certified in NRP.<sup>10</sup> However, some studies have shown the benefit of neonatal resuscitation training for medical (MD) students.<sup>11-13</sup> Alphonso and colleagues created an integrated obstetrics and neonatal simulation case but focused only on neonatal airway management skills and included only third-year MD students.<sup>13</sup> Therefore, we designed a neonatal resuscitation curriculum specifically for MD and physician assistant (PA) students who were not NRP certified, and we included additional steps in neonatal resuscitation, such as circulation, volume resuscitation, pneumothorax management, and interprofessional practice.

This curriculum utilized a blended learning approach consisting of a web-based module with an interactive video and a simulation session to foster knowledge, procedural, and behavioral skills required to perform effective neonatal resuscitation for final-year undergraduate MD and graduate PA students.

We utilized an interactive pedagogical strategy to engage learners who had no formal training in the principles of neonatal resuscitation. Our curriculum integrated relevant principles of anatomy and physiology in the web-based module, thus differentiating this course from the national NRP. Also, the multimodal design of this curriculum ensured that we could capture each learner's preferred learning style.

Since our target group was final-year MD and PA students who had chosen a neonatology elective to facilitate their transition to residency or job employment, we offered the full neonatal resuscitation skills to these learners, including airway, circulation, volume resuscitation, pneumothorax management, and interprofessional practice.

## Methods

We obtained approval from the Wake Forest School of Medicine Institutional Review Board prior to the design and implementation of the neonatal resuscitation curriculum.

The target learners were final-year MD and PA students who were on 4-week neonatology rotations in one of two neonatal

intensive care units (NICUs). Since this was an elective rotation, this training was offered as a part of the general neonatology curriculum on a monthly basis for two to three learners at a time.

## Development

The online module (Appendix A) was created in Storyline 360 (SCORM 1.2 compliant) by Cassandra Johnson using multimedia principles to manage cognitive load in the learners. Using audio and visual instruction, this module covered principles of resuscitation on airway management, cardiopulmonary resuscitation, vascular access, medications, and pneumothorax evacuation.<sup>14</sup> Modupeola O. Akinola reviewed the content of the modules and edited as appropriate.

The video (Appendix B) of a mock neonatal resuscitation demonstrated critical steps and teamwork during neonatal resuscitation. The module was housed in our learning management platform, CANVAS. The module was designed so that the learners could not advance the slides quickly, thereby ensuring that they spent appropriate time in knowledge transfer and retention prior to their simulation session.

Learners were expected to complete the online module and demonstration video prior to attending the simulation session.

For the simulation exercise, the simulation faculty developed two case scenarios based on common cases that we had encountered during delivery or through transport calls from surrounding community hospitals. An interprofessional team consisting of a nurse (played by the NICU fellow) and a respiratory therapist was available to perform steps in neonatal resuscitation with the learner who assumed the role of a team leader and a second learner who assumed the role of a team member when appropriate. The facilitators of the simulation sessions included an experienced neonatologist, respiratory therapist, and/or neonatal fellows who were NRP certified. Each facilitator received a written layout of each case and learning objectives prior to the first simulation session and also met to discuss expectations, roles, and steps for each case.

## Implementation

Approximately 1 week prior to the simulation training, MD and PA students completed a 20-question pretest (Appendix C) for assessment of baseline knowledge, reviewed the web-based module on neonatal resuscitation principles (Appendix A), and watched the 10.5-minute demonstration video of a mock neonatal resuscitation (Appendix B). During the last week of the rotation, learners participated in neonatal resuscitation simulation training in our medical school's Center for Experiential and Applied Learning.

Prior to starting the simulation, the facilitator (a neonatology fellow) explained the learning objectives and provided a verbal case description to each student (Appendices D & E). This verbal case description simulated the usual phone call received by the NICU team prior to a delivery. The nurse, respiratory therapist, and team member were aware of the case presentation and the simulation scenarios (Appendices D & E) but participated in a supportive role to the team leader/student.

The first simulation case was respiratory distress at delivery in a postterm female neonate (Appendix D). During the first simulation, either the MD or PA student assumed the role of the team leader. After completing their session as a team leader, students joined subsequent simulations as team members. The second simulation case was respiratory distress at delivery in a term female neonate (Appendix E) and had a new student assume the role of team leader. If there were more than two students in a session, we continued to alternate the two case scenarios between learners to allow each learner to assume the role of a team leader. Each case ran for approximately 10 minutes.

The simulation facilitator observed each case and evaluated the students' performance using the neonatal resuscitation critical action checklist (Appendix F). After both simulations were done, all students and team members took the posttest (Appendix C), had a 10-minute debriefing (Appendix G), and completed an optional perception survey (Appendix H).

#### Equipment/Environment

For the simulation cases, we used a high-fidelity neonatal mannequin, Tori, with realistic functions, including an airway for intubation, chest rise during bag-mask ventilation, and an umbilical cord for catheter placement. Tori's vital signs were displayed on a cardiorespiratory monitor controlled by our simulation technology specialists. Other equipment we used included radiant warmer, oxygen setup, positive pressure ventilation device (self-inflating bag and mask), endotracheal tubes with stylet, laryngoscope (Miller 0 blade), pulse oximeter and sensor, end tidal carbon dioxide detector, umbilical catheter, 18- or 20-gauge butterfly needle, syringes (1mL, 10mL, and 50mL), bulb syringe, suction catheter, blankets, hat, diaper, and a timer. The medications we used included epinephrine and surfactant. Lastly, we needed normal saline and a blood product (grape juice) for intravenous fluids.

#### Personnel

Each simulation case required six personnel to complete all tasks:

1. The nurse (acted by an NICU fellow) performed IV placement, administered medication, assisted the team leader in procedures, provided prompts to the team leader as appropriate, and periodically verbalized the duration of resuscitation.
2. The team leader (an MD/PA student) assigned team members their tasks, instructed team members on steps and procedures to be performed, maintained the neonate's head on the bed, and performed all invasive resuscitation procedures (i.e., intubation, umbilical catheter placement, and pneumothorax decompression).
3. The team member (an MD/PA student or actor) performed chest compressions.
4. The respiratory therapist offered respiratory support after airway establishment (invasive and noninvasive) and provided the appropriate equipment for positive pressure ventilation and intubation.
5. The simulation technician directed the vital-sign changes of mannequin for the case.
6. The simulation faculty/facilitator scheduled and coordinated simulation sessions, introduced team members and students prior to simulation, led the prebrief to discuss learning objectives and provide the case scenario, monitored performance using the neonatal resuscitation critical action checklist, and led the debriefing after each session.

#### Assessment

Learner improvement in knowledge was evaluated using a 20-question pre- and posttest (Appendix C). The pre-/posttest was a combination of clinical vignettes and traditional multiple-choice questions assessing learners' neonatal resuscitation knowledge, procedural, and behavioral skills in an interprofessional setting. All questions were written by Cassandra Johnson and reviewed by Modupeola Akinola and Kathryn Winn. A paired-samples *t* test was conducted to compare pretest and posttest scores.

Formative assessment for each team leader was provided during the postsimulation debrief using the neonatal resuscitation critical action checklist (Appendix F). The critical actions were developed based on neonatal resuscitation guidelines<sup>14</sup> and core competencies for interprofessional collaborative practice.<sup>15</sup> We used 20 of the 21 critical actions on the checklist to evaluate five domains in neonatal resuscitation (Airway: eight actions, Circulation: three actions, Volume Resuscitation: three actions, Pneumothorax Management: three actions, and Interprofessional Practice: three actions). On the checklist (Appendix F), the corresponding domain was named in parentheses beside each

critical action. Learners received a score of 1 point per action if the checklist was marked Yes/Yes with prompt, for a total score of 20 points. The last action, “Assigned correct Apgar score,” was not included in the scoring because it did not fall under any of the five domains.

We also administered an optional 22-question perception survey (Appendix H) to learners. This survey utilized a 5-point Likert scale to assess perception about skills in neonatal resuscitation, communication, and interprofessional collaboration.

### Debriefing

We performed a 10- to 15-minute debriefing after both scenarios using a tool (Appendix G) adapted from the five-step SHARP tool.<sup>16</sup> The validated SHARP tool was originally used to elicit feedback on surgical procedures, but we adapted it for neonatal resuscitation procedure. The simulation leader used prompts in the adapted SHARP tool to initiate self-reflection and learner-to-learner feedback about the simulation.

## Results

A total of 18 health professions learners (13 MD and five PA students) completed this neonatal resuscitation session from August 2017 to April 2018. Out of a possible 100 points, the average pretest score for all MD students was 60.4, and the average posttest score for MD students was 80.7, for an average score increase of 20.3 points. For PA students, the average pretest score was 64.0, and the average posttest score was 73.0, for an average score increase of 9.0 points. Based on a *t* test for the combined average scores for all students, there was a significant increase in the scores from pretest ( $M = 61.4$ ,  $SD = 15.3$ ) to posttest ( $M = 78.6$ ,  $SD = 8.0$ ),  $t(17) = -4.7$ ,  $p < .001$ .

The critical action checklist mean score, derived as a percentage of the total Yes/Yes with prompts points out of a maximum of 20 points, was 79% for all learners ( $N = 18$ ). The mean score for MD students was 82%, and the mean score for PA students was 72% (Table 1). The score for each checklist category is shown in Table 1 for MD and PA learners.

The optional learner perception survey had a response rate of 67% ( $n = 12$ ). We report responses on a 5-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*) to five questions (Questions 1, 11, 16, 18, and 19) that directly assessed learner perception of skills in neonatal resuscitation, communication, and interprofessional collaboration. Table 2 provides the percentage of learner responses, which were mostly favorable, for these questions. When asked if they were now able to perform the components of neonatal resuscitation, 100% of learners strongly agreed or agreed. When asked if the simulation helped their communication skills and ability to anticipate the needs of their team members, 92% of learners strongly agreed or agreed. When asked if the simulation helped their understanding of their roles and responsibilities during a neonatal resuscitation, 83% of learners strongly agreed or agreed.

Learners identified opportunities for improving the simulation curriculum. Comments from the perception survey included “It would be very beneficial to run the code sequence multiple times” and “The only thing I would suggest is to potentially do this simulation twice: once at beginning of our rotation and once at the end of our rotation.”

## Discussion

Our results show that this curriculum is effective in fostering learning of neonatal resuscitation principles. To our knowledge, this is the first neonatal resuscitation curricular resource developed and studied for both MD and PA students.

Since this curriculum was embedded in the general neonatology curriculum, we did not expect learners with no prior formal training in neonatal resuscitation to score 100 on the posttest. This was because the training had a limited time allotment that likely influenced retention of knowledge and skills.

However, the mean pretest score in our learners was higher than we expected, thus decreasing the average learning gain from pre- to posttest. We surmised that this may have been due to the activation of prior knowledge of concepts of resuscitation in other settings similar to neonatal resuscitation. This hypothesis

Table 1. Neonatal Resuscitation Critical Action Checklist Scores<sup>a</sup>

Group	Airway	Circulation	Volume Resuscitation	Pneumothorax Management	Interprofessional Practice	Total
PA ( $n = 5$ )	65%	93%	80%	40%	93%	72%
MD ( $n = 13$ )	75%	82%	85%	77%	100%	82%
PA and MD ( $N = 18$ )	72%	85%	83%	67%	98%	79%

Abbreviations: MD, medical students; PA, physician assistant students.

<sup>a</sup>Percentages are derived from the total Yes/Yes with prompts points out of a maximum of 20 points in the critical action checklist (Appendix F).

**Table 2.** Health Professions Learners' Optional Perception Survey Responses (*n* = 12)

Category	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
Neonatal Resuscitation Skills Performance (Question 1)	16%	84%	0%	0%	0%	0%
Confidence in Team Leadership Skills (Question 11)	0%	50%	25%	0%	0%	25%
Communication Skills (Questions 18-19)	42%	50%	8%	0%	0%	0%
Understanding Leadership Role/Responsibility (Question 16)	25%	58%	8%	8%	0%	0%

was confirmed during the simulation session when MD and PA students performed effectively in four domains of neonatal resuscitation—Airway, Circulation, Volume Resuscitation, and Interprofessional Practice. However, the students were not as effective in the fifth domain of Pneumothorax Management and were less likely to make this diagnosis in both clinical cases even though the recognition and treatment of pneumothorax had been covered in the module and demonstration video. It was plausible that prior knowledge and skills in the first four domains contributed to effective performance, whereas neonatal pneumothorax probably had not been previously encountered during the students' training. Therefore, we used the opportunity to further teach this particular skill to the learners.

We had some challenges during the implementation of our curriculum, especially with the simulation. Although we were able to recruit a respiratory therapist to participate in the monthly simulation, we were unable to get a nurse because the simulation center was outside the hospital. Therefore, a neonatology fellow played the role of the nurse. This was acceptable because of the overlap between the physician and nursing roles in neonatal resuscitation, with the major role difference being drawing up intravenous fluid and medication.

The optional survey had a response rate of 67%. We recognize that this low response rate is a limitation of this study. In the future, we will allocate a dedicated amount of time for students to complete the survey onsite at the end of the training session in order to increase response rate.

Future directions for this resource could include using the session as a refresher course on collaboration, patient-centered care, and communication for residents in pediatrics, family, and emergency medicine. Since implementing the module with students, we have had an opportunity to add it to the annual academic half-day sessions for pediatric residents.

## Appendices

- A. Neonatal Resuscitation Module folder
- B. Neonatal Resuscitation Video.mp4

- C. Pre-Posttest and Answers.docx
- D. Simulation Scenario 1.docx
- E. Simulation Scenario 2.docx
- F. Critical Action Checklist.docx
- G. Debriefing Tool.docx
- H. Perception Survey.docx

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

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## Ethical Approval

The Wake Forest School of Medicine Institutional Review Board approved this study.

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