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INNOVATIONS REPORT

A pirate ship sailed into the yacht club: How we built a novel pediatric emergency medicine curriculum for an emergency medicine training program

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Abstract

Background: Pediatric emergency medicine (PEM) has seen little progression toward a standardized PEM educational framework. The 2018 *Academic Emergency Medicine* Consensus Conference on Advancing PEM Education addressed this gap in core EM education. Absent elements include a “broad needs assessment to identify and evaluate existing curricula and systems gaps in EM training” and a “clearly defined core PEM curriculum that unifies and drives the learning process.” PEM education innovators were called to construct a “unified foundation in PEM education for all levels of emergency care” and to “promote innovation in teaching and learning strategies in curricula.” We endeavored to meet this challenge at our institution.

Methods: The PEM curriculum design is based on the Kern model of curriculum development and included a needs assessment, development of goals and objectives, educational strategies, implementation, evaluation, and programmatic feedback. We committed to using effective learning strategies and active learning methods in developing our curriculum and conducted a 1-year pilot within our EM residency’s didactic conference. We used exit surveys to collect feedback for each session as well as midyear focus groups to gauge the program’s effectiveness. At the start and end of the pilot year residents completed the PEM survey regarding the effect of the PEM curriculum on their self-assessed knowledge, training, and comfort in managing PEM topics.

Results: Feedback regarding the PEM curriculum was positive. Following 1 year of the pilot curriculum, learners in the PGY-1 and PGY-3 classes demonstrated statistically significant improvement in their self-assessed knowledge, training, and comfort with PEM topics. The PGY-2 class had a similar statistically significant improvement in self-assessed knowledge in PEM topics.

Conclusions: Our novel PEM curriculum was well received and has shown early evidence of improving self-assessed knowledge and comfort among EM residents.

NEED FOR INNOVATION

In the United States, most children presenting to emergency departments (EDs) are cared for by general emergency medicine (EM) physicians.¹⁻⁴ For EM training, the Accreditation Council of Graduate Medical Education (ACGME) mandates that 20% of patient encounters be dedicated to patients less than 18 years of age.⁵ Nevertheless, EM residents experience limited exposure in terms of breadth and acuity of pediatric presentations.⁶⁻¹¹ Additionally, the American Board of Emergency Medicine (ABEM) Model of Clinical Practice references age among “modifying factors” affecting patient management, which may minimize the distinctiveness of important PEM diagnoses.^{12,13} Addressing these educational shortcomings, the 2018 *Academic Emergency Medicine* (AEM) Consensus Conference “Advancing Pediatric Emergency Medicine Education” concluded that currently there is “no clearly defined core PEM curriculum that unifies and drives the learning process” for trainees.^{6-11,13-15}

OBJECTIVE OF INNOVATION

In response to the findings of the AEM consensus conference, we sought to create a comprehensive and pedagogically sound PEM curriculum within our EM residency program.

DEVELOPMENT PROCESS

Setting

Our institution is a Level I pediatric trauma center with an annual pediatric ED volume of nearly 20,000 visits/year, and our EM residency is a 3-year training program with 20 residents per class. Attending physicians in our pediatric ED include general EM physicians and fellowship-trained PEM physicians. Residents’ clinical exposure to PEM includes dedicated rotations in our pediatric ED (1 month as PGY-1, 2 weeks as PGY-2) in addition to two to three pediatric ED shifts per ED block (PGY-2, PGY-3). Formal didactic instruction on PEM topics is incorporated into a weekly 4-hour resident conference.

Development framework

We used a six-step approach to curriculum development as our guiding conceptual framework.¹⁶ We conducted a general and targeted needs assessment, developed broad educational goals and specific learning objectives, aligned both with educational strategies, and implemented and evaluated our new curriculum. The project was deemed exempt by our institution’s institutional review board.

Needs assessment

Nationwide, PEM education for EM residents is highly variable.^{6-11,13,14} Thus, in June 2018, we initiated a targeted needs assessment in our department to identify gaps in our existing PEM curriculum. We conducted semistructured interviews with focus groups of graduating EM residents and PEM and EM faculty who staff our pediatric ED.

Participants identified a number of shortcomings in our didactic curriculum: an overall lack of structure and organization and lack of consistent core topic coverage and an inability to track missed topics for self-study. PEM cases that most commonly evoked fear, frustration, and challenge among trainees included neonatal resuscitation, routine newborn care, congenital heart disease, identifying rashes, and developmentally challenging pediatric patients (Data Supplement S1, Appendix S1, available as supporting information in the online version of this paper, which is available at <http://onlinelibrary.wiley.com/doi/10.1002/aet2.10635/full>). Our findings were consistent with those of prior studies showing that EM providers express discomfort with pediatric patients, especially with regard to pediatric and neonatal resuscitations.^{9,17-19} Focus groups expressed the desire for an organized, purposeful curriculum of core PEM content with resources accessible during didactic sessions, during ED shifts, and independently for self-study.

Goals and objectives

With these priorities in mind, we created a comprehensive set of goals and objectives (Appendix S2).^{5,13,20-24} We referred to Baldwin and Kittredge’s educational guidelines for the PEM experience within a residency program, Mitzman’s prioritized topic lists, and Fleisher and Ludwig’s “Textbook of Pediatric Emergency Medicine” and then designated the frequency with which subject matter should be addressed: annually or once every 3 years.^{20, 21,23, 24}

EDUCATIONAL STRATEGIES

We committed to three educational principles in designing our curriculum: (1) optimizing memory retention, (2) using active learning methods in every session, and (3) incorporating asynchronous access to content.

Curriculum structure

A detailed description of the learning topics and teaching formats for our pilot can be found in Figure 1. We structured each 2-h conference session as follows: “Warm Up Quiz” (a three-question quiz to activate prior knowledge),³¹ “Cardinal Presentation” (a chief complaint and four differential diagnoses), “Nursery School” (a normal newborn issue), “Visual Diagnosis” (a rash or radiographic finding),

FIGURE 1 PEM topics: curriculum map. *Chief complaint topic will repeat annually; chief complaint topics without asterisk will repeat every 3 years

*Chief complaint topic will repeat annually; chief complaint topics without asterisk will repeat every three years

Session	Warm Up Quiz	Chief Complaint	Differential Dx	Nursery School	Visual Dx	House Retrieval Quiz
1*	Pediatric Cardiac Dysrhythmias (FALS)	Pediatric Cardiac Dysrhythmias (PALS)	SVT Bradycardia VT/VF Aysotole/PEA	Dacryostenosis	Measles	
2	Crying Infant	The Crying Infant ALCAPA	Incarcerated hernia Acute bilirubin encephalopathy Hair tourniquet Hyponatremia/ formula dilution	Colic	Petechiae	Pediatric dysrhythmias Dacryostenosis Measles
3*	Fever	Fever	Fever • 0-28d, • 1-2mo • 2-24mo • >24mo	PEM Performance Improvement / Case Review	Henoch Schonlein Purpura	Crying infant Colic Petechiae
4*	Pediatric Shock	Pediatric Shock	Sepsis Coarctation of Aorta GI Bleed (FPIES) Congenital Adrenal Hyperplasia	Slate grey spots	Keratitis pilaris	Fever, Henoch Schonlein Purpura
5*	Child Abuse (skin/bones)	Child Abuse	Child Abuse Cases/Small Group (detective, parent, CPS social worker, mandated reporter) Radiographic findings of orthopedic injuries in child abuse (Pediatric Radiology)	Transient neonatal pustulosis	Tinea capitis	Pediatric shock Keratitis pilaris Slate gray spots
6*	Pediatric Blunt Trauma	Pediatric Blunt Trauma	PECARN Head Injury Rule Pediatric cervical spine clearance/imaging Pediatric intra-abdominal injury rule Pediatric massive transfusion guidelines Car seat laws Pediatric concussion	Urine oxalate crystals	Eczema	Child Abuse (skin/bones), tinea capitis, transient neonatal pustulosis
7*	Pediatric Respiratory Distress and Failure	Pediatric Respiratory Distress/Failure -Anatomic considerations -Non-invasives and Adjuncts RSI Drugs Intubation Equipment	Asthma Bronchiolitis Croup Pertussis	Normal infant urine output	Varicella	Pediatric blunt trauma Urine oxalate crystals Eczema
8*	Neonatal resuscitation	Neonatal resuscitation Simulation Day (4 hours)	Rotating Small Groups: • Umbilical catheterization Epinephrine dosing • Chest compressions 3 lead ECG/ pulse ox • PPV, MRSOPA • LMA, Intubation equipment/sizing	Self-Directed Stations (2): NRP question prompt + video response via Flipgrid submission	Sim War 4 neonatal resuscitation simulation cases Each House runs a case Faculty panel scores on critical actions completed Debrief/Feedback 10 min didactic: normal newborn, preterm newborn, meconium stained AF, threshold of viability	
9	Vomiting	Vomiting	NEC Malrotation/volvulus Pyloric stenosis Intussusception	Tinea corporis	Radiographic findings in NEC, malrotation/volvulus, pyloric stenosis, intussusception (Pediatric Radiology)	Neonatal Resuscitation
10	Pediatric Behavioral Emergencies and Common Mimics	Toxicology: One Pill Kills	Depression, opioid OD, serotonin syndrome Acute psychosis, synthetic cannabinoids, Neuroleptic Malignant Syndrome Panic disorder, stimulant OD, Extrapramidal symptoms (Pediatric Psychiatry, Toxicology, ED Clinical Pharmacology)	PEM Performance Improvement	Hand Foot Mouth	Vomiting Tinea corporis Normal Newborn weight gain/loss
11	Pediatric Ocular Emergencies	Pediatric Ocular emergencies	Periorbital / Orbital cellulitis Hordeolum/stye/chalazion Neonatal conjunctivitis	Miliae	Fifth's Disease	Common Mimics of Pediatric Behavioral Emergencies Hand foot Mouth Disease
			Ocular foreign body Allergic chemosis Herpes ophthalmicus Chemical splash injury to eyes Ocular trauma (ruptured globe, traumatic mydriasis, hyphema)			
12	Congenital Heart Disease	Undifferentiated neonatal presentations of CHD Staged palliation and single ventricle physiology	Pediatric ED approaches to complications of staged palliation and single ventricle physiology • Oxygenation goals • Fluid resuscitation • RSI/Intubation considerations • Vasoactive infusions	Candidiasis (mouth/diaper)	Perianal strep	Pediatric ocular emergencies Fifth's disease Miliae
13	Pediatric Genitourinary Complaints	Evaluation of GU complaints Chaperones Normal anatomy Exam positions (prepubertal female)	Ovarian Torsion Imperforate hymen Infected urachal duct cyst Labial adhesion Urethral prolapse Vaginitis Straddle Injuries Circumcision bleeding Zipper injuries Epididymitis Balanoposthitis Phimosis/paraphimosis Hydrocele/Hemia Smegma	Testicular Imaging (Pediatric Radiology)	Molluscum contagiosum	Congenital Heart Disease Perianal strep Candidiasis (mouth/diaper)
14	Child Abuse (abusive head trauma)	Child Abuse (abusive head trauma)		PEM Performance Improvement	Pyogenic Granuloma	GU complaints Molluscum contagiosum
15	Technology Dependent Kids	Technology Dependent Kids	VP shunt GT replacement Browis/portacath Tracheostomy tube Baclofen pump	Teething	Pityriasis Rosea	Abusive head trauma Pyogenic granuloma
16	Limp	Limp	Avascular necrosis / SCFE Septic joint / Transient synovitis	Umbilical cord care/separation	Salter Harris I Fracture	Technology dependent kids Teething
			NAT / Toddler's fracture Neoplasm / Osteomyelitis			Pityriasis rosea
17	Pediatric Dental Emergencies	Pediatric Dental Emergencies	Normal anatomy Concussion Luxation Fracture Extrusion/Intrusion Avulsion	Erythema toxicum	Bullous myringitis	Limp Umbilical cord care Salter Harris I fracture

and the “House Retrieval Quiz” based on topics from the preceding conference.

Promoting active learning

Residents from all training levels were equitably split among four “houses.” Each session afforded opportunities for collaborative work within each house (Appendix S3). We used active learning techniques such as audience response, learner elaboration, and a cooperative learning strategy called the Jigsaw Method, which encourages learner interdependence and peer teaching.²⁵⁻²⁸

Optimizing retention

We anchored each session on a common chief complaint to launch a discussion of four likely and/or lethal differential diagnoses to approximate the clinical experience of evaluating undifferentiated patients in the ED.²²

Addressing the primacy–recency effect

Each session began with new content leaving announcements and administrative tasks for downtime.^{29,30} We limited “chief complaint” presentations to 20 min. Subsequent segments on a particular diagnosis began with a low-stakes formative assessment where learners responded electronically via an audience response platform.³¹ Faculty then led a 5- to 10-min “mini-lesson” to address misconceptions and clarify key points.³²⁻³⁷

Spacing and effortful retrieval

Each session concluded with a 10-question “House Retrieval Quiz,” a gamified group quiz that integrated content from the prior session using the Kahoot and Slido platforms.^{31,32,38}

Accessing content asynchronously

Learners could access all course materials before, during, and after each conference through the Canvas learning management system.³⁹

IMPLEMENTATION PHASE

We performed a 1-year pilot of our PEM curriculum during the 2019 to 2020 academic year. Two-hour sessions were conducted twice a month with one session running 4 hours, comprising 25% of the residents’ total didactic content for the year. To assess the effectiveness and acceptability of this new curriculum,

TABLE 1 Pre- and postcurriculum confidence in PEM-related topics

Group	PEM domain	Pre (IQR)	Post (IQR)	p-value
PGY-1	Knowledge	1 (1, 2)	3 (2, 3)	<0.001
	Training	1 (1, 2)	4 (3, 4)	<0.001
	Comfort	1 (1, 2)	3 (2.5, 4)	<0.001
PGY-2	Knowledge	2 (2, 2)	3 (2, 3)	0.002
	Training	3 (3, 4)	4 (4, 4)	0.030
	Comfort	2 (2, 3)	3 (2, 3)	0.106
PGY-3	Knowledge	2 (2, 3)	4 (4, 4)	<0.001
	Training	3 (3, 3)	4 (4, 4)	<0.001
	Comfort	3 (2, 3)	4 (4,4)	<0.001

we conducted brief “Exit Ticket” surveys at the end of each session.^{32,40-42}

PROGRAM EVALUATION AND OUTCOMES

Six months into the pilot, we collected a total of 249 Exit Ticket submissions. In response to the prompt of “What is working well?” participants identified active learning and small group work (65%, 161/249), “everything/great/fun” (14%, 35/249), retrieval quizzes (8%, 21/249), and asynchronous access to content (2%, 6/249).

Responses to “What is not working?” primarily related to disliking peer teaching and pre-session work (11%, 28/249). Eight percent (19/249) of comments related to challenges accessing or utilizing specific technology applications or “too much tech” and 3% (7/249) remarked on “overtime sessions/too much content/too fast paced.” Based on these responses and midpoint feedback from a resident and faculty focus group, we made two adjustments: (1) eliminating the expectation for learners to prepare in advance for sessions and (2) reducing the number of educational tech platforms (utilizing one or two per session rather than three or four).

Upon completion of our pilot, we measured the impact of the curriculum on learner self-efficacy in regards to PEM topics (Table 1). We surveyed each resident class in July of 2019 before the curriculum began and in July 2020 after 1 full year of implementation.

Course participants rated their level of agreement with the following statements on a 5-point Likert-style scale from “strongly disagree” to “strongly agree”:

- I have a body of knowledge about PEM that allows for independent practice.
- The amount of training I have received so far in PEM is adequate.
- I feel comfortable resuscitating a sick child on an ED shift.

We collected precourse survey responses from 14 of 20 PGY-1 residents (70%), 10 of 20 PGY-2 residents (50%), and 13 of 20 PGY-3 residents (65%). We collected postcourse survey responses from 20 of 20 PGY-1 residents (100%), 18 of 20 PGY-2 residents (90%),

and 19 of 20 PGY-3 residents (95%). Because the pre- and posttest data were unpaired, we performed a Wilcoxon rank-sum test with Bonferroni correction based on nine statistical comparisons (three comparisons \times three classes, $p < 0.0056$) for the scores of each class on each survey item. Learners in the PGY-1 and PGY-3 classes demonstrated statistically significant improvement in their self-assessed knowledge of, training in, and comfort with PEM topics. The PGY-2 class had a similar statistically significant improvement in self-assessed knowledge of PEM topics.

REFLECTIVE DISCUSSION

Leaders in PEM have long identified the need for a standardized longitudinal PEM curriculum for EM trainees.^{6–11,13–15,18,19,22,24,43–45} We sought to create and implement a comprehensive and pedagogically sound PEM curriculum for our EM residents. The curriculum pilot was well received, and we were able to detect early evidence of program effectiveness. This curriculum adapted easily to the “Zoom era” of socially distanced education. In addition, the sessions were recorded and available to residents at all times.

We also learned important lessons from the implementation process. Based on participants’ midcourse feedback, we eliminated the expectation for learners to prepare in advance for sessions and instead focused on optimizing learner engagement during sessions. Additionally, we worked on streamlining the use of educational technology. We began the year using a minimum of three to four educational technology platforms per session, each suited for a particular section of the session. In adjusting our approach, we discovered platforms that supported all the educational technology functions for a single session (for example, Slido can run “warm-up” quizzes, audience response functions, gamified “house retrieval quizzes,” and “exit ticket” surveys eliminating the need to switch between applications).^{32–35,37–42} We believe that this novel curriculum addresses important gaps in current PEM training for EM residents and hope that it may serve as a model for other programs.

CONFLICT OF INTEREST

The authors have no potential conflicts to disclose.

AUTHOR CONTRIBUTIONS

Study concept and design—Emily Andrada, Aaron Danielson; acquisition of data—Emily Andrada; analysis and interpretation of data—Emily Andrada, Sam Clarke; drafting of the manuscript—Emily Andrada, Sam Clarke; critical revision of the manuscript for important intellectual content—Emily Andrada, Aaron Danielson, Julia Magaña, Leah Tzimenatos, Sam Clarke; statistical expertise—Aaron Danielson, Sam Clarke.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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