

Pediatrics Residents' Confidence and Performance Following a Longitudinal Quality Improvement Curriculum

Cheryl Courtlandt, MD
Laura Noonan, MD
Maureen Walsh Koricke, PhD

Philip Sanford Zeskind, PhD
Sarah Mabus, MLA
Leonard Feld, MD, PhD

ABSTRACT

Background Quality improvement (QI) training is an integral part of residents' education. Understanding the educational value of a QI curriculum facilitates understanding of its impact.

Objective The purpose of this study was to evaluate the effects of a longitudinal QI curriculum on pediatrics residents' confidence and competence in the acquisition and application of QI knowledge and skills.

Methods Three successive cohorts of pediatrics residents (N = 36) participated in a longitudinal curriculum designed to increase resident confidence in QI knowledge and skills. Key components were a succession of progressive experiential projects, QI coaching, and resident team membership culminating in leadership of the project. Residents completed precurricular and postcurricular surveys and demonstrated QI competence by performance on the pediatric QI assessment scenario.

Results Residents participating in the Center for Advancing Pediatric Excellence QI curriculum showed significant increases in pre-post measures of confidence in QI knowledge and skills. Coaching and team leadership were ranked by resident participants as having the most educational value among curriculum components. A pediatric QI assessment scenario, which correlated with resident-perceived confidence in acquisition of QI skills but not QI knowledge, is a tool available to test pediatrics residents' QI knowledge.

Conclusions A 3-year longitudinal, multimodal, experiential QI curriculum increased pediatrics residents' confidence in QI knowledge and skills, was feasible with faculty support, and was well-accepted by residents.

Introduction

Quality improvement (QI) training during residency allows trainees to develop necessary skills to deliver high-quality patient care. Recognizing the importance of these skills, the Accreditation Council for Graduate Medical Education (ACGME) Common Program Requirements¹ include the competencies of practice-based learning and improvement and systems-based practice. Although residents are required to complete QI training, few studies address the optimal curriculum for physician training² and the elements that prepare physicians to incorporate QI learning into future practice.

Few longitudinal resident QI curricula include first-year residents^{3,4} or embed a QI coach. Many residency programs incorporate QI education during a 1-month ambulatory rotation⁵⁻⁷ or an elective

clinical rotation,⁸ include only second-year and third-year residents,^{9,10} or utilize longitudinal projects with a series of residents on monthly rotations.¹¹

The Center for Advancing Pediatric Excellence (CAPE) developed a longitudinal curriculum employing a multimodal format to improve pediatrics residents' confidence in their QI knowledge and skills and competence in QI methodology. The curriculum provided experiential learning, including conducting successive personal and practice-based QI projects, and culminated in the joining/leading of a multidisciplinary QI team, which is consistent with the ACGME's Clinical Learning Environment Review expectations for quality and safety improvements.¹² The purpose of this study was to evaluate the curriculum components involved in developing residents' confidence in QI knowledge and skills and to examine its relationship to QI competence.

Methods

Setting and Participants

Participants were 3 successive cohorts of pediatrics residents (N = 36) who completed the program's QI requirement from 2009 through 2014.

DOI: <http://dx.doi.org/10.4300/JGME-D-15-00032.1>

Editor's Note: The online version of this article contains overviews of Center for Advancing Pediatric Excellence (CAPE) staffing and quality improvement curricula, the precurriculum and postcurriculum component surveys, and the CAPE pediatric quality improvement assessment scenario.

Curriculum

The CAPE curriculum, a longitudinal experience based on the Model for Improvement^{13,14} and the adult learning theory emphasizing experiential learning,¹⁵ is provided as online supplemental material. Requirements included a personal improvement project (PIP)¹⁶ designed to teach QI basics with application to a personal, nonclinical activity; a reflective practice project (RPP) to identify and address gaps in clinical practice; resident membership in an ongoing inpatient or ambulatory QI project team; and leadership of a component of the QI project. Resident projects were chosen using both institutional strategic planning and resident interest.

The CAPE staffing included physicians and non-physicians and involved pediatrics faculty and 36 pediatrics residents. Support staff positions and job descriptions were adapted from existing positions and pay scales within the organization. An overview of CAPE staffing, including job titles, full-time equivalent status, education/experience, and job functions, is provided as online supplemental material. A QI coach and data analyst provided the coaching, with interactions individualized to each resident, as well as education, data presentation, data analysis, and project management tailored to suit project needs. Material costs were primarily associated with obtaining QI publications for training and QI resources.

Surveys and Assessments

To examine the curriculum's effects on confidence in QI knowledge and skills, residents completed surveys both at program entry and completion. At the end of postgraduate year (PGY) 3, residents rated their ability to understand and use the Model for Improvement before and after the PIP and RPP. Survey components are available as online supplemental material. At the PGY-3 assessment, residents ranked the educational value of individual curricular components.

The Quality Improvement Knowledge Application Tool (QIKAT),⁶ a commonly used, adult-focused method for QI curricular evaluation, may have limitations in pediatrics settings as the adult case content may not resonate with pediatrics residents. The CAPE staff developed the CAPE pediatric QI assessment scenario (PQIAS) and scoring, based on the QIKAT,^{6,17} to assess pediatrics residents' competence in applying QI methodology (available as online supplemental material). After assessing the QIKAT for suitability, we created the PQIAS to emphasize demonstrating competence with familiar content and

What was known and gap

As residency programs have developed quality improvement (QI) curricula, information on their educational value, feasibility, and impact is critical.

What is new

A longitudinal, multimodal, and experiential QI curriculum for pediatrics residents includes experiential projects, coaching, and resident project leadership.

Limitations

Scenario focus on the ambulatory setting, lack of a comparison group, and a small sample size all limit generalizability.

Bottom line

The QI curriculum increased pediatrics residents' confidence in knowledge and skills, and was feasible and acceptable to residents.

piloted it for attending and chief resident feedback. The PQIAS describes 1 outpatient scenario that prompts residents to formulate a QI project with aims, goals, measures, and 1 change idea or plan-do-study-act cycle. The PQIAS was administered at program completion. The PQIAS was evaluated by 2 blinded raters with QI expertise (C.C., L.N.). Residents received points for correct answers in individual PQIAS sections, which were summed for a total score.

The Carolinas HealthCare System provided Institutional Research Board approval.

Analyses

Ratings on individual scale items were summed and averaged for total scale scores for confidence in QI knowledge and skills. Paired *t* tests were used to compare residents' precurriculum and postcurriculum scores and pre-post PIP and RPP experiences. Analyses of residents' modal responses were conducted on rankings of the educational value of specified curricular components. Kendall tau-b was used to examine the interrater reliability of PQIAS scores. Following a median split of PQIAS scores, residents above and below the median were compared by independent *t* tests on confidence in QI knowledge and QI skill scales. All statistical analyses were conducted using SPSS Statistics version 21 (IBM Corp, Armonk, NY).

Results

Comparisons of confidence in QI knowledge and skills ratings were available for 31 residents. Four

TABLE 1

Curriculum Effectiveness Surveys

A. Assessment of Effectiveness of CAPE QI Curriculum on Residents' Confidence Using a 10-Point Likert Scale

	Precurricular Experience		Postcurricular Experience		P Value
	Mean	SEM	Mean	SEM	
QI knowledge	2.7	0.19	7.5	0.23	.001
QI tools	2.3	0.22	6.3	0.30	.001

B. Assessment of Effectiveness of PGY-1 CAPE QI Curriculum on Residents' Confidence Using a 5-Point Likert Scale

	Precurricular Experience		Postcurricular Experience		P Value
	Mean	SEM	Mean	SEM	
Personal Improvement Project					
Model for Improvement	1.5	0.12	3.6	0.17	.001
Data management plan	1.6	0.12	3.5	0.16	.001
Act on plan-do-study-act	1.6	0.12	3.7	0.16	.001
Display run chart data	1.7	0.15	3.4	0.17	.001
Reflective Practice Project					
Perform chart audit	2.8	0.18	4.1	0.14	.001
Identify practice gaps	2.7	0.16	4.1	0.13	.001
Strategy to address gaps	2.5	0.16	4.1	0.13	.001

Abbreviations: CAPE, Center for Advancing Pediatric Excellence; QI, quality improvement; SEM, standard error of the mean; PGY, postgraduate year.

residents did not complete the preassessment, and 1 transferred to another program before the post-assessment. All other comparisons were based on 35 residents who completed all surveys. Residents' perceived confidence in QI knowledge improved from a mean of 2.7 (standard error of the mean [SEM] = 0.19) to 7.5 (SEM = 0.23, $P < .001$). Residents' perceived confidence in QI tools improved from a mean of 2.3 (SEM = 0.22) to 6.3 (SEM = 0.30, $P < .001$; TABLE 1A). Comparisons of pre-post PIP and RPP ratings showed that residents reported significantly greater understanding of the Model for Improvement and abilities to use QI skills and tools (TABLE 1B).

Total scores on the PQIAS ranged from 8 to 20 with a median of 15.5; this also reflected the 80% mark of total possible points. The 2 independent raters showed high interrater reliability on this measure ($\text{tau-b} = 0.893$, $P < .001$). Compared to residents with scores below the median ($n = 17$), residents with scores above the median ($n = 18$) had significantly greater confidence in QI skills (above median: mean = 6.9, SEM = 0.37; below median: mean = 5.7, SEM = 0.40; $t(33) = 2.20$; $P < .035$), but not in QI knowledge (above median: mean = 7.8, SEM = 0.27; below median: mean = 7.2, SEM = 0.33; $t(33) = 1.54$; $P < .13$). Postcurriculum confidence scores

were higher for QI knowledge than QI skills for residents in both the lower competence ($t(16) = 3.83$, $P < .001$) and the higher competence ($t(17) = 3.50$, $P < .003$) groups.

Individual coaching consistently received a high modal ranking across the 3 years. Conducting a PIP and being a team member were also ranked as having high perceived educational value for PGY-1 and PGY-2 residents, respectively. Leading a team received the highest modal rating of educational experiences for PGY-3 residents. Didactics, Institute for Healthcare Improvement modules, and suggested readings were consistently ranked as having much lower perceived educational value.

Discussion

The CAPE curriculum significantly improved residents' perceived confidence in QI knowledge and skills. The 2 experiential learning projects imbedded in this curriculum, the PIP and RPP, were rated as significantly improving residents' perceived understanding of specific aspects of QI methodology. A unique component consistently ranked highly for its educational value was the QI coach's ability to individualize education and provide support for team activities.

TABLE 2

Sample of Resident Quality Improvement Projects (2009–2014) With Examples of Project Measures

Hospital Setting		Clinic Setting	
Project	Project Measures	Project	Project Measures
Assessment of Patient With Eating Disorder	Weight completed by 8 AM; abnormal orthostatic BP reported	Medical Management of Children With ADHD	Family reports 1 target behavior and management; intervention for BP > 95th percentile; intervention for weight decline
Whiteboards as Communication Tools in Patient Rooms	Whiteboards filled out correctly with goals for day and discharge date; family satisfaction with whiteboard as communication tool	Emergency Preparedness for Outpatient Hematology Oncology Clinic	Percentage of staff PALS certified; time between symptoms and initiation of emergency algorithm
Family-Centered Rounding	Team arrives at designated time for morning rounds; nurse participates in rounds	Health Literacy: Teach Back	Parents able to verbalize 3 key topics from visit; visit cycle time
Rapid Antibiotic Administration	Time–arrival to vital signs entered in EHR; time–arrival to IV access; time–arrival to IV antibiotics	Asthma Care: Pulmonary Function Testing	Patients with testing completed; patients with test results interpreted by provider
Mock Codes: PERT	Number of residents participating in mock codes; number of nurses participating in mock codes; number of respiratory therapists participating in mock codes	QIIN: Newborn Screening	Assessment of newborn screen completed at first visit; infants with out-of-range screening results receive confirmatory testing
Hematology Oncology: Improving Care for Children With Fever and Neutropenia	Time–arrival to IV antibiotics	QIIN: Bright Futures	Screen for maternal depression; developmental screen at 9-month visit

Abbreviations: BP, blood pressure; ADHD, attention deficit hyperactivity disorder; PALS, pediatric advanced life support; EHR, electronic health record; IV, intravenous; PERT, patient emergency response team; QIIN, quality improvement innovation network (American Academy of Pediatrics).

The longitudinal nature of the curriculum allowed for the benefit of reflection on learning and the development of confidence in QI skills and knowledge over time. The goal of the CAPE curriculum was to incorporate QI into daily resident work.^{4,18} Several challenges arose regarding integration of a longitudinal program into a monthly schedule. Residents spent approximately 40 hours over the 3 years on QI projects. As there was no protected time for QI work, time was integrated into the overall block schedule via individualized coaching sessions at resident requested times, typically during elective or outpatient months and before or after the noon conference. Team meetings were arranged around resident schedules, and project management was coordinated by the QI coach. All project teams were multidisciplinary. Although residents were involved

in generating plan-do-study-act cycles, much of the testing was performed by front-line staff in the patient care setting.

Faculty QI expertise was initially limited, with only 5 faculty members having formal QI training. These faculty members invested approximately 30 hours per resident project over the course of 3 years. A core group of faculty, self-identified as QI champions, embraced the CAPE curriculum and learned QI methodology side by side with residents. As learners themselves, most faculty functioned as content experts, not QI experts, on resident projects. Resident projects (TABLE 2) often were part of larger, organizationally driven projects. A few residents successfully generated an independent project. Despite time limitations, residents and faculty rated participation in the CAPE curriculum as a positive experience.

An important component of the evaluation of this curriculum was whether the educational components and confidence generated by the QI curriculum resulted in demonstrable QI competence, as measured by the PQIAS. Half of the residents obtained at least 80% of the possible PQIAS total points at program conclusion, suggesting that they were able to translate their perceived confidence into an ability to develop a QI project. Half of the residents did not achieve the 80% mark of success, suggesting that improved confidence does not necessarily signify competence. Residents above the PQIAS median reported significantly greater confidence in QI skills than residents below the median; no difference was found between resident groups in confidence of QI knowledge when related to QI competence. Resident competence thus appears associated with confidence in using such skills as creating a data collection sheet and/or generating a run chart or histogram, not confidence in knowledge, per se. Of interest, the lowest-rated components of the curriculum were those associated with didactic and nonexperiential learning or knowledge.

Curricular elements that were ranked as having the highest educational value were the interactive learning experiences, which required guided, active participation. While residents indicated that they had more confidence in their QI knowledge than QI skills, the latter scale reflecting active learning experiences was the one associated with demonstrated competence on the PQIAS.

Limitations of this educational innovation include the PQIAS scenario's sole focus on ambulatory care. It also is possible that residents' confidence improvements were affected by other factors, such as other experiences that may enhance confidence. However, in our institution, there are few opportunities for residents to participate in QI besides the CAPE curriculum.

Obtaining institutional funding for a comprehensive effort may be a challenge. In our case, a Duke Endowment grant provided funding to develop the CAPE QI curriculum and hire staff. Based on success in starting and sustaining improvement projects aligned with institutional goals, the Department of Pediatrics currently supports the CAPE staff. Residents have participated in more than 25 projects to date, and many projects have advanced to sustainability. In other settings, institutional support may hinge on the magnitude of the positive effects from resident participation on QI teams.

QI coaching support may not be available in all settings, but existing resources may be secured for projects strategically aligned with the institutional mission. Several residency programs at our institu-

tion have adapted and implemented components of the CAPE curriculum to align with available resources.

Areas for future research include whether guided resident involvement on QI projects affected outcomes, understanding how QI coaching can affect physicians in training and postresidency QI efforts, expansion of scenarios to assess QI competence, and the relationship to the acquisition of QI knowledge and skills at the completion of residency. Further studies should evaluate applicability of the curriculum to other residency training programs and other health professions training.

Conclusion

A 3-year longitudinal, experiential QI curriculum increased pediatrics residents' confidence in QI knowledge and skills. Demonstration of QI competence was not related to confidence, except in the area of acquisition of QI skills. The QI coaching and team leadership received the most favorable resident ratings. Our innovative approach to QI training is a feasible solution to developing QI leadership skills and embedding QI training into daily work.¹⁹

References

1. Accreditation Council for Graduate Medical Education. Common program requirements. www.acgme.org/acgmeweb/Portals/0/PFAssets/ProgramRequirements/CPRs2013.pdf. Accessed October 29, 2015.
2. Yanamadala M, Hawley J, Sloane R, Bae J, Heflin MT, Buhr GT. Development and assessment of a web-based clinical quality improvement curriculum. *J Grad Med Educ*. 2014;6(1):147–150.
3. Tomolo AM, Lawrence RH, Watts B, Augustine S, Aron D, Singh MK. Pilot study evaluating a practice-based learning and improvement curriculum focusing on the development of system-level quality improvement skills. *J Grad Med Educ*. 2011;3(1):49–58.
4. Shaikh U, Natale JE, Nettiksimmons J, Li ST. Improving pediatric health care delivery by engaging residents in team-based quality improvement projects. *Am J Med Qual*. 2013;28(2):120–126.
5. Djurichich AM, Ciccarelli M, Swigonski NL. A continuous quality improvement curriculum for residents: addressing core competency, improving systems. *Acad Med*. 2004;79(suppl 10):65–67.
6. Ogrinc G, Headrick LA, Morrison LJ, Foster T. Teaching and assessing resident competence in practice-based learning and improvement. *J Gen Intern Med*. 2004;19(5, pt 2):496–500.

7. Varkey P, Reller MK, Smith A, Ponto J, Osborn M. An experiential interdisciplinary quality improvement education initiative. *Am J Med Qual*. 2006;21(5):317–322.
8. Weingart SN, Tess A, Driver J, Aronson MD, Sands K. Creating a quality improvement elective for medical house officers. *J Gen Intern Med*. 2004;19(8):861–867.
9. Diaz VA, Carek PJ, Dickerson LM, Steyer TE. Teaching quality improvement in a primary care residency. *Jt Comm J Qual Patient Saf*. 2010;36(10):454–460, AP1–AP5.
10. Sepulveda D, Varaklis K. Implementing a multifaceted quality-improvement curriculum in an obstetrics-gynecology resident continuity-clinic setting: a 4-year experience. *J Grad Med Educ*. 2012;4(2):237–241.
11. Neuspiel DR, Hyman D, Lane M. Quality improvement and patient safety in the pediatric ambulatory setting: current knowledge and implications for residency training. *Pediatr Clin North Am*. 2009;56(4):935–951.
12. Weiss KB, Wagner R, Nasca TJ. Development, testing, and implementation of the ACGME Clinical Learning Environment Review (CLER) program. *J Grad Med Educ*. 2012;4(3):396–398.
13. Langley GJ, Moen RD, Nolan KM, Nolan TW, Norman CL, Provost LP. *The Improvement Guide: A Practical Approach to Enhancing Organizational Performance*. 2nd ed. San Francisco, CA: Jossey-Bass Publishers; 2009.
14. Courtlandt CD, Noonan L, Feld LG. Model for improvement—part 1: a framework for health care quality. *Pediatr Clin North Am*. 2009;56(4):757–778.
15. Noonan L, Courtlandt C, Walsh Koricke M, Mabus S, Feld L. Quality improvement education: a tool for transformation of healthcare. In: Lobdell KW, Stamou SC, eds. *Quality Improvement: Methods, Principles and Role in Healthcare*. Hauppauge, NY: Nova Science Publishers Inc; 2013:33–48.
16. Alemi F, Neuhauser D, Ardito S, Headrick L, Moore S, Hekelman F, et al. Continuous self-improvement: systems thinking in a personal context. *Jt Comm J Qual Improv*. 2000;26(2):74–86.
17. Varkey P, Karlapudi SP, Bennet KE. Teaching quality improvement: a collaboration project between medicine and engineering. *Am J Med Qual*. 2008;23(4):296–301.
18. Cooke M, Ironside PM, Ogrinc GS. Mainstreaming quality and safety: a reformulation of quality and safety education for health professions students. *BMJ Qual Saf*. 2011;20(suppl 1):i79–i82.
19. Wong BM, Levinson W, Shojania KG. Quality improvement in medical education: current state and future directions. *Med Educ*. 2012;46(1):107–119.



Cheryl Courtlandt, MD, is Co-Director, Center for Advancing Pediatric Excellence, Medical Director, Pediatric Asthma Program, and Attending Physician, Pediatric Specialties Care Division, Levine Children's Hospital, Carolinas HealthCare System; **Laura Noonan, MD**, is Director, Center for Advancing Pediatric Excellence, Pediatric Specialties Care Division, Levine Children's Hospital, Carolinas HealthCare System, and Senior Improvement Advisor, Charlotte Area Health Education Center, Carolinas HealthCare System; **Maureen Walsh Koricke, PhD**, is Quality Improvement Coach, Center for Advancing Pediatric Excellence, Pediatric Specialties Care Division, Levine Children's Hospital, Carolinas HealthCare System; **Philip Sanford Zeskind, PhD**, is Research Professor of Pediatrics and Pediatric Data Analyst, Center for Advancing Pediatric Excellence, Pediatric Specialties Care Division, Levine Children's Hospital, Carolinas Medical Center; **Sarah Mabus, MLA**, is Program Coordinator, Center for Advancing Pediatric Excellence, Pediatric Specialties Care Division, Levine Children's Hospital, Carolinas HealthCare System; and **Leonard Feld, MD, PhD**, is Senior Medical Director and Senior Academic Chair, Pediatric Specialties Care Division, Carolinas HealthCare System Medical Group, and Sara H. Bissell & Howard C. Bissell Endowed Chair in Pediatrics and Chief Medical Officer, Levine Children's Hospital, Carolinas HealthCare System.

Funding: The authors report no external funding source for this study.

Conflict of interest: The authors declare they have no competing interests.

Preliminary findings of this work were presented as an oral abstract presentation at the Academy for Healthcare Improvement Meeting, Baltimore, Maryland, May 27–30, 2014, and as a poster presentation at the Institute for Healthcare Improvement National Forum, Orlando, Florida, December 7–10, 2014.

Corresponding author: Laura Noonan, MD, Center for Advancing Pediatric Excellence, Pediatric Specialties Care Division, Levine Children's Hospital, Carolinas HealthCare System, MEB 415, 1000 Blythe Boulevard, Charlotte, NC 28203, 704.381.2273, fax 704.381.6841, laura.noonan@carolinashealthcare.org

Received January 26, 2015; revisions received April 13, 2015, and July 8, 2015; accepted August 12, 2015.