

Pediatric Intensive Care Unit Resident Educational Curriculum

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Abstract

Introduction: Consistent medical knowledge acquisition while caring for the critically ill can be challenging for learners and educators in the pediatric intensive care unit (PICU), a unit often distinguished by fluctuating acuity and severity. We implemented a standardized didactic curriculum for PICU residents to facilitate their acquisition and retention of knowledge in core PICU topics. **Methods:** We developed a comprehensive standardized curriculum for PGY 2-PGY 4 PICU pediatric and internal medicine-pediatric residents. Thirteen core topics were administered as 30-minute didactic sessions during the rotation, using either PowerPoint slides or a dry-erase board. Residents were tested to assess knowledge acquisition and retention. **Results:** Seventy-eight residents participated, 86% of whom completed posttests. Seventeen percent completed follow-up tests. Of the learners who participated, 60 (77%) completed pretests and posttests, indicating their confidence level each time. The pretest mean was 55% ($SD = 14.4\%$), and the posttest mean was 64% ($SD = 15.6\%$). This 9% increase was statistically significant ($p = .001$; CI, 3.9% to 14.8%). The follow-up test at 3 months, completed by 15% of this subgroup, demonstrated a mean score of 62% ($SD = 14.5\%$). When matched with posttest scores (mean score of 64%, $SD = 13.3\%$), there was no significant difference ($p = .7398$; CI, -11.7% to 16.2%), suggesting retention of previously acquired knowledge. **Discussion:** Our standardized didactic curriculum effectively facilitated the acquisition and retention of the medical knowledge of core PICU topics among PICU residents, in addition to their usual experiential learning.

Keywords

PICU, Pediatric Intensive Care, Curriculum, Critical Care Medicine, Pediatric Critical Care Medicine

Educational Objectives

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

1. Recognize and conceptualize core pediatric critical care topics and pathophysiology.
2. Describe the general management approach of pathologies common to the pediatric intensive care unit.
3. Demonstrate increased confidence in the evaluation and management of critically ill pediatric patients.

Introduction

Residents rotating through the pediatric intensive care unit (PICU) are expected to receive exemplary training and educational experience in the stabilization of critically ill children in order to appropriately manage their problems in the acute setting.¹ The PICU is usually a busy unit filled with young patients of various

and fluctuating levels of acuity, severity, and complexity. This environment can present both the learner and the educator with the formidable task of balancing the acquisition of new skills and medical knowledge while caring for the critically ill. A consistent method of teaching in the PICU could harmonize different training experiences to the quest for medical knowledge despite the challenging nature of this learning environment.² What is needed is an effective and well-balanced standardized curriculum that enhances medical knowledge acquisition and retention, demonstrates relevance to the clinical experiences encountered by the learner, enhances the learner's satisfaction with the educational experience, and is usable in various PICU settings. When compared to small-group teaching methods, lectures are a more efficient way of imparting knowledge to learners,³ which suggests the importance of standardized didactics to achieve this within short, protected teaching times.

A didactic educational curriculum for residents rotating in the PICU was evaluated in the past by Cullen and colleagues; all their residents showed improvement between their pretest and posttest knowledge scores.⁴ Residents' knowledge acquisition, however, did not correlate with the attendings' perception of an

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individual resident’s overall performance. Also, the retention of medical knowledge was not assessed. Another PICU curriculum that included didactics demonstrated knowledge acquisition and favorable educational experience on the part of the residents but did not assess knowledge retention after completion of the rotation.⁵

We created a broad standardized didactic curriculum comprising modules covering 13 core pediatric critical care topics. These modules were chosen from a list of core PICU topics deemed essential for PICU resident education by PICU faculty and from the General Pediatrics Content Outline set by the American Board of Pediatrics.⁶ With this standardized curriculum, we aimed to facilitate the acquisition and retention of knowledge in these areas for residents rotating in the PICU, complementing their experiential learning and hence leading to improved confidence levels and satisfaction. Çoruh and Kritek published a similar critical care curriculum in *MedEdPORTAL* for resident physicians, but their curriculum focused on adult ICU education and was case based.⁷ In addition to featuring a breadth of topics, our curriculum provides two different teaching methods within each module to allow flexibility in teaching style for facilitators. Also, each module of this curriculum is tailored to be administered as a 30-minute lecture (instead of the usual 60-minute lecture), allowing additional flexibility to facilitators to readily teach in any part of the day, especially in a busy unit where educational time for learners may not be protected.

Methods

We developed and implemented a comprehensive standardized didactic curriculum in a single tertiary academic medical center’s PICU. The curriculum targeted PGY 2-PGY 4 pediatric and internal medicine-pediatric residents as learners. Thirteen core PICU topics previously determined by the research team were administered as 30-minute didactic lectures over a 4-week PICU rotation (three to four lectures per week, sample schedule in [Figure 1](#)) by PICU fellows and faculty. No prerequisite knowledge was required prior to undergoing this curriculum, and no special training was required for educators to teach any of the modules; hence, first-year fellows were able to facilitate a module. Given that the curriculum covered core pediatric critical care topics, preferred educators for the modules included PICU attendings, fellows, nurse practitioners, and physician assistants.

We standardized each lecture by the learning objectives and evidence-based teaching guides (which educators were strongly encouraged to use) and then confirmed such by quality assurance. Each teaching guide was accompanied with a PowerPoint presentation that the educator had the option to use to teach the learners. The content of each module was reviewed by a content expert to ensure accuracy and quality. We conducted this project under the exempt status given by our local institutional review board (IRB15-1177).

Monday	Tuesday	Wednesday	Thursday	Friday
		Intro to PICU (Pretest)	Pharmacy/ sedation protocol	<i>DKA</i>
<i>Nutrition</i>	<i>Mechanical ventilation</i>	Radiology rounds	<i>Status asthmaticus</i>	<i>ARDS</i>
<i>Sepsis</i>	<i>Shock</i>	Radiology rounds	<i>Vasoactive agents</i>	<i>Sedation</i>
<i>Electrolyte abnormalities</i>	<i>Acid-base abnormalities</i>	Radiology rounds	<i>Renal failure</i>	<i>TBI/ICP</i>
<i>Arrhythmias</i>	(Posttest)			

Figure 1. This is a sample PICU rotation educational schedule. The PICU educational curriculum modules are in italics, and the assessments are in bold. Abbreviations: ARDS, acute respiratory distress syndrome; DKA, diabetic ketoacidosis; PICU, pediatric intensive care unit; TBI/ICP, traumatic brain injury/intracranial pressure.

Modules

The standardized curriculum consisted of 13 modules covering core PICU topics. Preparation for each module required review of the respective learning objectives, PowerPoint, and teaching guide. Modules were designed to be given within a 30-minute time slot. Each module consisted of a teaching guide and its respective PowerPoint. The modules/core topics included acid and base abnormalities (Appendices A and B), acute respiratory distress syndrome (Appendices C and D), arrhythmias (Appendices E and F), diabetic ketoacidosis (Appendices G and H), electrolyte abnormalities (Appendices I and J), mechanical ventilation (Appendices K and L), renal failure (Appendices M and N), sedation (Appendices O and P), sepsis (Appendices Q and R), shock (Appendices S and T), status asthmaticus (Appendices U and V), traumatic brain injury/increased intracranial pressure (Appendices W and X), and vasoactive agents (Appendices Y and Z). The general teaching plan for the teaching guides was as follows (specific teaching plans for each module were included in its respective teaching guide):

- Introduction and review of learning objectives: 2-3 minutes.
- Definitions, etiology, and pathophysiology: 5 minutes.
- Clinical manifestations and diagnosis: 7-8 minutes.
- Management: 10-12 minutes.
- Review and module evaluation: 2-3 minutes.

Supplies/Equipment

Each module had a teaching guide and PowerPoint presentation available at the discretion of the educator to allow for flexibility in teaching styles. Dry-erase board, markers, and AV equipment were also provided to educators to use as preferred for the PowerPoint presentations of each module, but the use of the dry-erase board and markers with the teaching guide only was encouraged to promote a more interactive teaching experience. The only exception to this recommendation was with the arrhythmias module, as using its PowerPoint enabled learners to readily view the rhythms discussed. Teaching guides were laminated to maintain durability of materials and kept in an educational folder for easy access by educators to use to teach. PowerPoints were accessible to educators and learners on our hospital's PICU website.

Assessments

To assess knowledge acquisition, residents completed a pre- and posttest (Appendices AA and AB, respectively) taken at the start and end of their PICU rotation. To assess knowledge retention, residents were asked to complete a follow-up test (Appendix AC) at least 3 months after the completion of their rotation. Tests comprised questions that touched upon at least one of

the learning objectives from each module. At each stage of this project, we assessed the learner's level of confidence in medical knowledge, level of satisfaction in the curriculum, and perceived improvement in medical knowledge after completing the curriculum. We made a module evaluation form to be completed after every lecture by the learner to add to the evaluation process of the course (Appendix AD).

Results

Seventy-eight residents participated in the curriculum. Eighty-six percent of participating residents completed posttests. Seventeen percent completed follow-up tests. Of the learners who participated, 60 of 78 (77%) completed pretests and posttests, indicating their confidence level each time. The pretest mean was 55% ($SD = 14.4\%$), and the posttest mean was 64% ($SD = 15.6\%$). This 9% increase from pre- to posttest means was statistically significant ($p = .001$; CI, 3.9% to 14.8%). The follow-up test at 3 months, completed by 15% of this subgroup of learners, demonstrated a mean score of 62% ($SD = 14.5\%$). When matched with posttest scores (mean score of 64%, $SD = 13.3\%$), there was no significant difference ($p = .7398$; CI, -11.7% to 16.2%), suggesting no significant loss of knowledge and the possible retention of previously acquired medical knowledge (Figure 2).

Ninety-eight percent (59 of 60) of this subgroup of learners perceived an improvement in their medical knowledge, and 82% (49 of 60) demonstrated an increase in their level of confidence in PICU medical knowledge after completing the curriculum. However, 67% (six of nine) of the residents who responded in the follow-up demonstrated a decrease in their confidence level at least 3 months after the completion of their rotation. Ninety percent (54 of 60) of this subgroup indicated satisfaction in the quality of the curriculum.

Discussion

In the development and implementation of this comprehensive PICU resident curriculum, we found that its use effectively facilitated knowledge acquisition and possibly retention of PICU core topics amongst pediatric and internal medicine-pediatric residents. We also showed that learners perceived the improvement in their medical knowledge and felt more confident in their knowledge. Although residents had higher levels of confidence at the end of the rotation, this confidence seemed to decrease over time even though medical knowledge was maintained months after the PICU rotation was completed.

This curriculum offers some advantages for use in the PICU. First, its lectures are quick, each requiring only 30 minutes to

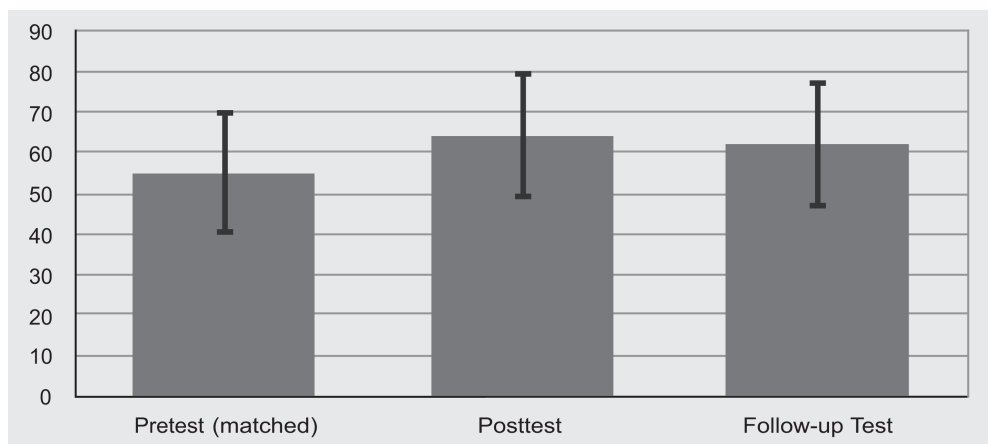


Figure 2. Matched mean test scores (%) of pediatric and internal medicine-pediatric residents at pretesting (55%, $n = 60$), posttesting (64%, $n = 60$), and follow-up testing (62%, $n = 9$). Error bars demonstrate the standard deviations: pretesting $SD = 14.4\%$, posttesting $SD = 15.6\%$, and follow-up testing $SD = 14.5\%$.

teach. This allows the learner and educator time flexibility amid a busy unit. Each module is equipped with a PowerPoint and a teaching guide, allowing flexibility amongst educators in choosing the teaching method based on their level of comfort. Also, the teaching guides are succinct and easy to use, two qualities highly favored in the PICU. Residents were very satisfied with the quality of the educational experience provided by the curriculum.

Lessons Learned

There were many lessons learned during the development and implementation of this standardized curriculum. With a curriculum this vast, as well as the number of learning objectives per module, attempting to effectively test whether each learner has achieved all the learning objectives would be quite lengthy. To reduce the potential for any testing fatigue, we limited the total number of questions pertaining to subject matter in the tests to 15. This undoubtedly limited how well the tests reflected knowledge acquisition. Another lesson we learned early in the implementation phase was that the PICU faculty and fellows preferred having a laminated copy of all the teaching guides available for teaching. Everyone found this to be extremely helpful in making the guides easily accessible to instructors and more durable. Because students verbally noted a preference for more interactive sessions during these lectures, we encouraged instructors to use dry-erase boards and markers with just the teaching guides to teach the modules, instead of the respective PowerPoint presentations, in order to promote a more interactive educational experience. The only exception to this recommendation was with the arrhythmias module, since using its PowerPoint enabled learners to readily view the rhythms discussed.

Limitations

There were, however, notable limitations in this study. When we implemented the curriculum, most educators were senior PICU fellows or faculty members. Novice educators (e.g., first-year fellows) may require more than 30 minutes to teach the lectures, but this will likely improve with time as medical knowledge and experience increase. Also, this study was completed in a single center, limiting the generalizability of the results. In addition, we had to restrict the learners we assessed to pediatric and internal medicine-pediatric residents, as other rotators through our PICU (i.e., PGY 1 emergency medicine residents and fourth-year medical students) had different rotation schedules, making their testing times different and less ideal.

We recognize that although the curriculum covers a breadth of core PICU topics, each module may not be as comprehensive as desired by the educator. Our goal to limit the time needed to teach any given module to 30 minutes indisputably could have limited the content in that module. However, the content provided can serve as a reliable foundation for facilitators to teach additional information on the covered topics.

We note that although this standardized curriculum likely added to the medical knowledge learners acquired during their PICU rotation, it is difficult to differentiate exactly how much of this improvement was attributable solely to the curriculum versus a learner's clinical experience and other teaching in the PICU (including bedside teaching and teaching during patient-centered rounds). In addition, although the knowledge acquisition noted was statistically significant, it was modest, with both pre- and posttest means being less than a passing score of 70%. This

might reflect high difficulty in the test questions. Also, a limitation with the follow-up testing is that with only 16% of learners completing this test, it is difficult to conclude if knowledge retention truly occurred.

Future Efforts

This comprehensive and broad standardized curriculum, filled with succinct yet effective didactic modules, achieved medical knowledge acquisition and possible knowledge retention amongst learners in the PICU. These achievements may lead to an improved overall educational experience, clinical performance, and patient care amongst PICU residents. Future educational scholarship efforts should focus on multicenter use of a standardized curriculum, with analysis of knowledge acquisition and retention amongst PICU residents. Also, other pedagogical methods and educational innovations should be investigated with regard to attaining significant knowledge retention and a positive impact on patient care in this unique work and learning environment.

Appendices

- A. Acid-Base Teaching Guide.docx
- B. Acid-Base PowerPoint.pptx
- C. ARDS Teaching Guide.docx
- D. ARDS PowerPoint.pptx
- E. Arrhythmias Teaching Guide.docx
- F. Arrhythmias PowerPoint.pptx
- G. DKA Teaching Guide.docx
- H. DKA PowerPoint.pptx
- I. Electrolytes Teaching Guide.docx
- J. Electrolytes PowerPoint.pptx
- K. Mechanical Vent Teaching Guide.docx
- L. Mechanical Vent PowerPoint.pptx
- M. Renal Failure Teaching Guide.docx
- N. Renal Failure PowerPoint.pptx
- O. Sedation Teaching Guide.docx
- P. Sedation PowerPoint.pptx
- Q. Sepsis Teaching Guide.docx
- R. Sepsis PowerPoint.pptx
- S. Shock Teaching Guide.docx
- T. Shock PowerPoint.pptx
- U. Status Asthmaticus Teaching Guide.docx
- V. Status Asthmaticus PowerPoint.pptx
- W. TBI-ICP Teaching Guide.docx

- X. TBI-ICP PowerPoint.pptx
- Y. Vasoactive Agents Teaching Guide.docx
- Z. Vasoactive Agents PowerPoint.pptx
- AA. Pretest.docx
- AB. Posttest.docx
- AC. Follow-Up Test.docx
- AD. Module Evaluation.docx

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

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Ethical Approval

The University of Chicago Institutional Review Board approved this study.

References

1. Program requirement for residency education in paediatrics. In: *Graduate Medical Education Directory 2004-2005*. American Medical Association; 2004:283-291.
2. Sabri N, Sun NZ, Cummings BA, Jayaraman D. The perceived effect of duty hour restrictions on learning opportunities in the intensive care unit. *J Grad Med Educ*. 2015;7(1):48-52. <https://doi.org/10.4300/JGME-D-14-00180.1>
3. Brown G, Manogue M. AMEE Medical Education Guide no. 22: refreshing lecturing: a guide for lecturers. *Med Teach*. 2001; 23(3):231-244. <https://doi.org/10.1080/01421590120043000>
4. Cullen EJ, Lawless ST, Nadkarni VM, McCloskey JJ, Corddry DH, Ketrack RG. Evaluation of a pediatric intensive care residency curriculum. *Crit Care Med*. 1997;25(11):1898-1903. <https://doi.org/10.1097/00003246-199711000-00031>

5. Haque A, Haider R, Salat MS. Teaching paediatric critical care medicine to paediatric residents. *J Pak Med Assoc.* 2010; 60(4):319-321.
6. General pediatrics content outline. American Board of Pediatrics. Accessed March 23, 2020. <https://www.abp.org/content/general-pediatrics-content-outline>

7. Çoruh B, Kritek PA. A case-based critical care curriculum for resident physicians. *MedEdPORTAL.* 2012;8:9276. https://doi.org/10.15766/mep_2374-8265.9276

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