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Quality Improvement Education for Pediatric Residents and Fellows

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Opinion statement

Quality improvement (QI) methodologies allow healthcare systems to improve the quality of care delivered to patients. Teaching trainees about these concepts and tools is now a required component of residency training. QI training in pediatric residency programs is generally well-accepted and feasible, and many programs include a project component that can effect change in clinical processes; however, there is lack of agreement on best practice standards for training residents in terms of content, format, and assessment. For example, though pediatric residents are generally satisfied with their QI training, one survey found that many did not use basic QI tools during their project design, implementation, and analysis. The majority of pediatric program directors note that a QI curriculum exists in their program but the formats vary; as opposed to residents, only 23% are satisfied with their current program. Additionally, some programs do not use a formal evaluation process to study and improve their curriculum. Innovations in teaching QI, such as focused residency tracks and faculty-resident co-learning, are exciting, but the priority must be creation of a standardized set of learning objectives for trainees. Barriers to successful QI training include lack of faculty expertise and cultural factors, such as misaligned values between the institution, GME, and/or residents. An emphasis on the scholarly output possible from QI projects may help assuage doubts for those who initially do not see the value of QI-based improvements.

Introduction

There are opportunities for improving the quality of care that we deliver to children in the Unites States [1]. It is generally accepted that QI methodologies can drive such improvements, and thus national resident/fellow educational groups recognize the need for educating trainees in quality science management. QI education, in some capacity, is now a required component in the guidelines from the Accreditation Council for Graduate Medical Education (ACGME) in the USA and CanMEDS in Canada [2, 3]. Once out of training, former residents also need to be familiar with QI concepts in order to maintain certification by the American Board of Pediatrics [4]. In general, there seems to be agreement that QI education is necessary, but details on best practice recommendations for educational content, format, and assessment are lacking.

In order to study current best practices in QI education for pediatric residents and fellows, we conducted a comprehensive search in Medline from 2010 to present, in addition to a cited reference search and topic search in Web of Science. The highest priority articles were chosen including those that specifically addressed pediatric resident/fellow education, those that discussed innovation in QI education, the most recently published systematic review, and a study of resident attitudes towards QI in general. A number of studies looked specifically at teaching either medical students or faculty; for the purposes of this review, these were not specifically included. In addition, a number of other articles that look specifically at QI education for trainees in other fields, such as internal medicine and surgery (other than those otherwise included above) were also not included.

Why educate residents in quality improvement techniques?

Academic medical centers, involved in directly training pediatric residents and fellows, have a unique role to play in QI education: they directly benefit from trainees improving the system of care for their patients, who are often the sickest among the population; they train academic physicians who will need to integrate QI into their teaching; and they train community physicians who will need to learn basic QI concepts and skills before they leave academia to practice in areas without strong QI infrastructure [5]. Residents also play a unique role within the academic medical center, as they participate in the daily complexities of such systems [6].

In addition to the above, there are now specific requirements for QI incorporation into residency training from accreditation bodies. Specifically, the Accreditation Council for Graduate Medical Education has set forth quality improvement goals within their six Core Competencies and "Milestones," which is their framework for developmental assessment of resident physician competency. These Milestones are arranged into levels 1–5, from novice to expert, and used in semi-annual review of resident performance, with Level 3 designed as a target for graduation. These, within the dimensions of Systems-Based Practice and Practice-Based Learning and Improvement, include items such as "Advocate for quality patient care and optimal patient care systems," "Work in inter-professional teams to enhance patient safety and improve patient care quality," and "Systematically analyze practice using quality improvement methods, and implement changes with the goal of practice improvement." Table 1 provides an example of one ACGME core competency with its associated milestone descriptions and case examples [2].

The ACGME also assesses and provides feedback on six focus areas during the Clinical Learning Environment Review (CLER), part of its training site

Table 1. Example of an ACGME Systems–Based Practice Pediatric Milestone

Systems–Based Practice (SBP) 2: Advocate for quality patient care and optimal patient care systems

Level of expertise	1	2	3	4	5
Description	Attends to medical needs of individual patient(s); wants to take good care of patients and takes action for individual patients' health care needs	Demonstrates recognition that an individual patient's issues are shared by other patients, that there are systems at play, and that there is a need for quality improvement of those systems; acts on the observed need to assess and improve quality of care	Acts within the defined medical role to address an issue or problem that is confronting a cohort of patients; may enlist colleagues to help with this problem	Actively participates in hospital-initiated quality improvement and safety actions; demonstrates a desire to have an impact beyond the hospital walls	Identifies and acts to begin the process of improvement projects both inside the hospital and within one's practice community
Example	Sees a child with a firearm injury and provides good care.	A physician notes on rounds, "We have sent home four-to-five firearm-injury patients and one has come back with repeated injury. We need to do something about that."	The physician works with colleagues to develop an approach, protocol, or procedure for improving care for penetrating trauma injury in children and measures the outcomes of system changes.	The physician attends a hospital symposium on gun-related trauma and what can be done about it and then arranges to speak on gun safety at the local meeting of the parent-teachers association.	Upon completion of quality improvement project, the physician works on new proposed legislation and testifies in City Council.

accreditation system. These areas include Patient Safety and Health Care Quality, in which QI is obviously key [7].

Current state of graduate medical education in quality improvement

A systematic review conducted in 2010 examined resident and medical student education in QI and patient safety. They specifically hoped to assess the educational content and teaching formats of the various curricula, assess the program's learning outcomes, and identify factors that either support or impede implementation of QI courses. After studying 41 different curricula meeting search criteria, they noted that curricula were generally well-accepted and successful at improving trainee knowledge of QI concepts, techniques, and tools. Commonly discussed topics in these courses included continuous quality improvement, root cause analysis, and systems thinking. Many courses included projects that improved clinical processes: one-third of studies demonstrated local change improvements. The authors noted that a number of "learner, faculty, and organizational factors," such as availability of faculty for mentoring, discussion of competing demands, and need for learner buy-in must be taken into consideration when implementing such programs. For example, some learners noted difficulty when noting discrepancies between material in their courses and their institutions' culture and standard practice. Learners also noted a need for institutional operational support, such as availability of information systems to facilitate data acquisition [8].

Current state of pediatric resident education in quality improvement

A number of studies have recently specifically described the current state of *pediatric* trainee education in QI via surveys of both pediatric Graduate Medical Education program directors and the residents themselves.

Mann et al. surveyed program directors as a needs assessment to describe national pediatric trainee QI educational practices and evaluation methods, including program director perceptions. Notable observations are listed here:

- 85% of program directors reported presence of a QI curriculum.

  - 83% reported didactics/formal lectures (most commonly in the form of noon conference), 26% of programs used online modules, and 19% used retreats.
  - 22% of programs taught in a day or less, while 12% taught over the entire three-year period.

- Only 23% were satisfied with their current QI educational program.
- Most programs taught continuous process improvement (65%), followed by model for improvement (40%), followed by lean and six sigma (13%).

  - Two-thirds taught specifically about PDSA cycles and data measurement, and only 9% introduced driver diagrams.
- Only 40% of programs assessed residents' QI knowledge acquisition; 17% of programs used no formal evaluation at all.
- Programs with more faculty involvement were more likely to have a resident submit an abstract to a professional conference (< 5 faculty: 38%; 5–9 faculty: 64%; > 9 faculty: 92%, p = .003). Of note, residents in programs that provided financial project support were twice as likely to present (not statistically significant).

It is interesting to note that 15% of program directors surveyed did not report teaching QI, despite the ACGME requirement for QI learning during residency [9•].

Similarly, Craig et al. conducted a national survey of third year pediatric residents from 45 programs of varying sizes across the country approximately 2 years later to better understand their QI experiences, perceptions around training, confidence in future independent QI work, as well as factors that facilitate QI learning. Specific domains within the 22-question survey also included curricular content, support, and hospital QI emphasis. The authors found that, though pediatric residents overall had positive QI educational experiences, a number of residents still felt their programs' curricula needed improvement, many were not confident about their ability to conduct future QI projects, and, most interestingly, many did not use basic QI tools for their projects. Some specific results are listed here:

- 94% reported receiving QI education during residency; 91% participated in a QI project as part of their curriculum and 33% reported learning during a QI-focused rotation.

  - Those who performed projects did not always attempt or complete standard QI techniques, such as outcome measurement, creation of AIM statements, PDSA cycles, or run charts, as depicted in Fig. 1 [10•].
- 93% agreed or strongly agreed that QI was taken seriously by their residency program; 90% agreed QI had a strong emphasis within their hospital.
- 74% had no prior QI experience.
- 72% felt comfortable using QI methodology after graduation; 61% felt they would be able to lead a QI project on their own.
- Most residents felt they had overall good faculty QI support and mentorship and exposure to hospital-based QI efforts.

  - Approximately one quarter of residents ranked administrative support and allotted project time as "inadequate."
- 74% were satisfied with their QI training overall [10•].

Interestingly, when comparing the Craig survey of residents and the Mann program director survey, one noticeable difference arises: only 23%
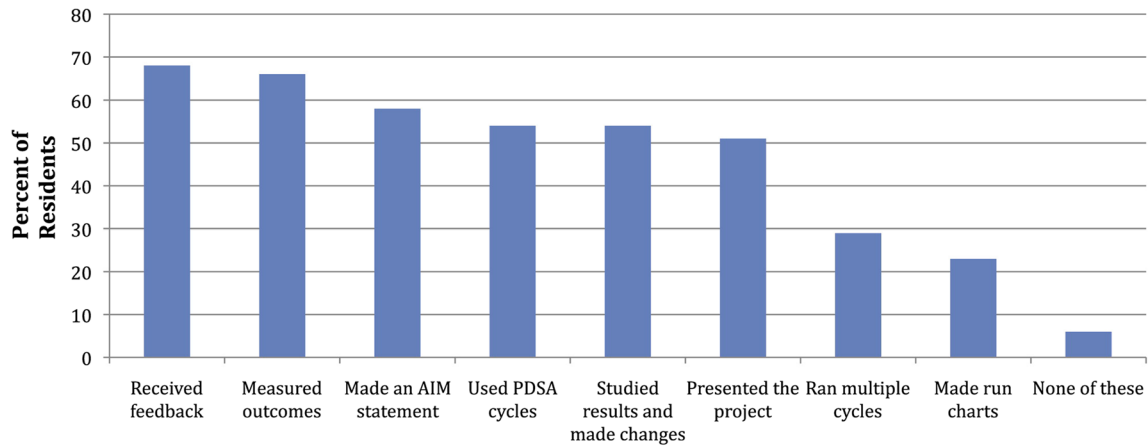
Fig. 1. Percent of Resident Respondents Using QI tools during QI Educational Curricula Nation-wide Reprinted from Academic Pediatrics, Volume 14, Edition 1, Craig, Mark S., Garfunkel, Lynn C., Baldwin, Constance D., Mann, Keith J., Moses, James M., Co, John P. T.et al., Pediatric resident education in quality improvement (QI): A national survey, page 54–61, Copyright 2014, with permission from Elsevier, license number 4192731317988 [10•].

of PPDs were satisfied with their curricula, as compared to 74% of residents. Though there was a 2-year difference between the two surveys, other factors likely account for the differences [9•, 10•]. Most strikingly, despite resident satisfaction with their training, they often failed to use standard QI tools such as AIM statements and PDSA cycles, which suggests the need for improvement in these curricula.

Examples of pediatric resident quality improvement curricula

Courtland et al. studied a longitudinal QI curriculum, the Center for Advancing Pediatric Excellence QI curriculum, at the Carolinas HealthCare System, specifically designed to increase resident confidence in QI knowledge and skills. Thirty-six total pediatric residents in three cohorts participated in the curriculum; residents showed significant increases between pre-post measures of confidence in QI skills, and the program was well-accepted by residents and achievable with faculty support. Residents found coaching and team leadership as the most educational components of the curriculum [11].

Shaikh et al. at the University of California, Davis, also showed that a longitudinal QI curriculum was not only feasible but effective. They also implemented a 3-year curriculum that evolved over time based on feedback. Resident/faculty teams designed and implemented 10 QI projects over 3 years in order to help residents learn QI concepts. Not only were the teams able to integrate QI concepts into their projects (e.g., via focused improvement, data collection, assessing change for success), but projects also resulted in multiple improvements to clinical processes/outcomes, such as increasing the rate of HPV vaccination rate in clinic from 50 to 90%, and increasing the number of

children receiving asthma home management care plans at hospital discharge from 53 to 78% [12].

Cultivation of quality improvement knowledge during fellowship training

It has been suggested that residency is the time to introduce basic QI concepts, while fellowship is an appropriate time to refine such concepts in order to allow for mastery [5]. An example of one such fellowship-specific training program was described by Gupta et al. in 2014; the Harvard Combined Fellowship Program in Neonatal-Perinatal Medicine requires all fellows to participate in a quality and safety educational module that includes didactic and experiential components over the 3 years of fellowship. The program includes workshops, completion of Institute for Healthcare Improvement (IHI) modules (of note, required for all trainees now at Boston Children's Hospital), Morbidity and Mortality conference participation, optional readings/web-based modules, and a project with evaluation by faculty and program directors. They specifically tailored the program to allow for alignment with the individual fellow's scholarly or research-based focus, and many of the projects have led to ongoing improvements [13].

You only improve what you measure: quantifying success in resident/fellow QI education

In order to truly understand and to justify resident QI education efforts, like with any QI project, it is important to assess outcomes. Improved patient or process outcomes from trainee-led projects is the ultimate standard for documenting the efficacy of QI training programs, but this can be difficult. A number of tools to evaluate QI efforts and assess QI skill, knowledge, and/or comfort have been published. Although investigators have designed their own evaluation tools, significant limitations exist [11, 12]. For example, Courtland designed the Pediatric QI Assessment Scenario, but noted that it only applies to a single scenario [11]. The Quality Improvement Knowledge Assessment Tool, or QIKAT, one of the best-known tools, was adapted to pediatrics by Glissmeyer but has low interrater reliability [14]. Doupnik et al. developed and validated the Assessment of Quality Improvement Knowledge and Skills (AQIKS), using the Model for Improvement framework and Glissmeyer's cases used for the pediatric QIKAT, to measure QI knowledge in pediatrics. When comparing second year residents who had completed a 1-year longitudinal QI course (both didactics and a project) to a control group of first-year residents who had not received any formal training, the second-year residents had a mean score 40% higher than baseline ($p < .001$). Importantly, this tool had higher interrater reliability among the three scorers than other currently published/validated tools (kappa = 0.74) [15].

Of note, measuring whether residents acquired knowledge at the end of a session does not necessarily correlate with the ability to maintain QI knowledge and skill. Techniques to assess long-term effects of QI educational programs need further study.

Innovation in QI education

Though there are few agreed-to standards for best practice in QI education, a few papers have recently begun to explore and publish novel concepts for incorporating this into the residency training.

The Mayo Clinic Internal Medicine Residency Program has validated the use of the "flipped classroom" model and demonstrated it to be superior to the non-flipped classroom. In a "flipped classroom" students review instructional content *prior* to class; they then devote class time to applying their newfound knowledge. Internal Medicine residents ($n = 143$) at Mayo Clinic participated in either a "flipped" or "nonflipped" QI curriculum; they were surveyed using the QIKAT before and after the course to measure both knowledge acquisition and perception changes. QI knowledge was significantly improved for those in the flipped vs the nonflipped course ($p < .0001$ for mean change in intervention group post-course vs no significant change for those in the control group) [16].

The University of Toronto used a "faculty-resident 'co-learning'" model that addresses the lack of faculty mentorship in QI, a common barrier. This curriculum not only trains residents successfully, but also, using a "train-the-trainer" model, contributes to building faculty capacity, sustaining the ability to continue to train residents. Over a period of 3 years, 56 faculty completed a year-long co-learning QI curriculum alongside residents that included pre-work, workshops, project work, and capstone project presentations. Half of these faculty, from 13 subspecialty residency programs, chose to continue as faculty mentors, and a quarter continued to teach QI courses for the program. The authors noted two distinct groups of faculty: those with QI experience who chose to participate in order to improve their teaching skills, and those with little to no exposure to QI who wanted to learn QI alongside the residents. Interestingly, faculty did not have concerns about learning along with residents: "One member explained by saying that 'medicine is a model of lifelong learning…if it's something new, why would you not all learn alongside?'" Unplanned outcomes such as QI teaching outside the curriculum, application of QI principles to other work, interdepartmental QI networking, and strengthening of one's QI professional role were other noted benefits. Though the residents were not interviewed, their evaluations of faculty (including the new faculty instructors) did not change over 4 years (range 4.6 to 4.9 on a 5-point Likert scale for all teachers, $p = .099$ for ANOVA comparison of overall teaching evaluations for all teachers), suggesting no detrimental effect to the quality of teaching once new faculty started teaching some of the QI classes. The curriculum successfully improved participant QI knowledge and skills and increased the number of faculty able to both mentor and teach QI [17].

At the University of Pennsylvania, 66 residents have matriculated to the "Healthcare Leadership in Quality" resident track. This is a multi-specialty 2-

year residency curriculum focused on quality improvement and patient safety. Residents are integrated into "Unit-Based Clinical Leadership" teams, composed of a physician and nurse lead, as well as a quality and safety manager, who work with the residents to complete a QI project. Most impressively, as of publication, all residents who had graduated from the track completed a capstone project (often in pairs), and all but three projects (out of 15) were presented at national meetings. Though only a small percentage of the various residency programs' residents are in this track, the authors surmise that the highly visible nature of the program enhances the culture of QI and benefits all residents indirectly [18].

Success factors and challenges

Strategies for and barriers to effective QI education have been identified in various studies. These include strong didactics, faculty mentorship, an experiential component including a project (ideally chosen by the student), time allotted for learning and project work, funding as applicable, program/ staff support, an institutional culture of QI, prioritization of QI by the institution and GME and resident interest [9•, 10•]. Moses suggests barriers to QI can be categorized into four domains: structure, commitment, expertise/resources, and culture [6].

The importance of culture and resident interest cannot be underestimated. In order to understand resident attitudes towards QI in general, Butler conducted four focus groups with 45 residents from three different residency programs (emergency medicine, neurology, and physical medicine/rehabilitation), querying about first impressions as well as general and project experiences around QI. Their results showed that, though residents view success within QI when they had strong mentorship, clear goals, and general stakeholder support, they often had difficulty understanding the QI vision, basic QI concepts, their role, and how to prioritize QI among other responsibilities. For example, many residents felt QI efforts disrupted patient care and that project goals opposed patient or provider care goals. They felt they did not understand the QI process well, were not informed about reasons for projects or results, and had difficulty getting data for their own projects. They expressed a sense of futility, felt "done-to," and did not feel their opinions were valued. They felt overworked and perceived QI work as a burden. Though there were no pediatric residents studied, and the article does not specifically address the format and content of QI learning in these residents' programs, as gleaned from this fairly in-depth methodology, the residents' opinions are clear, and there is room for improvement in shaping their vision of QI [19].

Recommendations for best practice

"5 dimensions of effective QI education programs" have been suggested to maximize active resident participation and QI learning: foundational

curricula to teach basic QI principles, strong faculty development to allow for solid teaching and role modeling, complete education for all residents including project experience, strategies to address the issue of time constraints, and evaluation of the effect of QI education on trainee competencies as well as clinical process and outcome measures [20••]. Regarding the foundational curricula and project experience, Mann very clearly and eloquently suggests a "clear set of expectations for QI curricula paired with a clear set of learning objectives" including "recommendations on content, design, support, and evaluation with flexibility for individual programs to adapt the recommendations" [9•].

Other specific recommendations include consideration of continuity clinic as a longitudinal curriculum site; adaptation of the American Board of Pediatrics Required Core Components of a Quality Improvement Project for use in residency QI training (thus requiring the use of standard components such as clear aim statements and data collection); and the need for partnership between GME leaders and quality and safety experts to develop "effective, replicable, and sustainable models that promote QI education being less episodic and more of an activity of daily learning" [5, 10•]. Moses also explicitly calls out the need to recognize the scholarship of quality improvement, for both trainees and faculty. The Association of Pediatric Program Directors added a fourth area for scholarly submission in the area of QI in 2009; many journals are dedicated to health care quality, and a number of non-QI journals now have added quality sections. By highlighting the scholarly aspect of QI, residents and faculty who may not have previously seen the benefit of QI may find some additional benefit to these training programs [6]. Moses also suggests that best practice must specifically incorporate a standard set of tools to be considered for teaching across different training programs, regardless of the improvement model embraced at various institutions (e.g., Lean, Six Sigma, Model for Improvement). Tools such as aim statements, run charts, pareto charts, and fishbone/cause-and-effect diagrams should be at least familiar to residents by the time they graduate residency.

Finally, though they were not specifically addressing QI educational curricula in their focus groups, Butler et al. suggest that, in order to obtain crucial resident buy-in, programs must address the hidden curriculum about QI by systematically explaining QI project goals and results, address any perception that QI is about cost-savings rather than care improvement, and widely share stories about successful quality improvement projects [19].

Conclusion

In order to cultivate a generation of practicing physicians who are able to provide high-quality care for their patients, pediatric training programs must create and disseminate best practices for QI education across institutions. Only

then are we truly embracing the spirit of improvement and working towards better outcomes for all.

Compliance with Ethical Standards

Conflict of Interest

Kristina Toncray declares that she has no conflict of interest.

Human and Animal Rights and Informed Consent

This article does not contain any studies with human or animal subjects performed by any of the authors.

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