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Annals of Pediatrics & Child Health

Research Article

Newborn Nursery Emergencies: Simulating the First Five Minutes

DeeAnne Jackson[1], Pranaya Chilukuri[2], Chrystal Rutledge[1], Stacy Gaither[1], Kristine Sawyer[3], and Nancy M. Tofil[1]*

[1]Department of Pediatrics, University of Alabama at Birmingham, USA

[2]University of Alabama at Birmingham School of Medicine, USA

[3]Dothan Pediatrics, USA

***Corresponding author**

Nancy M. Tofil, Department of Pediatrics, University of Alabama at Birmingham, 1600 5th Ave South CPPI 102, Birmingham, AL 35233, USA, Tel: 205-638-9387; Fax: 205-975-6505; Email: ntofil@peds.uab.edu

Submitted: 09 March 2018

Accepted: 10 March 2018

Published: 12 March 2018

ISSN: 2373-9312

Keywords

- Simulation; Newborn; Newborn nursery; Emergencies; First five minutes

Abstract

Objective: To provide training in the immediate response to newborn emergencies in a Level 1 newborn nursery, to assess the efficiency of this training for increasing the comfort level of pediatric residents and nurses in emergency recognition and response, and to identify systems issues that pose potential barriers to optimal patient care.

Patients and methods: Two simulation cases were designed and implemented monthly. Case 1 was respiratory distress and apnea. Expected management included recognition of respiratory distress/apnea, calling for assistance, and effectively performing bag valve mask ventilation. Case 2 was a seizure related to hypoglycemia. Expected management included checking blood glucose level, inserting an intravenous catheter, and administering intravenous dextrose. Debriefing occurred after each scenario focusing on management, barriers to care and inter-professional communication. Pre- and post-training, participants completed surveys assessing comfort level with newborn medical emergencies.

Results: Over a 10-month period, 40 learners (18 resident physicians (MD)/22 nurses (RN)) participated in training. There was a statistically significant improvement in perceived comfort level out of 5 from 3.74 ± 0.7 to 4.48 ± 0.42 ($p < 0.0001$) for residents and nurses. Overall average confidence was higher for nurses than residents (4.26 ± 0.75 versus 3.89 ± 0.75; $p = 0.02$) both pre- and post-simulation. Learning themes included: emergency response process (n=11), teamwork focus (n=10), seizure management (n=10), and effective bag valve mask ventilation/troubleshooting (n=7). Training was successful in identifying nursery systems issues including a deficit in pediatrics resident knowledge of the hypoglycemia protocol and staff inability to locate the pediatric code cart and infant code button.

Conclusions: Training of newborn nursery staff in the recognition and management of rare, newborn emergencies through simulation was successful in improving comfort level and identifying systems issues and strategies for improvement.

ABBREVIATIONS

NRP: Neonatal Resuscitation Program; NICU: Neonatal Intensive Care Unit; PDSA: Plan-Do-Study-Act

INTRODUCTION

Early recognition and management of newborn emergencies are keys to good patient outcomes [1]. Although, relatively infrequent, a variety of emergencies can present during the birth hospitalization of term and near-term newborns, after the initial transition period while the infant is admitted to the newborn nursery and typically rooming in with the mother on the postpartum unit. Newborn nurseries are staffed by a variety of providers who must be skilled to detect newborn emergencies and prepare for the initial response and stabilization of the infant [2].

Newborn emergencies which may occur in the first days of life include respiratory distress, lethargy, and seizures [3,4]. Newborn care providers are often trained in Neonatal Resuscitation Program (NRP), which focuses on the resuscitation and stabilization of newborns at the time of delivery; however, this training does not address emergencies that may arise in apparently healthy newborns after admission to the postpartum unit. The initial response to emergencies in previously healthy newborns is analogous to practicing the first five minutes of a code where nurses and pediatricians stabilize the infant until he or she can be safely transferred to a Neonatal Intensive Care Unit (NICU) [5,6]. Initial response training for unexpected inpatient emergencies often involves simulation and has been successfully used for pediatric and adult patients but little is written about its application to newborns [5-8]. Medical simulation is an effective means of practicing decision-making skills and emergency management in a non-threatening environment with immediate feedback and correction of errors [9,10]. While true emergencies are rarely encountered by a single clinician, simulation allows for emergency responses to be practiced on a regular basis. Thus, when a true emergency occurs, staff have already practiced the skills required for a rapid, appropriate response. Simulation

cases can be repeated until the team of participants achieves the appropriate responses with the expectation that patient outcomes will improve as providers' subjective skill and comfort levels improve. The suspension of disbelief accompanied by simulation training allows physician and nurse trainees to fall into the mode of taking care of a real patient [11].

The specific aims of this study are to provide training for the immediate response to newborn emergencies in a Level I newborn nursery, assess the efficacy of this training in increasing the comfort level of pediatric residents and nursing staff in emergency recognition and response, and to identify systems issues posing potential barriers to optimal patient care. Our hypothesis was that simulating the first five minutes of a newborn emergency would improve perceived skill and comfort levels of pediatric residents and nursing staff in the initial management of newborn emergencies prior to arrival of the infant code team. In addition, patient care will be improved through standardization of the initial response to newborn emergencies and correction of unit specific barriers.

METHODS

Study site

After the Institutional Review Board at the University of Alabama at Birmingham approved the study, monthly simulations were conducted for pediatric interns and nurses in the newborn nursery. This study took place in a Level I newborn nursery in a large academic medical center where patient care is provided by faculty from the Division of Academic General Pediatrics working with first year categorical pediatric residents and or second year combined internal medicine/pediatric residents. The infant code team and after-hours cross coverage care is staffed by pediatric residents and neonatology fellows who are on call in the NICU. Nursing care is provided by a registered nurse who cares for both the infant and the mother. Newborns routinely room in with their mothers for at least 23 hours of the day.

Recruitment methods

The study was conducted for twelve months from July 2016 – June 2017; the first two months of July and August served as pilot sessions allowing for case standardization with no data recorded. The simulation course occurred for one hour on the second Tuesday of each month in the afternoon. As all pediatric interns rotate through the newborn nursery once during their first year of training, this model allowed all interns to be exposed to this case. In addition, each case involved two to three newborn nursery nurses to allow for focus on interdisciplinary actions and communication.

Simulation session

The simulations involved focused on two specific scenarios: 1) respiratory distress and lethargy progressing to apnea and 2) seizure activity with apnea. Each scenario began with a structured pre-briefing description and demonstration of the features of the simulator, including the infant monitor, simulated breath and heart sounds, chest rise during breathing or bag-valve mask ventilation, location and presence of pulses, cyanosis and seizure actions. For each scenario the team was provided a history of present illness, delivery history, maternal prenatal history, family history, social history and review of systems (Appendix 1). After all participant questions were answered, the simulation began. Following each scenario, newborn care attending physicians and simulation experts co-led debriefings utilizing the technique of debriefing with good judgement [12,13]. The debriefing of each case reflected on initial management, stabilization of the infant, decisions to call the infant code team, and continued patient management while awaiting the code team's arrival. A debriefing guide was used for each case to standardize discussion points (Appendix 2).

Simulation scenarios

Two newborn emergency simulation cases were designed and piloted. In Case 1, a 23-hour-old newborn with progressively worsening respiratory distress experiences apnea. The required actions for this case include recognizing the apnea, calling for help, and effectively performing bag-valve mask ventilation. In Case 2, a progressively lethargic 16-hour-old newborn develops a seizure due to hypoglycemia. This simulation requires recognition of hypoglycemia as the cause of the seizure, insertion of an intravenous catheter, and administration of glucose.

Statistical analysis

Self-assessed comfort and skill data were collected from both nurses and residents pre- and post-simulation through surveys (Appendix 3). In addition, a survey of the simulation's effectiveness was collected. All surveys were anonymous. Data was analyzed using SPSS Version 23.0 (Chicago, IL) statistical software. Questions were grouped according to the medical problem: questions 1-3 regarding respiratory distress, questions 4-6 involving seizure management, and questions 7-10 focusing on emergency responses of calling a code and providing initial emergency care. A student t-test was used to analyze mean differences between the confidence reported in respiratory distress, seizure, and emergency care scenarios before and after the simulations. T-test analysis was also used to compare mean differences between the residents' and nurses' reported comfort levels. All tests were two tailed and a p-value of less than 0.05 was considered significant.

RESULTS

Forty learners (18 resident physicians and 22 nurses) participated in simulation training and submitted pre- and post-surveys over 10 months. 95% (38/40) of participants strongly agreed that the simulations were effective in learning to respond to newborn emergencies. Participants stated that they would recommend the simulations to others. The duration of time was deemed to be adequate for both performing the simulation and debriefing.

Table (1) shows a statistically significant increase in the self-perceived average comfort levels of treatment among nurses and residents from pre- to post-intervention. Overall, nurses have statistically significantly more self-perceived comfort on a 5 point scale than interns (4.26 ± 0.75 versus 3.89 ± 0.75, p = 0.02). Also, when analyzed separately, each group had a significant increase in perceived comfort. Nurses went from 4.05 ± 0.63 to 4.59 ± 0.38 (p = 0.009) whereas interns comfort improved from

Table 1: Average confidence scores of nurses and residents for respiratory, seizure, and emergency scenarios, both before and after simulation.

	Pre-simulation	Post-simulation	P-value
Respiratory Average	4.05 ± 0.76	4.58 ± 0.43	< 0.0001
Seizure Average	3.55 ± 0..81	4.32 ± 0.54	< 0.0001
Emergency Average	3.47 ± 0.90	4.46 ± 0.55	< 0.0001
Overall Average	3.74 ± 0.71	4.48 ± 0.42	< 0.0001

3.37 ± 0.62 to 4.41 ± 0.44 ($p < 0.001$). Learning themes from the participants' post-survey feedback comments were coded. These themes included emergency response practice (n=11), teamwork focus (n=10), seizure management (n=10), and effective bag valve mask ventilation/troubleshooting (n=7).

The simulation course allowed for multiple systematic improvements in a manner analogous to mini, rapid plan-do-study-act (PDSA) cycles. It became apparent after the first two sessions that interns did not know where the code buttons or code cart were located; these instructions are now included in unit orientation as well as a review of the unit's Newborn Hypoglycemia algorithm, as many participants were also unfamiliar with this protocol. Upon recognition of the lack of immediate access to an infant bag-valve-mask in some areas of the postpartum unit, the newborn admission process was changed so the bag-valve-mask from delivery is now saved in each infant's crib in case of a respiratory emergency. If the mask from delivery is visibly contaminated, a new one is obtained. The neonatal hypoglycemia case revealed that only one 5 ml syringe of 10% dextrose was available for immediate access from the nursery's medication dispensing cabinet. As the recommended initial dose of IV dextrose for symptomatic neonatal hypoglycemia is 2 ml per kilogram, the immediately available dose was inadequate for any infant weighing more than 2.5 kg [14]. The dispensing cabinet is now stocked with two 5 ml syringes of IV glucose for immediate availability. During one of the simulations a planned mock code was carried out and the infant code button was activated. The NICU team responded very quickly; however, outside of the team immediately caring for the infant, staff on the postpartum unit were unaware of the emergency. The infant code notification system has been adjusted to include an emergent broadcast to all staff on the postpartum unit so additional support is available if needed prior to the arrival of the infant code team.

DISCUSSION

Although most hospitals have code or emergency response teams, it takes time for the team to arrive at the bedside. In pediatric settings, Hunt et al. [6], reported that on average during pediatric mock codes, three minutes elapse before the arrival of a physician and six minutes before the code team's first member arrives. For this reason, many adult and pediatric settings practice the first five minutes of an emergency with bedside nurses allowing the patient to receive immediate life support such as bag-valve mask ventilation and chest compressions [5-8]. However, little attention has been paid to the first five minutes of an emergencies that may arise in previously healthy newborns. Our monthly interdisciplinary simulation-based education focusing on the initial management of newborn emergencies was effective in improving the confidence level of both pediatric interns and nurses. In addition, simulation proved to be a valuable tool to identify and eliminate unit-specific barriers to optimal emergency response.

Residents in our program spend only one month of their training providing care in the newborn nursery; however, they provide overnight cross coverage for the unit throughout their residency and are typically the first responders when a concern arises. As true emergencies are rare among healthy newborns in a Level I nursery, many residents may not encounter this situation during their one month block [15]. Simulation training during intern year allows trainees to practice initial management of a newborn emergency in a setting that facilitates identification of knowledge and skills gaps without compromising patient care. This has shown benefits such as earlier calls for assistance from interns who have participated in simulation [16].

Nurses and doctors may have different perceptions of the quality of patient care delivery. In one study, nurses reported that they experience less collaboration than physicians, and they are less satisfied than physicians with the quality of care that their unit's deliver [17]. By including both physicians and nurses together in simulated emergency scenarios, our goal was to foster effective collaboration for optimal patient care. Debriefing focused on team roles, skills, and clarity of communication. Nurses in our study reported higher levels of confidence in responding to newborn emergencies than residents, both at baseline and after simulation training. This is likely a reflection of the fact that the nurses have ongoing experience on the postpartum unit as their only work setting while residents rotate through different fields of pediatrics during their training, learning to treat a variety of patient types. Thus, nurses may practice an established type of care that is less subject to fluctuation while residents care for a greater spectrum of patients across multiple clinical settings which may affect their comfort level with the care they provide [18]. Additionally, our resident participants were still early in their training and likely still developing a solid grasp of each clinical environment [11,19].

Overall, multi-disciplinary simulation proved to be an effective way to increase the comfort level for both groups as all participants reported increased confidence in responding to uncommonly encountered newborn emergencies. Specific educational benefits cited by participants included teamwork focus, improved knowledge of newborn seizure management and improvement in skills needed for effective bag valve mask ventilation in newborns.

The simulation sessions also provided insight into unit-specific barriers to optimal newborn emergency response which have been addressed and corrected. Resident orientation has been amended to include location of emergency equipment and infant code buttons as well as introduction to and review of condition protocols, such as our newborn hypoglycemia algorithm. The unit's medication dispensing cabinet is now stocked with enough 10% dextrose for emergency dosing of infants of all potential birth weights, and each infant has a bag valve mask immediately available in the crib. Additionally, debriefing sessions at the

end of each simulation allowed participants to reflect on their own response and potential gaps in their knowledge. This also facilitated discussion of the appropriate management of infants after initial stabilization including indications for transfer to a higher level of care.

This study had limitations. It was performed at one site within one specialty which limited its generalizability. *In situ* simulation offers the benefit of training within the actual clinical care unit but obstacles include availability of faculty and simulator equipment as well as scheduling around resident days off, clinics, and other patient care demands. Our study design did not include a control group and did not allow for assessment of the long term effects of this education. Because this study was performed over the course of twelve months, interns who participated in the early months had less experience and less training so their confidence levels could vary significantly from the confidence levels reported by interns who performed the simulation towards the end of the year. Additionally, the participants' assessments centered on self-perception of their quality of care, not objective data such as time to initiation of skills or the attending's perception of their skill quality [20].

In the future, research should examine the month during which interns and nurses performed the simulation to assess variation in comfort levels at different points in training. Other areas for future research include tracking actual codes that are called in the newborn nursery to substantiate whether our initial case selections are in-line with clinical experience and to follow residents who have participated in simulation training to assess long term benefits in responding to newborn emergencies as part of the cross cover team. Over time, we hope to show that simulation training is translating to improved care of these infants.

CONCLUSION

In conclusion, medical simulation provides the opportunity to practice decision making skills and emergency management in a non-threatening environment with immediate feedback and correction of errors. Monthly simulation training allows a regular inter-disciplinary forum to promote collaboration between pediatric residents and postpartum unit, improve the initial response to newborn emergencies, and identify and eliminate unit-specific barriers for an optimal response. This mode of education may be useful in other pediatrics residency programs to ultimately improve patient outcomes.

FUNDING SOURCE

University of Alabama at Birmingham Department of Pediatrics Founders Fund Education Grant

CONTRIBUTOR STATEMENTS

Dr. Jackson, conceptualized the scenarios and data recording sheets used for the study, assisted in debriefing the scenarios and collecting data, critically revised the manuscript and approved the final manuscript as submitted.

Dr. Sawyer – conceptualized the scenarios and data recording sheets used for the study, assisted in debriefing the scenarios, collecting data and approved the final manuscript as submitted.

Ms. Chilukuri – assisted with data collection, entry and analysis, assisted with scenario implementation and drafted the initial manuscript and approved the final manuscript as submitted.

Dr. Rutledge and Ms. Gaither – assisted with scenario implementation and debriefing, data collection, conceptualization and initial study design and critically reviewed the manuscript and approved the final manuscript as submitted.

Dr. Tofil – served as the senior mentor assisting with conceptualization and design of the study, assisted with scenario implementation and debriefing, data analysis, assisted with the initial draft and critically reviewed the manuscript and approved the final manuscript as submitted.

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Appendix 1: Case Scenarios.

Case 1

2 day old infant female with seizure

History of Present Illness:

Infant is a 2 day old female who is transferred from mother's room to nursery for an 8 hour history of poor feeding. Initially after birth, she was breast feeding well every 2-3 hours for 20 minutes each feeding. Throughout the day on day of life 2 she has been increasingly less interested in feeding and has to be woken up to be fed. Now she is not latching at all. Mom has noticed that she seems more floppy over last few hours as well. Afebrile Patient is brought into NBN for evaluation where she proceeds to have general tonic clonic seizure.

Past Medical History: Born at 39 wga via spontaneous vaginal delivery without complications. Mother is healthy and does not have any medical problems or take medications. She is negative for Hepatitis B, HIV, syphilis, gonorrhea and chlamydia , Group B Strep.

Past Surgical History: none

Allergies: No known drug allergies

Family History: Maternal grandmother has hypertension, paternal grandfather died from a myocardial infarction.

Social History: Has not been home from hospital. Parents live together in Birmingham. No smoke exposure. No maternal drug or alcohol use.

Review of Systems: Positive for decreased feeding and decreased urine output. Negative for fever, vomiting, rash, difficulty breathing.

Physical Exam:

Weight: 3.4 kg (50%), Head Circumference: 35.5 cm (75%), Height: 51cm (75%)

Temperature 99.9F, heart rate 155, blood pressure 73/55, respiratory rate 38, 97% on room air

General: lethargic infant, poor cry

Head, Eyes, Ears, Nose, Throat: normocephalic atraumatic, anterior fontanel open, soft and flat, pupils equal and reactive to light, moist mucous membranes

Cardiovascular: regular rate and rhythm, no murmur, 2+ femoral pulses

Respiratory: clear to auscultation bilaterally with shallow breaths, no w/r/r

Abdomen: soft, non-tender, non-distended, normoactive bowel sounds

Skin: warm and dry, no rash

Neurologic: hypotonic, poor suck, positive moro reflex, positive plantar and palmar grasps

Case 2

1 day old infant male with respiratory distress

History of Present Illness:

Infant is a 1 day old male who is transferred from mother's room to nursery for respiratory distress. Infant was able to participate in skin to skin time after delivery and has been breastfeeding well every 2-3 hours since delivery 20 hours prior to presentation. Has had wet diapers and passed a meconium stool. Mom called out for nurse due to infant suddenly working hard to breath and turning blue around his lips. When nurse arrives to room, infant has blue lips and acrocyanosis.

Past Medical History: Born at 40 weeks gestational age via spontaneous vaginal delivery. Had meconium at delivery but only required routine resuscitation with Apgar scores of 7 and 9 at 1 minute and 5 minutes, respectively. Mother is healthy and does not have any medical problems or take medications. She is negative for Hepatitis B, HIV, syphilis, gonorrhea and chlamydia, Group B Strep.

Past Surgical History: none

Allergies: No known drug allergies

Family History: Dad- hypertension

Social History: Has not been home from hospital. Parents live together in Birmingham. No smoke exposure. No maternal drug or alcohol use.

Review of Systems: positive for increased work of breathing. Negative for fever, vomiting, rash, cough.

Physical Exam:

Weight: 3.4 kg (50%), Head Circumference: 35.5 cm (75%), Height: 51cm (75%)

Temperature 98.9F, Heart Rate 155, Blood Pressure 73/55, Respiratory Rate 52, 85% on Room Air

General: infant male with moderate respiratory distress

Head, Eyes, Ears, Nose, Throat: Normocephalic atraumatic, anterior fontanel soft and flat, pupils equal round and reactive to light, moist mucous membranes, oropharynx clear

Cardiovascular: regular rate and rhythm, no murmur, 2+ femoral pulses

Respiratory: tachypneic with subcostal and intercostal retractions, no area of decreased breath sounds

Abdomen: soft, non-tender, non-distended, normoactive bowel sounds

Skin: warm and dry, no rash, acrocyanosis.

Neurologic: normal tone, normal moro reflex, normal plantar and palmar grasps, poor suck

Appendix 2: Case Debrief Guide and Scenario Progression.

Case 1 Debrief: Respiratory Distress in Newborn Nursery

Expected Interventions:

1. ABC's
a. Ask for Pulse oximetry and place on oxygen (Nasal Cannula vs. Face Mask vs. Blow-by)
i. NOTE: Nursery monitors will only record respiratory rate if nursing staff places electrodes on newborn. Otherwise, team must count out breaths/minute for accurate rate. Note: while blow-by oxygen may be administered briefly during the initial transition period or during emergency management in the Newborn Nursery; babies with a continuous oxygen requirement require transfer to a higher level of care
b. Place on continuous cardiac monitoring
c. Assess capillary refill and perfusion
2. Call for assistance from Attending or from neonatology team.
3. Appropriate timing to the infant code team via code button
4. Continue to assess ABCs, gather equipment and code cart
5. Start bag mask ventilation if needed
6. Turn on radiant warmer
a. NOTE: Newborns in sepsis are generally hypothermic rather than febrile
7. Place 2 peripheral IVs
a. NOTE: In nursery, can obtain access and give bolus fluids (10cc/kilo NS), but any newborn requiring MIVF must be transferred.
8. Check point of care glucose, draw other labs (complete blood count, chemistry, complete metabolic panel) as necessary though results will usually not return until after NICU transfer is complete

Scenario Progression:

1. Intern called to room to assess. Call for Attending/Fellow. Locate Code Button on wall and call for NICU.
2. Nursing orders: Placed on cardiorespiratory monitors and oxygen saturation monitor. Oxygen face mask (10L blow by) started and saturations increase from initial 80% on room air to 94-96%. Temp 98.9F, BP 78/58. Normal cap refill and perfusion. Improved work of breathing and resolution of perioral cyanosis and acrocyanosis. Assess axillary temperature and lack of hypothermia or fever. Turn on warmer if necessary. Consider intracranial process with checking for soft and flat AF.
*a. SCENARIO PROGRESSION: Nurse says, "Baby has stopped breathing, and I'm bagging now." Next step: Immediately press **Code Button** on wall.*
3. Order routine labs: complete blood count, chemistry, bedside Glucose
4. +/- Obtain IV access

Case 2 Debrief: Initial Seizure Management in Newborn Nursery

Expected Interventions and Scenario Progression:

1. Access Airway, Breathing and Circulation (ABCs)
2. Start timeline from seizure onset and confirm newborn is lying in flat position.
3. Call infant code team with code button
4. Continue to assess ABCs, gather equipment and code cart
5. Place on continuous cardiac monitor
6. Place on oxygen, start bag mask ventilation if needed
7. Turn on radiant warmer
8. Place 2 peripheral IVs
9. Check point of care glucose with glucometer, electrolytes, draw other labs as necessary. Follow UAB Newborn Nursery Hypoglycemia Algorithm.
a. SCENARIO PROGRESSION: When team requests glucose check, delay giving labs during simulation for 30 seconds because nursery glucometer takes 30 sec to 1 minute to calibrate and result.
b. LABS: Glucose = 24
10. Give D10W bolus +/- IV fluid bolus Dose = 2 mL/kg of D10W pushed slowly over 1 minute.. After bolus, start D10W IV infusion at 80-100 mL/kg/day while preparing for transfer. The initial bolus for symptomatic infants may be given on the Mother- Baby Unit with MD at bedside or en route. All infants receiving IV glucose require transfer to NICU ASAP.
a. NOTE: In newborns, goal blood glucose is 40-50. Glucometer will record levels down to 25, but lower measurements will just read as "Low" on device. Always follow-up glucometer readings with serum measurement.
b. Seizure medication options
c. Phenobarbitalis available in emergency medication box with infant code cart for persistent seizure after correction of hypoglycemia.
1. Initial dose 20 mg / kg

Appendix 3: Newborn Emergency Simulation Survey Have you attended the Newborn Emergency Simulation? ☐ **Yes** ☐ **No** Please respond to the following questions using a scale from 1 to 5, with 5 being the most confident and 1 being the least confident.					
How confident do you feel about recognizing an infant in respiratory distress?	1	2	3	4	5
How confident do you feel about placing a baby on pulse oximetry?	1	2	3	4	5
How confident do you feel about starting oxygen on a baby?	1	2	3	4	5
How confident do you feel about giving positive pressure ventilation to a newborn?	1	2	3	4	5
How confident do you feel about recognizing an infant having a seizure?	1	2	3	4	5
How confident do you feel about recognizing that an infant is lethargic?	1	2	3	4	5
How confident do you feel about recognizing when it is appropriate to call an infant code on the Mother Baby Unit?	1	2	3	4	5
How confident do you feel about knowing the process for calling an infant code on the Mother Baby Unit?	1	2	3	4	5
How confident do you feel in caring for an infant in an emergency while you are waiting for the code team to arrive?	1	2	3	4	5

Cite this article

Jackson D, Chilukuri P, Rutledge C, Gaither S, Sawyer K, et al. (2018) Newborn Nursery Emergencies: Simulating the First Five Minutes. Ann Pediatr Child Health 6(2): 1145.