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Competent for Unsupervised Practice: Use of Pediatric Residency Training Milestones to Assess Readiness

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Abstract

Purpose

To describe clinical skills progression during pediatric residency using the distribution of pediatric milestone assessments by subcompetency and year of training and to determine reasonable milestone expectations at time of graduation.

Method

Multi-institutional cohort study of the milestones reported to the Accreditation Council for Graduate Medical Education for all 21 pediatric subcompetencies. Most subcompetencies were measured using five milestone levels (1 = novice, 2 = advanced beginner, 3 = competent, 4 = proficient, 5 = master); 3 subcompetencies had only four levels defined.

Results

Milestone assessments for 2,030 pediatric residents in 47 programs during academic year 2013–2014 were obtained. There was significant variation in end-of-year milestone ratings for residents within each level of training, which decreased as training level increased. Most (78.9%; 434/550) graduating third-year pediatric residents received a milestone rating of ≥ 3 in all 21 subcompetencies; fewer (21.1%; 116/550) received a rating of ≥ 4 in all subcompetencies. Across all training levels, professionalism and interpersonal communication skills were rated highest; quality improvement was rated lowest.

Conclusions

Trainees entered residency with a wide range of skills. As they advanced, skill variability within a training level decreased. Most graduating pediatric residents were still advancing on the milestone continuum toward proficiency and mastery, and an expectation of milestone ratings ≥ 4 in all categories upon graduation is unrealistic; milestone ratings ≥ 3 upon graduation may be more realistic. Understanding current pediatric residents' and graduates' skills can help to identify key areas that should be specifically targeted during training.

The public now expects outcomes-based assurance of physician competence.[1,2] Graduation from residency may no longer be sufficient evidence to assure the public that a physician is competent to practice independently. As a first step in developing a standardized method for examining resident and fellow progression across training programs toward becoming independent practitioners, the Accreditation Council for Graduate Medical Education (ACGME) recently required that programs evaluate their trainees using Educational Milestones (milestones) beginning July 1, 2013.[3,4] The ACGME defines milestones as observable developmental levels of behavior organized under the six ACGME competency domains; milestones are competency-based developmental outcomes that can be demonstrated progressively by learners from the beginning of training through graduation to unsupervised practice.[4] The six ACGME competency domains are patient care (PC), medical knowledge (MK), interpersonal and communication skills (ICS), practice-based learning and improvement (PBLI), professionalism (Prof), and systems-based practice (SBP).

Each specialty worked with the ACGME and their relevant American Board of Medical Specialties to create specialty-specific frameworks for expressing their milestones.[4] The milestones for pediatrics were developed by a working group composed of pediatric educators and informed by the literature to describe the stages learners progress through for each competency.[5] The pediatric milestones intentionally span the continuum of medical education from novice, commensurate with an early medical student, to seasoned practicing pediatric expert.[6–8] For most competencies, five milestone levels were defined; however, for some competencies, the working group felt that there was not enough information in the literature to support the distinction between proficiency and mastery, and thus only four milestone levels were defined.[9,10]

When initially released, in the introduction to most specialty milestones, the ACGME stated that milestone level 4 is the graduation target, but not a requirement for graduation. Some disciplines define explicit benchmarking in their milestones; internal medicine benchmarks designate level 4 as "ready for unsupervised practice," and physical medicine and rehabilitation similarly designates level 4 as "graduation target."[11,12] Nevertheless, there is not universal agreement about how residents do or should progress along the milestones, even within specialties with explicit benchmarking.[13–16] In pediatrics, the milestones were intended to describe developmental progression without explicit benchmarks, with a plan as a community of educators to investigate the validity and reliability of milestones for formative feedback and summative evaluation. Thus, empirical evidence was

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posited to be the basis to standardize expectations for milestone achievement by pediatric residents across pediatric programs.[17] Currently, there are no published normative data for milestone ratings at each level of pediatric training. Our research seeks to provide data to help inform national discussions about pediatric milestone expectations at each level of training as residents progress toward unsupervised practice.

The specific aims of our study were to determine distribution of pediatric milestone ratings by subcompetency and level of training, and to determine reasonable milestone expectations at time of graduation from pediatric residency based on distribution of milestone scores of third-year pediatric residents. We hypothesized that because trainees enter residency with diverse backgrounds and experiences, they would similarly enter residency at various milestone levels for different competencies. Additionally, we hypothesized that residents would progress at different rates through the milestones, but that variability between learners would decrease as level of training increased.

Method

Data collection

We performed a prospective multi-institutional cohort study in academic year 2013–2014. Program directors were recruited at the 2013 Association of Pediatric Program Directors (APPD) annual spring meeting, as well as through the APPD Longitudinal Educational Assessment Research Network (LEARN) listserv. Program directors could choose to submit data midyear (December 2013–January 2014), end of year (June–July 2014), or both. These time periods were chosen to correspond with the ACGME milestone reporting periods.

Program directors completed a survey on program demographic information and submitted a standardized spreadsheet with deidentified resident demographic information and subcompetency milestone ratings. If program directors completed the survey more than once, we used data from the most recently completed survey in the analysis. Program demographics were program size (small [≤ 30 residents], medium [31–60 residents], large [≥ 61 residents]) and program region (Northeast, Midwest, South, West). Resident demographics were gender; degree type (MD, DO, other); medical school (U.S. medical graduate, international medical graduate [IMG]); type of pediatric training (categorical, combined); and level of training (postgraduate year [PGY] 1, PGY2, PGY3). For the purposes of this study, we used only data from categorical pediatric residents, as residents from combined pediatric programs (e.g., medicine–pediatrics) may have had a variable number of months of training in pediatrics at different PGYs, and it may have been more difficult to compare their milestone ratings across level of training. Program directors were required to report milestone ratings (1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5) for each resident for each of the 21 subcompetencies required by the ACGME. In 3 pediatric subcompetencies (PC4—transfer of care, SBP1—coordinate care, and SBP3—teamwork), the maximum milestone score is 4. How residents were assessed to arrive at milestone ratings was left to the discretion of each institution's program director and clinical competency committee. APPD LEARN subsequently encrypted the data set with a one-way cipher to further deidentify the data prior to analysis so that even the residents' own sites cannot reidentify the data.[18]

The institutional review boards at the University of California, Davis and each participating program approved this study.

Analysis

We compared program characteristics of enrolled study programs versus unenrolled programs nationally using the American Medical Association's Fellowship and Residency Electronic Interactive Database Web site.[19] We compared characteristics of study residents versus all residents nationally using National Resident Matching Program data of categorical pediatric residents from 2011 to 2014[20] and an American Board of Pediatrics survey of 95% of U.S. and Canadian pediatric residents from 2007.[21] We performed chi-square analyses in STATA/SE Version 12.1 statistical software (STATA Corporation, College Station, Texas). We performed all other analyses in SAS Version 9.4 statistical software (SAS Institute, Inc., Cary, North Carolina).

To understand relative difficulty in rating different subcompetencies, the percentage of milestone evaluations missing for each subcompetency was analyzed. Missing milestone evaluations comprise those subcompetencies for which program personnel did not report a milestone score for a resident, including those that programs identified as not yet assessable.

We then used descriptive statistics to summarize subcompetency milestone ratings for each level of training. We calculated total mean milestone rating for each resident by adding all subcompetency ratings for the resident and dividing by all nonmissing subcompetency ratings.

Results

A total of 47 pediatric residency programs (23.6%; 47/199 programs in the United States), representing 2,030 unique categorical residents, participated in the study. Compared with nonparticipating programs, study residency programs were similar in distribution of size (29.8% [14/47] small, 36.2% [17/47] medium, and 34.0% [16/47] large; $P = .09$) and program region (23.4% [11/47] Northeast, 27.7% [13/47] Midwest, 29.8% [14/47] South, 19.2% [9/47] West; $P = .30$). The demographic distribution of participants reflects those of all U.S. pediatric residents in terms of PGY distribution, degree type, and gender (Table 1).[20,21] The subgroup of residents with midyear data had fewer IMGs than national percentages (12.9% vs. 17.9%); however, our subgroup of residents with end-of-year data had a similar distribution of IMGs as national data (16.1% [277/1,717] vs. 17.9% [1,383/7,728]; $P = .14$).

Missing milestone ratings

The percentage of residents with missing milestone ratings decreased from midyear to end of year, but it did not differ by year of training. Midyear milestone ratings were missing for more than 10% of residents for quality improvement (QI) (PBLI3), professional conduct (Prof3), and advocacy for quality health care and patient care systems (advocacy; SBP2). By end of year, most subcompetencies had ≤ 1% missing milestone ratings, with the exceptions of QI (PBLI3) and advocacy (SBP2), which still had ≥ 5% missing.

Table 1

Demographic Characteristics of 2,030 Pediatric Residents and a National Comparison Sample, From a Multi-Institutional Study of Clinical Skills Progression by Pediatric Milestones, 2013–2014

Resident characteristic	No. (%) of all study residents (N = 2,030)	No. (%) of midyear study residents (n = 1,309)	No. (%) of end-of-year study residents (n = 1,717)	No. (%) of all pediatric residents nationally[a]	*P* value comparing all study residents with all pediatric residents
Gender					.93
Female	1,484 (73.1)	957 (73.1)	1,237 (72.0)	6,019 (73.0)	
Male	546 (26.9)	352 (26.9)	480 (28.0)	2,226 (27.0)	
Degree type[b]					.65
MD	1,828 (90.1)	1,167 (89.2)	1,558 (90.7)	6,733 (89.7)	
DO	192 (9.5)	136 (10.4)	154 (9.0)	773 (10.3)	
Other	10 (0.5)	6 (0.5)	5 (0.3)	N/A	
Medical school					.002
U.S. medical graduate	1,726 (85.1)	1,139 (87.1)	1,439 (83.9)	6,345 (82.1)	
International medical graduate	303 (14.9)	169 (12.9)	277 (16.1)	1,383 (17.9)	
Level of training[c]					.46
PGY1	680 (33.6)	443 (33.9)	572 (33.4)	2,757 (35.0)	
PGY2	686 (33.9)	447 (34.2)	580 (33.9)	2,616 (33.2)	
PGY3	658 (32.5)	417 (31.9)	559 (32.7)	2,488 (31.6)	

Abbreviation: PGY indicates postgraduate year.

[a]National data from the National Resident Matching Program from U.S. categorical pediatric resident postgraduate year 1 slots from 2011 to 2014 (degree type, international medical graduate [IMG], MD/DO),[21] and 2007 American Board of Pediatrics survey of all pediatric residents in the United States and Canada with a 95% response rate (gender).[22]

[b]One of all study residents was missing degree type. *P* value calculated comparing (MD + other)/DO overall versus MD/DO nationally because national data did not have an "other" category. "Other" degrees were MBBS, which were counted as MD in national data.

[c]Six of all study residents were missing level of training.

Subcompetency milestone distribution

Figure 1 shows a radar graph demonstrating end-of-year mean pediatric subcompetency scores for PGY1s, PGY2s, and PGY3s. The radar graphs for PGY1s, PGY2s, and PGY3s have similar patterns, with increase in mean resident milestone ratings by about 0.5 points for each additional year of training. Mean subcompetency scores for PGY1s were 2.5 to 3.1, for PGY2s were 3.1 to 3.6, and for PGY3s were 3.6 to 4.0. For all years, Prof and ICS were the highest-rated competencies, but PGY1s had a greater difference between PC and Prof/ICS scores than PGY3s.

Figure 2 shows that although there was significant variation in end-of-year milestone ratings for residents within each level of training, variation of milestone ratings across subcompetencies decreased as level of training increased. The milestone ranges for the middle 90% (excluding the top 5% and bottom 5%) of residents were 1.5 to 4.0 for PGY1s, 2.0 to 4.5 for PGY2s, and 3.0 to 4.5 for PGY3s. Although milestone scores for residents at the 95th percentile only differed by 0.5 between PGY1 (4.0) and PGY3 (4.5), scores for residents at the 5th percentile differed by 1.5 (1.5–3.0) for the same time period. Thus, the gap in milestone scores between lower-performing and higher-performing residents narrowed during residency training.

Table 2 shows the milestone ratings received by pediatric residents by level of training for the 5th, 25th, 50th, 75th, and 95th percentiles of pediatric residents. Table 2 shows that for most subcompetencies, the majority (> 75%) of PGY1s receive similar or higher milestone ratings than the lowest 5% of pediatric PGY2s. Similarly, for all subcompetencies except QI (PBLI3), > 75% of PGY2s receive similar or higher milestone ratings than the lowest 5% of pediatric PGY3s. The 5th percentile milestone rating for end-of-year PGY1s was 1.5 for learning activities (PBLI2) and advocacy (SBP2) and ≥ 2.0 for the other subcompetencies. The 25th percentile for PGY1s was 2.0 to 2.5 for most subcompetencies and 3.0 for humanism (Prof1) and professionalization (Prof2). The 50th percentile for PGY1s was 2.5 for 8 subcompetencies (most PC, MK, PBLI, and SBP subcompetencies) and 3.0 for 13 subcompetencies (all ICS and Prof subcompetencies except Prof6 [accept ambiguity], SBP3 [teamwork], PBLI1 [identify limits], PBLI4 [incorporate feedback], PC3 [transfer of care], and PC5 [develop management plans]).

For PGY2s, the lowest-scoring competencies were PBLI2 (learning activities), PBLI3 (QI), and SBP2 (advocacy), with 5th, 25th, and 50th percentiles of 2.0, 2.5, and 3.0, respectively. The 5th, 25th, and 50th percentiles for the remaining competencies were 2.5, 3, and 3.5, respectively.

For PGY3s, the 5th percentile for all subcompetencies was 3.0. For PGY3s, PBLI3 (QI) scored lower than the other subcompetencies, with 25th and 50th percentiles of 3.0 and 3.5. For the remaining subcompetencies, the 25th and 50th percentiles for PGY3s were 3.5 and 4.0, respectively. It was uncommon for end-of-year PGY3s to be rated a 4 in every subcompetency (21.1%; 116/550), even when only examining subcompetencies with a five-point milestone scale (24.0%; 132/550). Fewer than half (45.8%) of PGY3s received ≥ 3.5 in every subcompetency. Most (79.1%) PGY3s received milestone ratings ≥ 3 on every subcompetency. Table 3 provides the milestone descriptors for level 3 for each subcompetency.

Discussion

Trainees enter residency with a wide variety of skills, yet by the end all should leave as competent physicians who are ready for unsupervised practice. This large cohort study with over 2,000 unique residents, representing almost a quarter of all pediatric residency programs nationally, describes the progression of competence defined by milestone assessments during pediatric residency training. We found that only 22% of

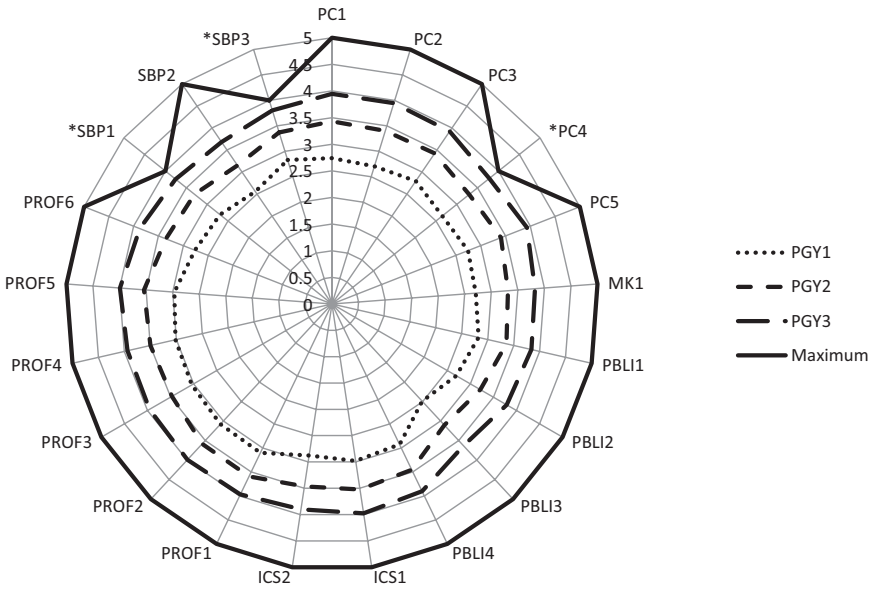

Figure 1 Radar graph of mean subcompetency milestones for pediatric residents at end of year for each level of training, from a multi-institutional study of clinical skills progression by pediatric milestones, 2013–2014.
*These subcompetencies have only four milestone levels.
Abbreviations: PC indicates patient care; MK, medical knowledge; PBLI, practice-based learning and improvement; ICS, interpersonal and communication skills; Prof, professionalism; SBP, systems-based practice; PGY, postgraduate year.

graduating pediatric residents scored a 4 or above on all subcompetencies. This indicates that achievement of all 4s should not be an expectation for graduation from pediatric residency. The milestones written for pediatrics intentionally span the continuum of medical education. Level 5 narratives describe masters, and level 4 describes mastery/proficient behaviors for the three subcompetencies with only four milestone levels, so it is not surprising that pediatricians do not attain these levels until they are in practice. The current minimum milestone levels identified by this study for 79% of pediatric residents at the end of their final year of training (PGY3) were 3.0.

Our finding that approximately 80% of pediatric residents attained a milestone score of 3.0 (competent) or higher at the end of their final year of training suggests that the development from competent to proficient and then to expert may require additional deliberate practice beyond residency. The finding that approximately 80% of pediatric residents attained a milestone score of 3.0 rather than 4.0 or 5.0 suggests that milestone assessments support less grade inflation compared with traditional Likert-type assessments. This finding is supported by previous studies, which have shown that milestone-based assessments are better able to illustrate trainee progression compared with traditional Likert-type assessments, where trainees often uniformly receive high ratings.[22–24]

The milestones offer the medical community the opportunity to determine what level of competency is needed for independent practice. For pediatrics, 80% of participating graduating pediatric residents score level 3 (competent) or higher. If the minimum goal for unsupervised practice is not competent (level 3), but proficient (level 4) or higher, then residency must allow for individualized deliberate practice on subcompetencies so that residents may benefit from effective feedback from experienced faculty.[25,26] This may require more flexibility during residency for individualized, non-rotation-based training. This may also be true for practicing physicians—that individualized, deliberate practice with feedback on how to improve may help practicing physicians continue to improve after graduation, and advance, rather than decline, in their quality of care.[27]

Pediatric residency programs can compare their residents' milestones with the large national data set reported in our study for the purposes of setting learning goals and providing additional learning experiences. Our findings suggest that early in training there are greater gaps between lower- and higher-performing residents and between lower- and higher-scored competencies. As training progresses, these gaps narrow, so that by the end of residency training, performance between residents and across competencies is more uniform. Residents receiving the lowest 5% milestone scores, particularly if those milestone scores are achieved by the vast majority (> 75%) of residents from a lower level of training in the same institution, may suggest the need for more intensive intervention or remediation to help those lowest-performing residents. Overall, residents received higher milestone scores in Prof and ICS than in other areas over the three years of training. This is consistent with previous studies demonstrating that pediatric residents self-assess their Prof and ICS competency areas as highest.[28] Higher milestone scores in Prof and ICS may be due to trainees entering residency with more advanced Prof and ICS skills. Alternatively, it is possible that Prof and ICS are not well assessed during residency, potentially due to few direct observations, which could lead to assumed higher competency in these areas than would be actually demonstrated if these skills were directly observed.

Graduating residents had lowest milestone ratings for PBLI3 (QI). This subcompetency also had the most missing milestone scores across years of training. Together, these findings suggest that QI skills develop later in training and may also be more difficult to assess in the context of required rotations. There has recently been improved recognition of the importance of QI in producing health care providers that can meet the 2014 Institute of Medicine "triple aim" of health: to improve individual patient care, improve the health of populations, and reduce per capita costs of care.[1] QI is now an integral component of clinical learning environment reviews performed by the ACGME.[29] In addition, the American Board of Medical Specialties' current standards for maintenance of certification require some participation in QI activities for diplomates in all specialties.[30] In a recent survey, pediatric program directors reported that the most critical aspects of successful QI education included residents doing actual projects and involvement of faculty with QI expertise.

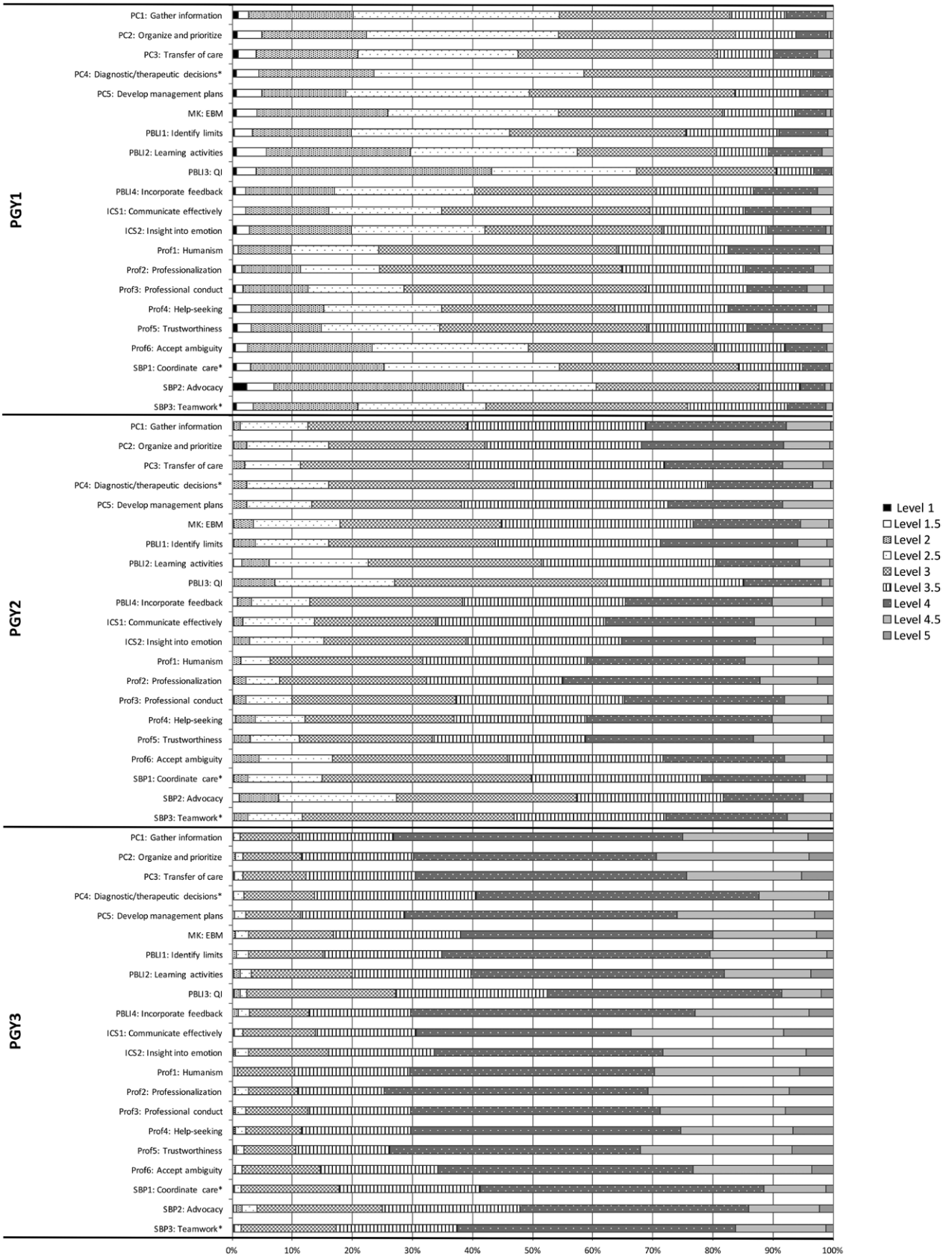

Figure 2 End-of-year milestone assessments by level of pediatric resident training, from a multi-institutional study of clinical skills progression by pediatric milestones, 2013–2014.

*These subcompetencies have only four milestone levels.

Abbreviations: PC indicates patient care; MK, medical knowledge; PBLI, practice-based learning and improvement; ICS, interpersonal and communication skills; Prof, professionalism; SBP, systems-based practice; PGY, postgraduate year; EBM, evidence-based medicine; QI, quality improvement.

Table 2

End-of-Year Milestone Assessments by Level of Training for the 5th, 25th, 50th, 75th, and 95th Percentiles of Pediatric Residents, From a Multi-Institutional Study of Clinical Skills Progression by Pediatric Milestones, 2013–2014

	PGY1					PGY2					PGY3				
Subcompetency	**5%**	**25%**	**50%**	**75%**	**95%**	**5%**	**25%**	**50%**	**75%**	**95%**	**5%**	**25%**	**50%**	**75%**	**95%**
PC1: Gather essential and accurate information about the patient	2.0	2.5	2.5	3.0	4.0	2.5	3.0	3.5	4.0	4.5	3.0	3.5	4.0	4.5	4.5
PC2: Organize and prioritize responsibilities to provide patient care that is safe, effective, and efficient	2.0	2.5	2.5	3.0	4.0	2.5	3.0	3.5	4.0	4.5	3.0	3.5	4.0	4.5	4.5
PC3: Provide transfer of care that ensures seamless transitions	2.0	2.5	3.0	3.0	4.0	2.5	3.0	3.5	4.0	4.5	3.0	3.5	4.0	4.0	5.0
PC4[a]: Make informed diagnostic and therapeutic decisions that result in optimal clinical judgment	2.0	2.5	2.5	3.0	4.0	2.5	3.0	3.5	3.5	4.0	3.0	3.5	4.0	4.0	4.5
PC5: Develop and carry out management plans	2.0	2.5	3.0	3.0	4.0	2.5	3.0	3.5	4.0	4.5	3.0	3.5	4.0	4.5	4.5
MK: Locate, appraise, and assimilate evidence from scientific studies related to their patients' health problems	2.0	2.0	2.5	3.0	4.0	2.5	3.0	3.5	3.5	4.5	3.0	3.5	4.0	4.0	4.5
PBLI1: Identify strengths, deficiencies, and limits in one's knowledge and expertise	2.0	2.5	3.0	3.0	4.0	2.5	3.0	3.5	4.0	4.5	3.0	3.5	4.0	4.0	4.5
PBLI2: Identify and perform learning activities to guide personal and professional development	1.5	2.0	2.5	3.0	4.0	2.0	3.0	3.0	3.5	4.5	3.0	3.5	4.0	4.0	4.5
PBLI3: Systematically analyze practice using quality improvement methods, and implement changes with the goal of practice improvement	2.0	2.0	2.5	3.0	4.0	2.0	2.5	3.0	3.5	4.0	3.0	3.0	3.5	4.0	4.5
PBLI4: Incorporate formative evaluation feedback into daily practice	2.0	2.5	3.0	3.5	4.0	2.5	3.0	3.5	4.0	4.5	3.0	3.5	4.0	4.0	4.5
ICS1: Communicate effectively with patients, families, and the public, as appropriate, across a broad range of socioeconomic and cultural backgrounds	2.0	2.5	3.0	3.5	4.0	2.5	3.0	3.5	4.0	4.5	3.0	3.5	4.0	4.5	5.0
ICS2: Demonstrate the insight into emotion and human response to emotion that allows one to appropriately develop and manage human interactions	2.0	2.5	3.0	3.5	4.0	2.5	3.0	3.5	4.0	4.5	3.0	3.5	4.0	4.5	4.5
Prof1: Humanism, compassion, integrity, and respect for others; based on the characteristics of an empathetic practitioner	2.0	3.0	3.0	3.5	4.0	2.5	3.0	3.5	4.0	4.5	3.0	3.5	4.0	4.5	5.0
Prof2: Professionalization: A sense of duty and accountability to patients, society, and the profession	2.0	3.0	3.0	3.5	4.0	2.5	3.0	3.5	4.0	4.5	3.0	3.5	4.0	4.5	5.0
Prof3: Professional conduct: High standards of ethical behavior which includes maintaining appropriate professional boundaries	2.0	2.5	3.0	3.5	4.0	2.5	3.0	3.5	4.0	4.5	3.0	3.5	4.0	4.5	5.0
Prof4: Self-awareness of one's own knowledge, skill, and emotional limitations that lead to appropriate help-seeking behaviors	2.0	2.5	3.0	3.5	4.0	2.5	3.0	3.5	4.0	4.5	3.0	3.5	4.0	4.5	5.0
Prof5: Trustworthiness that makes colleagues feel secure when one is responsible for the care of patients	2.0	2.5	3.0	3.5	4.0	2.5	3.0	3.5	4.0	4.5	3.0	3.5	4.0	4.5	5.0
Prof6: The capacity to accept that ambiguity is part of clinical medicine and to recognize the need for and to utilize appropriate resources in dealing with uncertainty	2.0	2.0	2.5	3.0	4.0	2.5	3.0	3.5	4.0	4.5	3.0	3.5	4.0	4.0	4.5
SBP1[a]: Coordinate patient care within the health care system relevant to their clinical specialty	2.0	2.0	2.5	3.0	4.0	2.5	3.0	3.5	3.5	4.0	3.0	3.5	4.0	4.0	4.5
SBP2: Advocate for quality patient care and optimal patient care systems	1.5	2.0	2.5	3.0	4.0	2.0	2.5	3.0	3.5	4.0	3.0	3.5	4.0	4.0	4.5
SBP3[a]: Work in interprofessional teams to enhance patient safety and improve patient care quality	2.0	2.5	3.0	3.0	4.0	2.5	3.0	3.5	4.0	4.5	3.0	3.5	4.0	4.0	4.5

Abbreviations: PC indicates patient care; MK, medical knowledge; PBLI, practice-based learning and improvement; ICS, interpersonal and communication skills; Prof, professionalism; SBP, systems-based practice; PGY, postgraduate year.
[a]These subcompetencies have only four milestone levels.

Table 3

Level 3 (Competent) Milestone Ratings Achieved by 79% of All Graduating Pediatric Residents, From a Multi-Institutional Study of Clinical Skills Progression by Pediatric Milestones, 2013–2014

Subcompetency	Level 3 (competent) summary of milestone rating descriptor
PC1: Gather essential and accurate information about the patient	Data gathering is driven early in the process by real-time development of differential diagnosis using illness scripts.
PC2: Organize and prioritize responsibilities to provide patient care that is safe, effective, and efficient	Almost always organizes the simultaneous care of many patients with efficiency, despite interruptions, proactively anticipating future needs.
PC3: Provide transfer of care that ensures seamless transitions	Adapts and applies a standardized handover template, relevant to individual contexts, reliably and reproducibly. Begins to anticipate potential issues for the transferee.
PC4[a]: Make informed diagnostic and therapeutic decisions that result in optimal clinical judgment	Develops a focused differential diagnosis and management plan.
PC5: Develop and carry out management plans	Develops and carries out management plans using both knowledge and experience, effectively focusing on key information. Begins to incorporate patients' assumptions and values into plans.
MK: Locate, appraise, and assimilate evidence from scientific studies related to their patients' health problems	Identifies knowledge gaps, asks answerable clinical questions, critically appraises a topic by analyzing the major outcomes, and applies evidence to practice.
PBLI1: Identify strengths, deficiencies, and limits in one's knowledge and expertise	Personal performance improvement is self-motivated. Actively questions and applies knowledge in developing care plans or in teaching activities.
PBLI2: Identify and perform learning activities to guide personal and professional development	Seeks learning resources based on learning needs, goals, and nature of learning content and method.
PBLI3: Systematically analyze practice using quality improvement methods, and implement changes with the goal of practice improvement	Gains insight for quality improvement needs from individual encounters and population data. Participates in quality improvement activities.
PBLI4: Incorporate formative evaluation feedback into daily practice	Understands others' points of view and changes behavior to improve specific deficiencies that are noted by others.
ICS1: Communicate effectively with patients, families, and the public, as appropriate, across a broad range of socioeconomic and cultural backgrounds	Effectively establishes rapport. Mitigates physical, cultural, psychological, and social barriers in most situations.
ICS2: Demonstrate the insight into emotion and human response to emotion that allows one to appropriately develop and manage human interactions	Anticipates, reads, and reacts to emotions in real time. Gains and maintains therapeutic alliances with others.
Prof1: Humanism, compassion, integrity, and respect for others; based on the characteristics of an empathetic practitioner	Understands and responds, with kindness and compassion, to patient- and family-expressed needs.
Prof2: Professionalization: A sense of duty and accountability to patients, society, and the profession	Appreciates the gravity of the professional role of "doctor." Fully engaged in patient care activities demonstrating a sense of duty.
Prof3: Professional conduct: High standards of ethical behavior which includes maintaining appropriate professional boundaries	Conducts interactions professionally, with a sense of duty and accountability, in nearly all circumstances.
Prof4: Self-awareness of one's own knowledge, skill, and emotional limitations that lead to appropriate help-seeking behaviors	Recognizes limitations and usually asks for help when needed.
Prof5: Trustworthiness that makes colleagues feel secure when one is responsible for the care of patients	Task follow-up and follow-through require little prompting.
Prof6: The capacity to accept that ambiguity is part of clinical medicine and to recognize the need for and to utilize appropriate resources in dealing with uncertainty	Anticipates and focuses on uncertainty, looking for resolution by seeking additional information.
SBP1[a]: Coordinate patient care within the health care system relevant to their clinical specialty	Assists families with navigation of the complex health care system. Frequently involves patient/family in decisions at all levels of care. Communicates well with team members and consultants, including during transition of care.
SBP2: Advocate for quality patient care and optimal patient care systems	Acts within the defined medical role to address an issue or problem that is confronting a cohort of patients.
SBP3[a]: Work in interprofessional teams to enhance patient safety and improve patient care quality	Excellent team player who recognizes the roles and value of other health care professionals, and seeks their input for appropriate issues.

Abbreviations: PC indicates patient care; MK, medical knowledge; PBLI, practice-based learning and improvement; ICS, interpersonal and communication skills; Prof, professionalism; SBP, systems-based practice.

[a]These subcompetencies have only four milestone levels.

Both factors, if included in curricula, may make assessment more accurate and feasible.[31,32] Because QI methodology has only recently been integrated into medical education, few faculty have QI expertise. Therefore, faculty development is essential to increase both the depth and breadth of QI expertise so that faculty may effectively serve as role models and mentor residents in QI projects. Although most (88%) participating pediatric program directors reported having residents do QI projects, not all programs required that residents do so,[33] which would make it more difficult to assess residents' QI milestones. Pediatric residents may need more dedicated hands-on QI experience during residency if the goal is for practicing pediatricians to be able to lead QI projects. Furthermore, to effectively engage in meaningful QI activities, current graduates and pediatricians in practice may need additional QI training or mentorship while in practice.

Our study has several limitations. The intervals between milestone levels may not be uniform within or across competencies, making it difficult to synthesize and comparatively interpret milestone data. Furthermore, in pediatrics, three subcompetencies have only four milestone levels, whereas the rest have five. Our study was performed using information from categorical pediatric residents. Milestone evaluations from combined programs and other subspecialties might be different. It is possible that our data may not represent actual attainment of milestone levels by residents; evaluators may have expected graduating residents to perform higher than interns and so may have rated them higher even if their performance was equivalent (anchoring); or an evaluator's good impression of the resident in one subcompetency area may have influenced how he/she rated another subcompetency area (halo effect). In addition, our study was performed during the first year milestone reporting was required by the ACGME. It is possible that milestone evaluations for subsequent years may be different as programs gain more experience using milestones in assessing resident performance. However, one of the strengths of this study is that it was conducted in the first year milestones were required to be reported to the ACGME, before national discussions occurred about where residents should be when they graduate, a discussion which may create its own bias in future assessments.

Many of the key findings in this study are generalizable to other disciplines and highlight important next steps in milestones research. Milestones have not been validated with postgraduate performance, which would be an important step if they are to be used as graduation thresholds or to inform employers about graduates' skills. Even with explicit milestone descriptors, standardizing assessment practices and faculty development are essential to enable comparison of residents between training programs. Currently, APPD LEARN is working with the American Board of Pediatrics and the National Board of Medical Examiners to create a standardized set of assessment instruments for use across programs to create robust validity evidence for progression decisions.[34]

This study's large data set helps us to better understand the current development of competence in pediatric residency training. Understanding the skill sets of our current pediatric graduates can help with workforce planning and identifying key areas that should be better targeted during training. Pediatric program directors can compare their own residents' milestones against this national data set. The key findings from this study are likely to be generalizable to other disciplines. Trainees enter residency with a wide range of skills and thus a large range of milestone scores. In general, professionalism and communication competencies are present or develop earliest in training, clinical skills develop significantly during residency, and QI milestones remain lowest at graduation from residency. The milestone gap between lower- and higher-performing residents narrows throughout residency, so that by graduation milestone scores are more uniform across residents and competencies. The significant variation between programs in milestone progression highlights the need for more uniform approaches to assessment across programs. To inform workforce planning and postgraduate training, we must first agree on the thresholds for graduation from residency. On the basis of the milestones reported for graduating residents in this study, the current minimum milestone level for approximately 80% of graduating pediatric residents was 3.0 (competent).

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References

1 Institute of Medicine. Graduate medical education that meets the nation's health needs. 2014. www.nap.edu/read/18754/chapter/1. Accessed June 2, 2016.
2 National Academies of Sciences, Engineering, and Medicine. Improving diagnosis in health care. 2015. www.nap.edu/read/21794/chapter/1. Accessed June 2, 2016.
3 Nasca TJ, Philibert I, Brigham T, Flynn TC. The next GME accreditation system—rationale and benefits. N Engl J Med. 2012;366:1051–1056.
4 Accreditation Council for Graduate Medical Education. Milestones. 2015. http://www.acgme.org/acgmeweb/tabid/430/ProgramandInstitutionalAccreditation/NextAccreditationSystem/Milestones.aspx. Accessed June 2, 2016.
5 Carraccio C, Gusic M, Hicks P, eds. The Pediatric Milestones Project—competencies. Acad Pediatr. 2014;14(25 suppl):S13–S97.
6 Hicks PJ, Schumacher DJ, Benson BJ, et al. The pediatrics milestones: Conceptual framework, guiding principles, and approach to development. J Grad Med Educ. 2010;2:410–418.
7 Englander R, Hicks P, Benson B; Pediatric Milestone Project Working Group. Pediatrics milestones: A developmental approach to the competencies. J Pediatr. 2010;157:521–522.e1.
8 Englander R, Burke AE, Guralnick S, et al. The pediatrics milestones: A continuous quality improvement project is launched—now the hard work begins! Acad Pediatr. 2012;12:471–474.
9 Schumacher DJ, Englander R, Hicks PJ, Carraccio C, Guralnick S. Domain of competence: Patient care. Acad Pediatr. 2014;14(2 suppl):S13–S35.
10 Guralnick S, Ludwig S, Englander R. Domain of competence: Systems-based practice. Acad Pediatr. 2014;14(2 suppl):S70–S79.
11 Accreditation Council for Graduate Medical Education, American Board of Internal Medicine. The Internal Medicine Milestone Project. 2014. http://www.acgme.org/acgmeweb/Portals/0/PDFs/Milestones/InternalMedicineMilestones.pdf. Accessed June 2, 2016.
12 Accreditation Council for Graduate Medical Education, American Board of Physical Medicine and Rehabilitation. The Physical Medicine and Rehabilitation Milestone Project. 2015. https://www.acgme.org/acgmeweb/portals/0/pdfs/milestones/pmrmilestones.pdf. Accessed June 2, 2016.
13 Marhatta A, Messina D, Petrini JR, Lecaj A, Ahmadi R. Survey of developmental milestones in internal medicine among residents and faculty. Conn Med. 2014;78:293–298.
14 Ebert TJ, Fox CA. Competency-based education in anesthesiology: History and challenges. Anesthesiology. 2014;120:24–31.
15 Thomas CR. Introduction and commentary on the psychiatry milestones. Acad Psychiatry. 2014;38:253–254.
16 Smith CS, Hill W, Francovich C, et al. Developing a cultural consensus analysis based on the internal medicine milestones (M-CCA). J Grad Med Educ. 2011;3:246–248.
17 Hicks PJ, Englander R, Schumacher DJ, et al. Pediatrics milestone project: Next steps toward meaningful outcomes assessment. J Grad Med Educ. 2010;2:577–584.
18 Schwartz A, Young R, Hicks PJ. Medical education practice-based research networks: Facilitating collaborative research. Med Teach. 2014:1–11.
19 American Medical Association Fellowship and Residency Electronic Interactive Database. FREIDA Online. 2016. https://ama-assn.org/go/freida. Accessed June 2, 2016.
20 National Resident Matching Program. Results and data: 2014 Main Residency Match. 2015. http://www.nrmp.org/wp-content/uploads/2014/04/Main-Match-Results-and-Data-2014.pdf. Accessed June 2, 2016.
21 Freed GL, Dunham KM, Jones MD Jr, McGuinness GA, Althouse L; Research Advisory Committee of the American Board of Pediatrics. General pediatrics resident perspectives on training decisions and career choice. Pediatrics. 2009;123(suppl 1):S26–S30.
22 Bartlett KW, Whicker SA, Bookman J, et al. Milestone-based assessments are superior to Likert-type assessments in illustrating trainee progression. J Grad Med Educ. 2015;7:75–80.
23 Friedman KA, Balwan S, Cacace F, Katona K, Sunday S, Chaudhry S. Impact on house staff evaluation scores when changing from a Dreyfus- to a milestone-based evaluation model: One internal medicine residency program's findings. Med Educ Online. 2014;19:25185.
24 Kuo LE, Hoffman RL, Morris JB, et al. A milestone-based evaluation system—the cure for grade inflation? J Surg Educ. 2015;72:e218–e225.
25 Ericsson KA. Acquisition and maintenance of medical expertise: A perspective from the expert-performance approach with deliberate practice. Acad Med. 2015;90:1471–1486.
26 Hashimoto DA, Sirimanna P, Gomez ED, et al. Deliberate practice enhances quality of laparoscopic surgical performance in a randomized controlled trial: From arrested development to expert performance. Surg Endosc. 2015;29:3154–3162.
27 Choudhry NK, Fletcher RH, Soumerai SB. Systematic review: The relationship between clinical experience and quality of health care. Ann Intern Med. 2005;142:260–273.
28 Li ST, Tancredi DJ, Burke AE, et al. Self-assessment on the competencies and reported improvement priorities for pediatrics residents. J Grad Med Educ. 2012;4:445–453.
29 Weiss KB, Wagner R, Nasca TJ. Development, testing, and implementation of the ACGME Clinical Learning Environment Review (CLER) program. J Grad Med Educ. 2012;4:396–398.
30 American Board of Medical Subspecialties. Standards for the ABMS program for maintenance of certification (MOC) for implementation in January 2015. 2014. www.abms.org/media/1109/standards-for-the-abms-program-for-moc-final.pdf. Accessed June 2, 2016.
31 Craig MS, Garfunkel LC, Baldwin CD, et al. Pediatric resident education in quality improvement (QI): A national survey. Acad Pediatr. 2014;14:54–61.
32 Philibert I, Gonzalez Del Rey JA, Lannon C, Lieh-Lai M, Weiss KB. Quality improvement skills for pediatric residents: From lecture to implementation and sustainability. Acad Pediatr. 2014;14:40–46.
33 Mann KJ, Craig MS, Moses JM. Quality improvement educational practices in pediatric residency programs: Survey of pediatric program directors. Acad Pediatr. 2014;14:23–28.
34 Hicks PJ, Schwartz A, Clyman SG, Nichols DG. The pediatrics milestones: Pursuit of a national system of workplace-based assessment through key stakeholder collaboration. Acad Pediatr. 2014;14(2 suppl):S10–S12.