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Pediatric Hospitalist Resuscitation Skills Refresher Training With Pauses for Deliberate Practice

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Abstract

Introduction

Pediatric hospitalists are expected to lead resuscitative efforts for cardiopulmonary arrests, but the infrequency of these events and pediatric advanced life support (PALS) re-certifications are insufficient to maintain skill proficiency. We created a novel resuscitation refresher curriculum for pediatric hospitalists with strategic pauses during simulations for expert and peer coaching of procedural skills.

Methods

In a tertiary care academic pediatric hospital between September 2018 to June 2019, pediatric hospitalists and fellows voluntarily participated in a series of three quarterly two-hour training sessions taught by expert peer facilitators. Sessions focused on the thirty-second rapid cardiopulmonary assessment and each of the pediatric advanced life support (PALS) algorithms. Scenarios were strategically paused to practice critical hands-on skills. Cases centered on the themes of shock, respiratory, and cardiac emergencies and took place in a high-fidelity simulation lab requiring a technician and expert peer facilitator. Participants anonymously completed Likert scale-based evaluations after each session and again at the end of the year that focused on participants' own perceived change in their comfort levels in performing various resuscitation skills and in knowing basic resuscitation steps. As part of our institutional and personal assessment of the curriculum, an end-of-year survey additionally asked participants to reflect on the overall simulation curriculum and resultant changes in their clinical practice.

Results

Comfort in all skills practiced across the three sessions increased. The end-of-year survey showed a significant rise in comfort above baseline but some decrements when compared to that immediately post-training. Ninety-six percent of pediatric hospitalists rated the overall quality of the training "better" or "much better" than other resuscitation training (including PALS classes and traditional simulations with skills training after the scenario). The overall effect of the curriculum on perceived knowledge, skills, and confidence levels was significant ($p < 0.0001$).

Conclusion

Serial resuscitation skills refreshers with expert peer coaching and strategic pauses for hands-on skills practice can result in significant improvements in perceived knowledge and comfort with skill performance as well as the leadership role among pediatric hospitalists.

Categories: Medical Education, Medical Simulation, Pediatrics
Keywords: peer learning, pals, pediatric hospitalist, simulation education, pediatric resuscitation

Introduction

Despite ample opportunities for pediatric resuscitation simulation training at academic institutions, pediatric hospitalists are rarely the target participants. Students and residents, however, can usually expect to participate in various forms of resuscitation simulation training regularly. Due to time pressure and a sheer number of participants, these crowded training sessions usually don't provide opportunities for individuals performing skills to be coached to achieve an ideal standard. The average pediatric hospitalist in a busy practice may only be afforded resuscitation refresher training every two years as part of pediatric advanced life support (PALS) certification. Although the prevalence of pediatric inpatient cardiopulmonary arrests is rare [1], the pediatric hospitalist is still expected to competently take charge of the team and manage the resuscitation for at least the first five minutes until a more robust code team response can be organized [2,3]. This leadership requires proficiency in various individual hands-on skills, knowledge of the PALS resuscitation algorithms, and the ability to direct, observe and correct team performance. Pediatric hospitalists practicing at smaller community hospitals may be expected to lead the resuscitative efforts through a post-resuscitative phase until critical care transport arrives, which can be a daunting proposition

when they feel out of practice.

The resuscitation literature has many examples of poor performance during cardiopulmonary resuscitation (CPR) even by "experts" [4,5], the decay of skill after training within six months [6], and how refresher training with mock codes enhances skill retention, knowledge, simulated performance, and comfort level [7-9]. In a recent publication, the American Heart Association highlighted new specific recommendations based on resuscitation education science [10]. They called for deliberate practice and mastery learning for resuscitation training and tasks. They also touted the benefits of booster training and spaced learning in small groups to optimize CPR skill retention and performance over time. This builds on the American Heart Association (AHA)'s 2015 resuscitation quality improvement initiative that was created in recognition that training every two years is suboptimal. This initiative emphasized that more frequent training, including cognitive and psychomotor skills using simulated cases, would be helpful for physicians who may encounter patients in cardiac arrest [11].

Several pediatric resuscitation simulation studies have been published, most of which follow one of two formats: uninterrupted cases with post-scenario debriefing [12-14] or rapid cycle deliberate practice (RCDP), which provides increasingly challenging cases with pauses for directive feedback during and after each resuscitation [15-17]. Similar to some RCDP scenarios, this curriculum embeds deliberate pauses during scenarios for expert-guided skills practice. Unlike RCDP scenarios, this curriculum pauses scenarios before each skill is performed to ensure that correct performance is done from the beginning with expert guidance and peer observation until participants are comfortable with that skill. Rather than allowing participants to perform a skill and then pause to correct their technique as in RCDP, the unique approach we took was based on the philosophy that correct performance of each skill from the start is important to ensure that participants become accustomed to only utilizing the correct technique. This approach was highly regarded shortly after implementation in this setting. Also, instead of primarily targeting the pediatric resident, as the learner as in most studies, this curriculum was created for the attending pediatric hospitalist level provider. It covers all the PALS algorithms, addressing the most likely scenarios a pediatric hospitalist may face in the critical first five minutes of resuscitation.

Our quarterly resuscitation curriculum for pediatric hospitalists and fellows taught in a non-threatening environment to optimize skill performance with deliberate pauses for expert and peer coaching was recently outlined in an opinion piece [18]. This new curriculum with frequent training of hands-on skills aimed to improve pediatric hospitalists' comfort in performing resuscitations, their knowledge, and psychomotor proficiency.

Materials And Methods

Development

This pediatric hospitalist resuscitation refresher curriculum entailed a series of three quarterly two-hour small-group simulation-based training sessions. The scenarios were designed for use in a high-fidelity simulation lab with a technical support person, simulation facilitator, and no more than four participants per session. Target participants included pediatric hospitalist attending physicians, advanced practice providers, pediatric hospital medicine fellows, and pediatric chief residents. Participants were all from the same hospital medicine division but worked at seven different clinical sites: a tertiary care center and six community sites. All simulations occurred in the tertiary care center's simulation center.

The simulation facilitator was a pediatric hospitalist with prior critical care experience; however, this role could ideally be filled by any experienced pediatric hospitalist in the division comfortable facilitating for their peers. Having a peer facilitator, as opposed to a specialist from another division, was intentional in order to decrease the social anxiety surrounding an already stressful situation to allow participants to maximally focus on their learning objectives. The facilitator was the primary person who provided the introductory presentation, described the scenario, ran the cases, coached the skills practice, and led the debriefs. During the cases, the facilitator also verbalized exam findings that the mannequin could not demonstrate and interjected with occasional phrases as indicated in each scenario summary.

In addition to the facilitator, a technical support person skilled in managing high-fidelity simulators assisted with each case. Their role was to set up equipment and manage the mannequin's change in vital signs in real-time.

Study design and equipment

Simulations were run in a high-fidelity sim center at a tertiary care children's hospital from September 2018 to June 2019. Simulations primarily utilized the Laerdal SimBaby (Maharashtra, India) and the PRESTAN Infant Manikin (Mayfield, Ohio, US) with cardiopulmonary resuscitation (CPR) monitor. Basic resuscitation equipment, including a full code cart, airway supplies, suction, intravenous (IV) fluid supplies, intraosseous (IO) equipment, defibrillator, and emergency medications, was used. Some scenarios also utilized diagrams and de-identified chest X-rays (CXRs) and electrocardiograms (ECGs) as supplements for the skills or to assist in case progression.

Implementation

Participants were incentivized to participate as part of their academic goals linked to their end-of-year bonus, and they signed up voluntarily. During each quarter, a two-hour session was offered a total of 10-14 times, usually twice a day during five to seven days that were randomly distributed over two months. Simulation dates were determined according to the facilitator's availability, and the same facilitator-led each of these sessions. Participants were allowed to sign up for any date that worked for their schedule, making each group of four participants per session random and different in each quarter. Four was considered the maximum number of participants per session to allow each to actively participate in every simulation case and to practice each skill under the facilitator's supervision. Some participants only attended a session during one quarter, and others attended a session during two or all three quarters. Each quarter of simulations focused on a different skill set, with quarter one focusing on basic CPR skills, quarter two on respiratory skills, and quarter three on cardiac skills. Participants consisted mostly of pediatric hospitalists with some pediatric hospital medicine fellows and pediatric chief residents.

Prior to attending their scheduled simulations, participants were encouraged to review the PALS algorithms and other pertinent handouts. At the beginning of each session, the facilitator briefly reviewed CPR pearls and physiology using a 15-minute Microsoft PowerPoint presentation. After a brief orientation describing the goals of the curriculum and mannequin functionality, the scenario stem was read, and the case was initiated.

When the simulation outline indicated a "PAUSE to demonstrate", for example, after participants stated they'd like to give a push-pull bolus, the entire group stopped the scenario, and the facilitator asked for a participant to demonstrate the skill correctly. Then, each participant performed the skill while being observed and given real-time coaching and feedback by the facilitator and their peers. Special emphasis was placed on the performance of the rapid cardiopulmonary assessment, chest compressions, and bag-valve-mask ventilation (BVM). One participant in each group was given a skill-specific assessment checklist to check themselves and facilitate coaching of peers during their skill performance. This included checklists for the rapid cardiopulmonary assessment, IO placement, and endotracheal intubation, where applicable. These checklists were intended to be cognitive aides to prompt optimal skills performance but not for objective measurements or scoring. After each participant had practiced skill to their and the facilitator's satisfaction, the scenario was returned to live-action.

Scenarios

The three quarters within the curriculum focused on cases that highlight basic resuscitation skills and enabled a detailed exploration of the practical hands-on skills involved. Each session had 2-4 scenarios, which built on and reinforced the skills highlighted in prior scenarios. The second quarter's first scenario is included below (Figures *1*-*6*).

Session 2: Respiratory Emergencies
Scenario 1

SIMULATION CASE TITLE: Tracheostomy plug resulting in cardiopulmonary failure

LEARNER AUDIENCE: Pediatric Hospitalist

PATIENT NAME: Carol **Weight:** 12 kg **Allergies**: NKDA **Immunizations:** UTD except Influenza

PATIENT AGE: 30 months

CHIEF COMPLAINT: She presents through the ED for admission with "Bronchiolitis", despite use of her pulmonary sick plan.

PHYSICAL SETTING: Pediatric ward

Note for Facilitator: A **PAUSE** is indicated where the scenario is stopped to demonstrate hands-on skills. Each participant should practice every skill and be observed by the facilitator to ensure accurate performance.

Brief narrative description of case	30 month old premature infant with chronic lung disease and tracheostomy, hospitalized with bronchiolitis, develops a trach plug resulting in cardiopulmonary failure requiring trach replacement, CPR, NS bolus and Epi. Focus on proper CPR technique, trach replacement, DOPE mnemonic, and the utility of the PEEP valve. PALS Diagnosis: Cardiopulmonary failure
Primary Learning Objectives	*Demonstrate comfort with skills covered in Session 1: Rapid cardiopulmonary assessment (RCPA), Broselow tape use, NS bolus (Push-pull with 3-way stopcock and Double pinch method), Use of Epi Bristojet, BVM* 1. Use DOPE mnemonic and logical approach to clearing airway due to plugged tracheostomy. 2. Demonstrate an emergency tracheostomy change and knowledge of Emergency Trach Management Algorithm. 3. Identify and correct the underlying causes of arrest using the Hs & Ts.
Critical Actions	-Perform CPR -Suction & replace Tracheostomy
Learner Preparation or Prework	Review pre-session handouts Watch introductory power point presentation

FIGURE 1: Session 2: Respiratory Emergencies - Scenario 1 page 1

INITIAL PRESENTATION			
Initial vital signs	HR 45, RR 10 & dropping, O2 65% & dropping Old BP 75/45. If cycled, new BP 55/30.		
Overall Setting and Appearance	Participant enters room after being called to bedside by RN CR monitor is alarming Mannequin attached to monitor in standard crib		
Standardized Participants (and their roles in the room at case start)	Facilitator is present, playing the role of the bedside RN		
HPI	**Present History**: She presents through the ED for admission with "bronchiolitis" despite use of her pulmonary sick plan. She has a 3-day history of increasing cough, congestion, and respiratory distress with copious trach secretions. She is febrile to 38.5C and is being admitted to the ward. **ED Initial vitals**: HR 140, RR 55, Sat 85% on room air, improved to 95% on 40% Trach collar. **ED Exam**: Diffuse wheezing, crackles and prolonged expiratory phase with subcostal & intercostal retractions with minimal response to albuterol or racemic epinephrine. The 4.0 Peds Shiley is in place, requiring frequent suctioning. The rest of the exam was unremarkable by report. A PIV was placed and a 20ml/kg NS bolus given for dehydration. RN calls to notify you the patient has finally arrived (>8 hours of waiting for a bed) on the ward and has concern for respiratory distress, tachycardia, and agitation.		
Past Medical/Surgical History	**Medications**	**Allergies**	**Family History**
Former preemie (prolonged NICU course) -Mild developmental delay due to HIE -Chronic lung disease of prematurity -Trach dependent (4.0 Peds Shiley, recently upsized from the one placed during NICU).	Albuterol QID Pulmicort BID MVI	NKDA	Non-contributory

FIGURE 2: Session 2: Respiratory Emergencies - Scenario 1 page 2

Physical Examination	
General	Cyanotic, laying in bed, unresponsive, no spontaneous movement
HEENT	Nasal congestion, rhinorrhea
Neck	Copious trach secretions
Lungs	Agonal respirations, paradoxical chest wall movements, tiny squeaks from around the trach
Cardiovascular	CRT 5, mottled, central cyanosis -Weak central pulses -Cold extremities up to mid-wrist/ankle
Abdomen	Liver not palpable
Neurological	Scant movement with painful stimuli, un-arousable, non-focal exam, pupils reactive
Skin	No rash
GU	Dry diaper
Psychiatric	N/a

INSTRUCTOR NOTES - CHANGES AND CASE BRANCH POINTS		
Intervention / Time point	**Change in Case**	**Additional Information**
Participant enters room after being called to bedside by RN CR monitor is alarming	VS HR 45, RR 10 & dropping, O2 65% & dropping Old BP 75/45, If cycled, new BP 55/30 **Sim tech notes:** Breath sounds markedly diminished (lower volume)	Participants should -Perform 30 second RCPA -Call a Code Blue. -Begin CPR with BVM and chest compressions Review Hs & Ts
When team begins CPR, **PAUSE to demonstrate** *Proper BVM ventilation *Chest compressions (coordination and switching between providers, use of backboard)		
Resume live action	BVM ineffective	

FIGURE 3: Session 2: Respiratory Emergencies - Scenario 1 page 3

Team attempts ventilation through tracheostomy tube	Scant air movement, poor compliance	
Attempt suctioning of trach	Catheter meets with resistance	
When team requests replacing tracheostomy tube, **PAUSE to demonstrate** *Emergent trach replacement *Review Emergent Trach Management Algorithm *Review alternative options for trach replacement (smaller tube, ET tube, over suction catheter as guidewire, and using obturator as a retractor to lift and stabilize one edge to the stoma). *Use of ETCO2 device (airway placement & ROSC) *Utility of PEEP Valve *DOPE mnemonic use	Key Question to be asked by Team: Why does patient have trach? Does she have airway anomalies/a critical airway? Facilitator answer "No"	Facilitator asks participants, *"Have you ever replaced a tracheostomy tube in a patient? How many and how long ago?"*
Resume live action Tracheostomy replaced CPR and ventilation via tracheostomy tube under way	VS HR 30 Apneic O2 sats not picking up BP undetectable (if cycled)	Participant should -Administer Epinephrine -Consider NS bolus (20 ml/kg)
Approx. 3 min later After: -CPR -Trach change -Epi - +/- NS Bolus	VS HR 130 RR 20-30 (If BVM is stopped, RR 70, sats <70%) O2 98% (Sats should slowly rise from 60% to 98% over 90 secs receiving BVM with 100% O2) BP 80/55 Physical Exam -more spontaneous movement, squirming, easily arousable, non-focal neuro exam, pupils reactive	Participant should -Re-perform RCPA

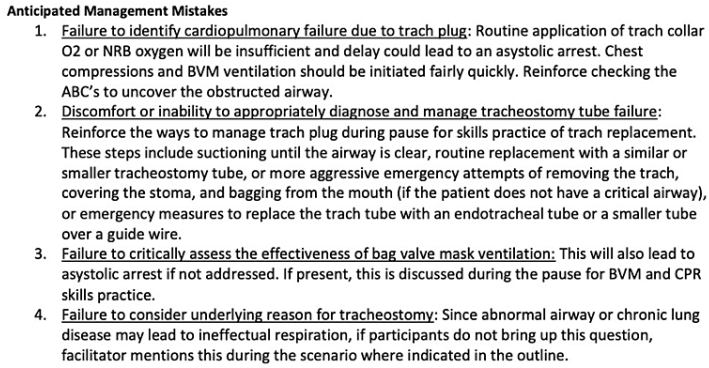
FIGURE 4: Session 2: Respiratory Emergencies - Scenario 1 page 4

	-Diffuse wheezing, rhonchi, crackles, good air movement w/ BVM -improved trach secretions -CRT 3-4/pink -cool fingertips and toes -1+ peripheral/2+ central pulses -liver edge at RCM -no rash	
Case Resolution (ventilation via trach ongoing)	No change	Participant should discuss post resuscitation care: -Secure vascular access X2 -Glucose check -Temperature: if patient comatose post arrest targeted temperature management can be used→either maintain Normothermia (36-37.5°C) x5 days, or 32-34°C x48hrs, then normothermia x3 days -Normal oxygenation (94-99%) and ventilation (PCO_2 NI) -Goal BP ≥5th %ile -Evaluate for organ dysfunction -Transfer to PICU
Debrief	Solicit 1 liner Ask for reactions +/Δ	

Ideal Scenario Flow

As the physician enters the room and performs a rapid cardiopulmonary assessment it is apparent that the patient is rapidly deteriorating with a PALS physiologic diagnosis of cardiopulmonary failure. With the rapid initiation of bag valve mask ventilation and chest compressions, a critical appraisal will reveal ineffective ventilation with deterioration due to profound hypoxemia from a plugged tracheostomy tube. The use of diagnostic aids such as the H's& T's or the DOPE mnemonic will rapidly highlight the need for a tracheostomy tube replacement, if suctioning won't relieve the obstruction. There are multiple opportunities to pause to refresh the basic skills reviewed in Session 1 but also opportunities to practice tracheostomy tube suctioning and an emergency algorithm for the replacement of a tracheostomy tube. Once the tube is replaced, CPR with effective bag valve mask ventilation through the tracheostomy tube along with an epinephrine dose and a fluid bolus, the patient will recover rapidly but will need ongoing rescue breathing for respiratory failure. The case ends with a brief discussion of post resuscitation care.

FIGURE 5: Session 2: Respiratory Emergencies - Scenario 1 page 5



Anticipated Management Mistakes

1. Failure to identify cardiopulmonary failure due to trach plug: Routine application of trach collar O2 or NRB oxygen will be insufficient and delay could lead to an asystolic arrest. Chest compressions and BVM ventilation should be initiated fairly quickly. Reinforce checking the ABC's to uncover the obstructed airway.
2. Discomfort or inability to appropriately diagnose and manage tracheostomy tube failure: Reinforce the ways to manage trach plug during pause for skills practice of trach replacement. These steps include suctioning until the airway is clear, routine replacement with a similar or smaller tracheostomy tube, or more aggressive emergency attempts of removing the trach, covering the stoma, and bagging from the mouth (if the patient does not have a critical airway), or emergency measures to replace the trach tube with an endotracheal tube or a smaller tube over a guide wire.
3. Failure to critically assess the effectiveness of bag valve mask ventilation: This will also lead to asystolic arrest if not addressed. If present, this is discussed during the pause for BVM and CPR skills practice.
4. Failure to consider underlying reason for tracheostomy: Since abnormal airway or chronic lung disease may lead to ineffectual respiration, if participants do not bring up this question, facilitator mentions this during the scenario where indicated in the outline.

FIGURE 6: Session 2: Respiratory Emergencies - Scenario 1 page 6

The first quarterly session focused on hypovolemic shock leading to cardiac arrest requiring CPR. The 30-second rapid cardiopulmonary assessment was reinforced in each scenario of this session and throughout the curriculum. The second session covered the initial management of respiratory failure, emphasizing the importance of appropriate bag-valve-mask ventilation technique, considerations surrounding endotracheal tube intubation, and troubleshooting with emergent replacement of an obstructed tracheostomy tube. The third session highlighted the management of cardiac emergencies due to rhythm disturbances. Each session built on the prior by reinforcing high-quality CPR techniques.

Debriefing

At the end of each scenario, the facilitator led the debriefings, and if there were at least three participants, one was asked to observe before initiation of the case to take notes, evaluate the performance of individual skills using a checklist as mentioned above, and assist with a debriefing of their peers. The facilitator used a Debriefing Guide, which was based on the promoting excellence and reflective learning in simulation (PEARLS) healthcare debriefing tool [19]. After reactions and a one-line case summary were elicited, the debrief was a mix of directive feedback for specific skills, and either a plus/delta (i.e., what went well and what could be changed) or guided advocacy inquiry regarding overall performance during the simulation. The debrief ended with participants vocalizing their personal "take-aways" from the case.

Afterward, participants were given handouts and checklists for their own reference as a “toolkit” of resources to review the skills and concepts covered in the simulation, as well as to enable them to teach

those skills to others more effectively.

Statistical analysis

Immediately after each session, we distributed an anonymous five-point Likert-scale evaluation to each participant. See the below evaluation for session 2 as an example (Figure 7).

Pediatric Resuscitation Skills Refresher Training: Session 2
Respiratory Emergencies
EVALUATION

- Simulation Date: _____ Simulation Instructor: _____
- Curriculum: Pediatric Hospitalist Resuscitation Skills Refresher Training Curriculum
- **Respiratory Scenarios**

SIMULATION EVALUATION:

1. The Introductory PowerPoint presentation was useful.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

2. The hands on skill based scenarios were helpful.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

3. The refresher teaching on individual skills during the scenarios was effective.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

4. The information presented and skills refreshed will change the way I practice.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

CLINICAL CONFIDENCE:
I feel comfortable with my ability to:

	Prior to session					***After session***				
1 – Strongly Disagree *2 - Disagree*	*3 - Neutral*			*4 - Agree*		***5 – Strongly Agree***				
5. Perform rapid cardiopulmonary assessment, BVM ventilation and Chest compressions	1	2	3	4	5	1	2	3	4	5
6. Replace a Tracheostomy tube	1	2	3	4	5	1	2	3	4	5
7. Prepare for Intubation with SOAPME mnemonic	1	2	3	4	5	1	2	3	4	5
8. Perform Endotracheal Intubation	1	2	3	4	5	1	2	3	4	5
9. Deliver medications via ETT	1	2	3	4	5	1	2	3	4	5
10. Utilize PEEP Valve and EtCO2 detector effectively	1	2	3	4	5	1	2	3	4	5

COMMENTS:
What did you learn?

What was the most useful aspect of the session?

Did this impact your comfort level supervising others to perform to above procedures? If so, which procedures?

What would you recommend changing?

FIGURE 7: Session 2 Evaluation

As we were modifying a longstanding survey instrument routinely used for simulations at our institution, we did not collect additional validity or reliability evidence for this tool. Evaluations contained 9-10 Likert-scale questions and four free text questions. Several of the Likert-scale questions asked participants to rate their perceived comfort levels with performing specific resuscitation skills before the session and compare it with their current comfort level immediately after the session. These questions changed every quarter to highlight the different skills that were practiced during each quarter's simulations. Other questions asked participants to rate their confidence in leading a code and to discuss whether they had gained comfort in teaching any of the skills they had learned.

A few months after the three quarterly sessions were completed, an anonymous "End of Year Evaluation" was also distributed to participants who attended any or all sessions (Figures 8, 9).

Pediatric Resuscitation Skills Refresher Training:
End of Year Evaluation

Years practicing as Pediatric hospitalist _____
Do you practice at sites other than the main campus Yes / No?
If yes, # shifts/month at the Community Hospital _____

- Which sessions did you attend:
  - ☐ Session 1 The Basics: Hypovolemic Shock & Asystole, IO needle, BVM and CPR
  - ☐ Session 2 Respiratory: Trach plug/Sepsis & PEA, Trach Change and Intubation
  - ☐ Session 3 Cardiac Emergencies: SVT, VT, Cardioversion and Defibrillation

Since completing your simulation skill refresher training, please rate your current comfort level with the following: (Answer only if you attended a session that include this skill)

1 – Strongly Disagree *2 - Disagree*	*3 - Neutral*	*4 - Agree*	***5 – Strongly Agree***
Performing complete rapid cardiopulmonary assessment	1 2 3	4	5
Placing Intraosseous line	1 2 3	4	5
Performing push-pull bolus technique	1 2 3	4	5
Performing effective BVM ventilation	1 2 3	4	5
Performing Timely Effective CPR	1 2 3	4	5
Correctly Placing OP/NP tube	1 2 3	4	5
Replacing a Tracheostomy tube	1 2 3	4	5
Preparing for Intubation with SOAPME mnemonic	1 2 3	4	5
Performing Endotracheal Intubation	1 2 3	4	5
Delivering medications via ETT	1 2 3	4	5
Utilizing PEEP Valve effectively	1 2 3	4	5
Utilizing an EtCO2 detector effectively	1 2 3	4	5
Performing vagal maneuvers for SVT	1 2 3	4	5
Delivering Adenosine effectively	1 2 3	4	5
Managing & Cardioverting SVT	1 2 3	4	5
Managing & Defibrillating pulseless VT	1 2 3	4	5
Completing a post-resuscitation stabilization including (Temp, BP, Glucose, O_2 Sats, $PaCO_2$, Tx Seizures)	1 2 3	4	5

FIGURE 8: End of Year Evaluation page 1

1 – Much worse *2 – Not as good* *3 –About the same* *4 - Better* *5 – Much Better*	
Relative value of this training compared with other forms of simulation based resuscitation training (PALS, BLS, other simulations, etc.) you've participated in the past 2 years?	1 2 3 4 5

Post session Self Reflection assessment
I feel comfortable with my:

	Prior to sessions					*After sessions*				
1 – Strongly Disagree *2 - Disagree*	*3 - Neutral*			*4 - Agree*		*5 – Strongly Agree*				
Overall knowledge of resuscitation requiring PALS algorithms (cognitive)	1	2	3	4	5	1	2	3	4	5
Performing the pragmatic skills necessary to run a resuscitation (psychomotor)	1	2	3	4	5	1	2	3	4	5
Confidence level running a resuscitation (Anxiety level, affect)	1	2	3	4	5	1	2	3	4	5

Please provide brief responses to the questions below:

Please provide a few examples of what you have learned?

What was the most useful aspect of the session(s)?

Has the information presented and skills refreshed changed the way you practice?
If so, how?

Have you had the opportunity to **use** any of the skills covered in the session(s) you've attended? If so, which skills? How do you feel your performance of the skills went? Did the skill refresher training impact how you provided care?

Have you had the opportunity to **teach** any of the skills covered in the session(s) you've attended? If so, which skills? Did you feel you could adequately teach the skill(s)? Did the skill refresher training improve your ability to teach the skill?

Have you had the opportunity to refer to or use any of the handouts and checklists provided during the session(s) you've attended? Please describe?

Do you feel your ability to debrief simulations or real life encounters has changed as the result of your participation in these sessions? If so, how?

FIGURE 9: End of Year Evaluation page 2

This survey was part of our personal and institutional simulation program's assessment of the curriculum to evaluate the curriculum's overall effect beyond the immediate post-session reflections and identify ways to improve the value of the simulation program. This survey contained 21 Likert-scale questions that asked about participants' current comfort levels in performing all of the skills covered in the three sessions of the curriculum. It also contained seven free text questions that probed whether participants had made changes in their practice after participating in this simulation curriculum and asked for further reflections on the curriculum.

Comfort levels with performing each procedure or resuscitation skill were scored on a scale of one to five; where one indicated the participant "strongly disagreed", and five indicated the participant "strongly agreed" with feeling comfortable performing the procedure. For each session, the comfort level with each procedure was compared before and after the session using a paired t-test. The mean of the responses from each training session was analyzed using a one-way analysis of variance (ANOVA). Pre-training comfort levels with performing the complete rapid cardiopulmonary assessment across three sessions were also analyzed using ANOVA. Comfort levels with the rapid cardiopulmonary assessment across all three sessions were analyzed using the analysis of covariance (ANCOVA), treating the pre-training comfort level as a covariate and post-training comfort level as the response.

While the infrequency of pediatric resuscitation events made actual patient-level objective outcomes difficult to obtain, we solicited testimonials about how this simulation curriculum may have affected

participants' management in resuscitation events. These testimonials were shared by participants both in the end-of-year survey as well as ad hoc as the events occurred.

Results

Among the 89 pediatric hospitalists invited to these sessions, an average of 35 participants attended each of the three quarterly sessions (44, 29, and 32 participants in the first, second, and third sessions, respectively).

After the first quarter's sessions, respondents rated their comfort levels in placing an IO line, performing push-pull boluses, effective BVM ventilation, timely effective CPR, and correctly placing an OP/NP tube compared to before attending the session. The average increase between pre- and post- comfort levels on a five-point Likert scale was 1.4 ($p < 0.0001$). Similarly, after the second quarter's sessions, comfort levels in replacing tracheostomy tubes, preparing for and performing intubation, and delivering medications via endotracheal tube (ETT) also increased (mean 1.2, $p < 0.0001$). After the third quarter's sessions, comfort in performing vagal maneuvers for supraventricular tachycardia (SVT), delivering adenosine, managing and cardioverting SVT, managing and defibrillating pulseless ventricular tachycardia (VT), and completing a post-resuscitation stabilization also increased an average of 1.3 points ($p < 0.0001$). Similar trends were seen when participants rated their comfort levels at the end-of-year survey. However, overall improvement in comfort levels at the end of the year compared to immediately post-session was slightly lower (Table *1*).

I feel comfortable with my ability to:	Sessions 1-3 surveys	Prior to training	Immediately after training	Comparing prior and after		End of year survey	End of year vs prior to first session	
(Strongly Agree = 5, Strongly Disagree = 1)	N	Mean	Mean	Mean Difference	p-value	N	Mean Difference	p-value
Session 1: The basics								
Place Intraosseous line	44	2.82	4.39	1.57	<0.0001	27	1.1448	< .0001
Perform push- pull bolus technique	43	2.44	4.47	2.02	<0.0001	27	1.5211	< .0001
Perform effective BVM ventilation	44	4.02	4.81	0.80	<0.0001	26	0.6696	0.0002
Perform timely effective CPR	43	3.47	4.60	1.14	<0.0001	26	1.1381	< .0001
Correctly place OP/NP tube	44	2.86	4.41	1.50	<0.0001	25	0.8964	0.0008
Session 2: Respiratory emergencies								
Replace a tracheostomy tube	29	3.24	4.52	1.28	<0.0001	25	0.8386	0.0092
Prepare for intubation with SOAP-ME mnemonic	29	3.03	4.38	1.34	<0.0001	24	0.8822	0.0004
Perform endotracheal intubation	29	3.24	4.21	0.97	<0.0001	24	0.6336	0.0123
Deliver medications via ETT	27	2.81	3.93	1.11	<0.0001	24	0.7619	0.0022
Session 3: Cardiac emergencies								
Perform vagal maneuvers for SVT	32	3.38	4.69	1.31	<0.0001	27	1.0324	< .0001
Deliver Adenosine effectively	32	3.59	4.66	1.06	<0.0001	26	0.7524	0.0013
Manage & Cardiovert SVT	32	3.13	4.56	1.44	<0.0001	26	1.0288	< .0001
Manage & Defibrillate pulse less VT	32	2.69	4.19	1.50	<0.0001	26	1.3125	< .0001
Complete a post resuscitation stabilization	32	3.34	4.50	1.16	<0.0001	25	0.8963	< .0001

TABLE 1: Evaluation results prior to and after Sessions 1-3 and End of year survey comparison

Comparison of comfort levels performing specific skills based on 5-point Likert scale ranging from “strongly agree" = 5 to “strongly disagree” = 1

Among the 29 participants responding to the end-of-year survey, the vast majority had attended all three quarterly sessions. They rated an overall 1.2-point increase in their comfort in performing the rapid cardiopulmonary assessment (Table *2*).

I feel comfortable with my ability to:	Session Survey (N)	Prior to	Post	Comparing Prior and Post	Pre-training across three sessions	End of year vs before Session 1
(Strongly Agree = 5, Strongly Disagree = 1)		Mean	Mean	p-value	p-value (ANOVA)	
Perform a complete rapid cardiopulmonary assessment	1 (44)	3.34	4.52	<0.0001	0.0081	n/a
	2 (29)	3.83	4.69	<0.0001		
	3 (32)	3.78	4.75	<0.0001		
	End of year (27)	4.56	n/a	n/a	n/a	<0.0001

TABLE 2: Evaluation of comfort with rapid cardiopulmonary assessment prior to and after Sessions 1-3 and in the end-of-year survey

Comparison of comfort levels based on a 5-point Likert scale ranging from “strongly agree" = 5 to “strongly disagree” = 1

While most participants had not had the opportunity to use the skills refreshed in these sessions on an actual patient, a few reported teaching these skills with greater comfort. Overall comfort in performing the pragmatic resuscitation skills and confidence in running a resuscitation each increased by 1.4 points (p <0.0001) (Table 3).

End of year survey		Prior	Post	Comparing Post to Prior	
I feel comfortable with my: (Strongly Agree = 5, Strongly Disagree = 1)	N	Mean	Mean	Mean Difference	p-value
Overall knowledge of resuscitation requiring PALS algorithms (cognitive)	28	3.46	4.50	1.0357	< .0001
Performing the pragmatic skills necessary to run a resuscitation (psychomotor)	28	2.96	4.36	1.3929	< .0001
Confidence level running a resuscitation (anxiety level, affect)	28	2.68	4.04	1.3571	< .0001

TABLE 3: End-of-year survey: Reflections on the impact of the curriculum

Compared to prior simulation training without expert peer coaching or deliberate pauses during scenarios for skills practice, this training was rated “better” or “much better” by 96% of participants. When asked what the most useful aspect of the curriculum was, a typical response included the “hands-on, frequent breaks to debrief/explain/clarify” and the “non-threatening environment among division peers”. Others reported that the “increased confidence in handling code situations is invaluable”. After a recent code event, a colleague recalled, “the repetition of good CPR technique and the H’s/T’s was really helpful in the code…there were so many instances during the code when there was a callback to a simulation lesson that I felt comfortable during the actual management once the code started.” Another colleague assisting in the management of a child in cardiac arrest in a community hospital emergency room stated, “I am grateful that I had knowledge and tools from the simulation to use that allowed me to manage the situation with less fear and uncertainty.” Regarding the most useful aspect of the session, one respondent mentioned “the fact that they build upon each other. I was able to practice skills from prior sessions in the later sessions, which helped solidify my knowledge and skills. These sessions have been fantastic.”

Discussion

Although the pediatric hospital medicine division had an existing simulation curriculum before this model, facilitators were usually content experts who were not hospitalists, there was no continuity of facilitators, and sessions did not build on prior skills. Hence, hospitalist comfort with resuscitation skills and executing PALS basics was still lacking. Out of concern that this lack of proficiency may affect pediatric hospitalists’ confidence and performance, especially when working at remote community sites, this novel curriculum was tailored to focus on the first five minutes of resuscitation and lifesaving hands-on skills. It served our pediatric hospitalists who practice in various clinical settings across seven different sites.

Key differences between this simulation curriculum and others at the institution and in the literature include training by and for pediatric hospitalists, and the use of guided deliberate pauses for skills practice during

scenarios utilizing expert peer facilitators. Having pauses occur before skills are performed in a scenario reinforces the correct method from the start until a satisfactory performance is achieved according to the peer expert and objectively using skills checklists. This model also resonates with the AHA's new resuscitation science education emphasis on deliberate practice and mastery learning with booster training spaced over time [10]. Our results reflect the benefit of this approach given the serial and persistent documented improvements in the RCPA over time. While there were slight decrements in comfort levels with resuscitation skills at the end of the year compared to immediately after each session, the sustained overall comfort with resuscitation skills may be attributed to repeated practice in cases that built on prior skills and emphasized correct performance.

This curriculum has several limitations. First, it assumes a pediatric hospital medicine division member with resuscitation experience may be willing to lead these sessions. Some pediatric hospitalists may find it challenging to implement this curriculum at their sites if they have no such division expertise, and this curriculum did not address training the trainer. Further, the lack of a high-fidelity simulation lab with a technician able to run the simulations may not take away from the hands-on skills practice, but it may interfere in the suspension of disbelief during these sessions. The two-hour time commitment required for participation may also not be feasible in some practice settings. Support from division leadership by providing paid non-clinical time for the facilitator to run these sessions and linking participation with incentives was instrumental for this project and could be the key to successful implementation at other sites.

Other limitations include the fact that the objectives and evaluations in this study center on comfort levels as opposed to objective measures due to the logistical challenge of collecting objective data. Outcome changes are especially challenging to track as our hospitalists practice at seven different clinical sites, which is why we solicited testimonials at the end-of-year survey about how the curriculum changed their practice. However, only a few participants reported practice change, likely due to the rarity of resuscitation events in pediatric hospital medicine. Although this survey mostly assessed level 1 outcomes in the New World Kirkpatrick Model [20], respondents noting a subjective change in their knowledge and ability to teach the skills they learned indicate some achievement of level 2 outcomes in this model. The next step to gauge the efficacy of this curriculum would be to objectively assess improvement in participants' resuscitation and skills performance using a validated checklist and evaluating the time to perform each intervention.

Given the overwhelmingly positive reviews after this first year's curriculum, new curriculum content was developed, now in its third year. Due to the COVID-19 pandemic, the third year of simulations has been all virtual, still emphasizing the use of rapid cardiopulmonary assessment and the Hs and Ts from PALS.

Conclusions

Although simulation training sessions in this pediatric hospital medicine division existed before our novel curriculum, restructuring sessions by incorporating deliberate pauses during scenarios for practicing skills and reinforcing the basic skills every quarter basis had a more profound effect on pediatric hospitalist resuscitation comfort in performing these life-saving interventions than expected. Other pediatric hospital medicine groups may benefit from this curriculum for providers in the community and tertiary care hospitals alike. This curriculum showed that a recurring, deliberate, and structured approach to simulation and skills practicing can be the key to reducing performance anxiety and increasing pediatric hospitalist confidence in their resuscitation knowledge and psychomotor skills. Our next steps include using a validated checklist to evaluate performance and time to intervention. Additionally, we aim to have videotaped simulation scenarios to allow for more comprehensive debriefing and improve perceived self-efficacy. Future directions also include having on-site community hospital-based team resuscitations that shift the primary focus from performing tasks correctly to integrated teamwork.

Additional Information

Disclosures

Human subjects: Consent was obtained or waived by all participants in this study. Children's National IRB issued approval Pro00013760. The Children's National IRB certified this as an exempt study. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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