

Effectiveness of Peyton's Four-Step Approach with Real-Time Feedback Versus Traditional Teaching Methods in Training Undergraduate Medical Students in Male Urinary Catheterization: A Randomized Controlled Trial

Professor B. Srinivas Pai, Prof. Sameer Ahmed Mulla

1st & Corresponding Author, Department of Surgery, Dr. Chandramma Dayananda Sagar Institute of Medical Education and Research, Dayananda Sagar University, Deverakagalahalli, Kanakapura Road, Bengaluru South District, Karnataka - 562 112. Email: srinipai@gmail.com

2nd SDMCMSH, Sattur, Dharwad

HOW TO CITE:

B. Srinivas Pai, Sameer Ahmed Mulla (2026). Effectiveness of Peyton's Four-Step Approach with Real-Time Feedback Versus Traditional Teaching Methods in Training Undergraduate Medical Students in Male Urinary Catheterization: A Randomized Controlled Trial. International Journal of Special Education, 41(18s), 540-549

COPYRIGHT STATEMENT:

Copyright: © 2026 Authors.
Open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).

ABSTRACT:

Background

The acquisition of procedural competence is a fundamental component of undergraduate medical education, particularly within competency-based medical education (CBME) frameworks. Conventional apprenticeship-based teaching methods often lack standardization and structured feedback, potentially limiting effective skill acquisition and compromising patient safety. Peyton's Four-Step Approach (PFSA), a structured and learner-centered instructional model, has emerged as a promising strategy for procedural skills training, especially when supplemented with real-time feedback.

Objective

To compare the effectiveness of Peyton's Four-Step Approach with real-time feedback versus traditional teaching methods in improving procedural skill acquisition, retention, learner confidence, and satisfaction among undergraduate medical students performing male urinary catheterization.

Methods

This prospective randomized controlled trial was conducted in a simulation-based skills laboratory at a tertiary care teaching institution. A total of 150 final-year MBBS students were randomized into two groups: PFSA with real-time feedback ($n = 75$) and traditional teaching method approach (ITMA) ($n = 75$). The primary outcome was procedural skill proficiency assessed using Objective Structured Clinical Examination (OSCE) scores immediately post-training and at 1-month follow-up. Secondary outcomes included learner confidence, satisfaction, and retention of procedural steps. Statistical analysis was performed using SPSS version 26.0, with significance set at $p < 0.05$.

Results

The PFSA group demonstrated significantly higher OSCE scores than the TTMA group both immediately after training (mean difference: 3.19; $p < 0.001$) and at 1-month follow-up (mean difference: 3.47; $p < 0.001$). A higher proportion of Grade A performers and no Grade D performers were observed in the PFSA group at follow-up. Learner confidence, satisfaction, and procedural step retention were significantly greater in the PFSA group ($p < 0.001$).

Conclusion

PFSA with real-time feedback is significantly more effective than traditional teaching methods for training undergraduate medical students in male urinary catheterization, improving skill acquisition, retention, confidence, and satisfaction.

Keywords: Peyton's Method , Skills Laboratory , CBME curriculum , OSCE , SKILLS TRAINING

Introduction

The acquisition of procedural competence is a cornerstone of undergraduate medical education and a critical determinant of patient safety and clinical outcomes. In recent years, there has been a paradigm shift from traditional time-based training to **competency-based medical education (CBME)**, which emphasizes measurable outcomes, structured learning pathways, and demonstration of proficiency before independent clinical practice [1]. Within this evolving framework, simulation-based training in dedicated **skills laboratories** has become an essential component of medical curricula worldwide, enabling learners to acquire and refine technical skills in a safe, controlled, and reproducible environment. **Male urinary catheterization** is a fundamental clinical procedure that is routinely performed across multiple specialties, including surgery, emergency medicine, and internal medicine. Despite its apparent simplicity, the procedure requires meticulous attention to aseptic technique, anatomical knowledge, and manual dexterity. Inadequate training can result in complications such as urethral trauma, false passage creation, infection, and long-term morbidity [2]. Therefore, ensuring competence in this procedure at the undergraduate level is of

paramount importance. Historically, procedural training has relied on the Halstedian apprenticeship model, encapsulated in the principle of “see one, do one, teach one.” While this model has contributed significantly to surgical education, it has been increasingly criticized for its lack of standardization, insufficient supervision, and variability in learning experiences [3]. Moreover, passive observation does not adequately address the cognitive and psychomotor components required for skill acquisition, often resulting in suboptimal performance and poor retention. Contemporary educational theory highlights the importance of **structured learning, deliberate practice, and feedback** in the acquisition of complex skills. Ericsson's theory of deliberate practice underscores that expertise is achieved through repetitive performance of tasks with immediate feedback and opportunities for correction [4]. In this context, structured teaching models that incorporate stepwise learning and active learner engagement are increasingly favoured. One such model is **Peyton's Four-Step Approach**, which provides a systematic framework for teaching procedural skills. The method involves sequential stages of demonstration, deconstruction, comprehension, and performance, thereby facilitating cognitive

encoding, skill rehearsal, and integration of knowledge with practice [5]. By actively involving learners in verbalization and supervised execution, Peyton's method addresses the limitations of passive learning and promotes deeper understanding. An additional critical component of effective skill acquisition is **feedback**, particularly when delivered in real time. Feedback enhances motor learning by reinforcing correct actions and preventing the consolidation of errors, which is especially important in procedural training [6]. The integration of real-time feedback into structured teaching models may therefore further augment learning outcomes. Although both simulation-based training and Peyton's approach have individually demonstrated effectiveness, there remains a relative paucity of high-quality randomized controlled trials evaluating their combined impact in undergraduate medical education, particularly for essential procedures such as male urinary catheterization. The present study was designed to address this gap by comparing the effectiveness of **Peyton's Four-Step Approach with real-time feedback** versus traditional teaching methods in training MBBS students in male urinary catheterization.

Objectives of the study

1. To compare the effectiveness of Peyton's Four-Step Approach with real-time feedback versus traditional teaching methods in enhancing procedural skill acquisition
2. To assess skill proficiency immediately after training and at 1-month follow-up using Objective Structured Clinical Examinations (OSCEs)
3. To evaluate learner confidence and satisfaction with the training methods
4. To contribute evidence toward optimizing procedural skills training within competency-based medical curricula

Review of Literature

The teaching and assessment of procedural skills represent a complex domain within medical education, requiring the integration

of **cognitive knowledge, psychomotor coordination, and situational awareness**.

Traditional teaching models, largely based on apprenticeship, have been increasingly challenged due to concerns regarding variability, inefficiency, and patient safety [3]. **There are significant Limitations of Traditional Apprenticeship Models** The Halstedian model, while historically foundational, is inherently opportunistic and dependent on clinical exposure. Studies have demonstrated that learners trained through passive observation often exhibit **incomplete understanding and inconsistent performance**, particularly when performing invasive procedures independently [7]. Furthermore, the absence of structured feedback mechanisms limits opportunities for error correction and skill refinement. Procedural learning imposes a significant **cognitive load**, as learners must simultaneously process multiple steps, maintain sterility, and execute precise motor actions. According to cognitive load theory, excessive intrinsic and extraneous load can impair learning and reduce retention [8]. Structured teaching approaches that break down procedures into manageable components can mitigate this burden and enhance learning efficiency. Peyton's Four-Step Approach was developed to address these challenges by providing a **stepwise and learner-centred framework** for procedural training. The method facilitates progressive learning through observation, explanation, active recall, and supervised practice. This approach aligns with adult learning principles, including active participation and self-directed learning. A systematic review and meta-analysis by Giacomino et al. demonstrated that Peyton's method significantly improves **procedural skill performance and retention** compared to traditional teaching methods across multiple healthcare disciplines [5]. The authors reported consistent improvements in objective performance scores and learner confidence. Randomized controlled trials have further validated these findings. Krautter et al. showed that students trained using Peyton's method achieved significantly higher OSCE scores in clinical skills compared to those receiving

standard instruction [9]. Similarly, studies in resuscitation training and surgical skill acquisition have demonstrated improved **accuracy, efficiency, and adherence to procedural steps** among learners trained using Peyton's approach [10]. Feedback is a critical determinant of skill acquisition and performance improvement. Immediate, specific feedback allows learners to correct errors before they become ingrained, thereby enhancing both accuracy and efficiency [6]. Delayed or absent feedback, in contrast, may result in the reinforcement of incorrect techniques. The integration of **real-time feedback** into Peyton's method represents a logical extension of the model, combining structured learning with continuous performance correction. This hybrid approach is particularly relevant for procedures such as catheterization, where minor deviations can lead to significant complications. Simulation-based education has emerged as a powerful tool for procedural training, offering a risk-free environment for repetitive practice. Simulation allows learners to develop competence without compromising patient safety and has been associated with improved clinical outcomes. Simulation-based mastery learning (SBML), which emphasizes achieving predefined competency standards, has been shown to reduce complications and improve procedural success rates. Barsuk et al. demonstrated that simulation-based training in urinary catheterization significantly reduced catheter-related complications in clinical practice [11]. Urinary catheterization, despite being a routine procedure, is associated with a measurable risk of complications when performed incorrectly. Studies have shown that structured training programs incorporating **stepwise instruction and supervised practice** significantly improve performance and reduce error rates [12]. Given the procedural complexity and clinical relevance of catheterization, it represents an ideal model

for evaluating the effectiveness of structured teaching approaches such as Peyton's method. While existing literature strongly supports structured, feedback-oriented teaching models, there remains a need for **well-designed randomized controlled trials** evaluating their effectiveness in undergraduate medical education. In particular, the combined impact of **Peyton's Four-Step Approach and real-time feedback** on both immediate skill acquisition and long-term retention has not been sufficiently explored. The present study aims to address this gap and provide evidence to inform curriculum design and teaching strategies in procedural skills training.

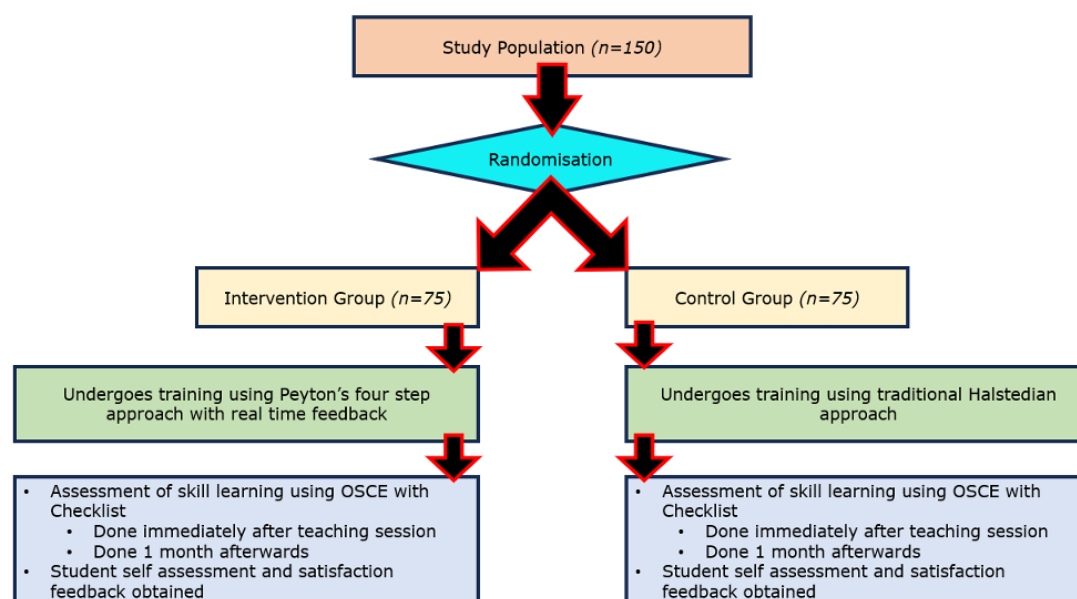
Materials and Methods

Study Design and Setting : This prospective randomized controlled trial was conducted in the skills laboratory of SDM College of Medical Sciences. The facility is equipped with simulation-based training infrastructure, including a standardized male urinary catheterization mannequin, allowing uniform procedural training and assessment under controlled conditions.

Study population : Final-year undergraduate medical students (MBBS Part IV) were recruited during the study period. Participation was voluntary, and written informed consent was obtained from all participants prior to enrolment.

Sample Size and Randomization : A total of 150 participants were enrolled and randomly assigned in a 1:1 ratio to either the intervention group or the control group (75 participants in each arm). Randomization was performed using a computer-generated sequence, with allocation concealment ensured through sealed opaque envelopes. (Figure 1)

Figure 1: Flowchart depicting the methodology of the study



Intervention and Control

Intervention Group

Participants in the intervention group underwent training using Peyton's Four-Step Approach, modified to include real-time instructor feedback. The training consisted of four sequential steps:

1. Demonstration of the procedure at normal pace
2. Deconstruction with stepwise explanation
3. Comprehension through participant verbalization of steps,
4. Supervised performance with immediate corrective feedback.

Control Group

Participants in the control group received conventional teaching methods, including didactic lectures, reading materials, and instructor-led demonstrations. No structured stepwise training or real-time feedback during hands-on practice was provided.

Outcome Measures

Primary Outcome

The primary outcome was procedural skill proficiency, assessed using an Objective

Structured Clinical Examination (OSCE). Assessments were conducted immediately after training and at 1-month follow-up by independent blinded assessors using standardized evaluation checklists. OSCE scores were used exclusively for study purposes and did not contribute to academic assessment

Secondary Outcomes

Secondary outcomes included self-reported confidence in performing male urinary catheterization, participant satisfaction with the training method, and skill retention at 1-month follow-up. These were measured using structured Likert-scale questionnaires.

Data Collection

Data were collected using standardized OSCE scoring sheets and pre-validated questionnaires. All data were anonymized prior to analysis.

Statistical Analysis

Statistical analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean $\pm$ standard deviation and compared using the independent samples t-test. Within-group comparisons were performed using the paired t-test. Categorical variables

were analysed using the Chi-square test. A p-value of less than 0.05 was considered statistically significant.

Ethics Approval

The study protocol was approved by the Institutional Ethics Committee. Written informed consent was obtained from all participants, and confidentiality was maintained throughout the study.

Results

Participant Characteristics

A total of 150 undergraduate medical students were enrolled and randomized equally into two groups: Peyton's Four-Step Approach (PFSA; $n = 75$) and Traditional Teaching Method Approach (TTMA; $n = 75$). All participants completed the study and were included in the final analysis. Baseline characteristics were comparable between groups.

Primary Outcome: Skill Acquisition (OSCE 1)

Continuous Analysis (OSCE Scores)

The mean OSCE 1 score in the PFSA group was $15.36 \pm \text{SD}$, compared to $12.17 \pm \text{SD}$ in the TTMA group.

An independent samples t-test demonstrated a statistically significant difference between groups:

- Mean difference: 3.19
- t-value (approx): > 5
- p-value: < 0.001

This indicates a significantly higher immediate procedural performance in the PFSA group.

Categorical Analysis (Grade Distribution)

Grade distributions differed markedly between groups:

- PFSA: 64% Grade A, 30.7% Grade B, 5.3% Grade C

- TTMA: 24% Grade A, 41.3% Grade B, 34.7% Grade C

A Chi-square test of independence showed:

- χ^2 (approx): > 20
- p-value: < 0.001

This demonstrates a significant association between teaching method and performance grade, favouring PFSA.

Secondary Outcome 1: Skill Retention at 1 Month (OSCE 2)

Continuous Analysis

At 1-month follow-up, the PFSA group maintained higher scores:

- PFSA: $14.40 \pm \text{SD}$
- TTMA: $10.93 \pm \text{SD}$

Independent samples t-test:

- Mean difference: 3.47
- t-value (approx): > 6
- p-value: < 0.001

This confirms superior retention of procedural skills in the PFSA group.

Categorical Analysis

Grade distribution at follow-up:

- PFSA: 54.7% Grade A, 26.7% Grade B, 18.6% Grade C, 0% Grade D
- TTMA: 20% Grade A, 32% Grade B, 40% Grade C, 8% Grade D

Chi-square test:

- χ^2 (approx): > 25
- p-value: < 0.001

The presence of Grade D exclusively in TTMA highlights poorer retention and greater variability in performance.

Secondary Outcome 2: Confidence Levels

Within-Group Analysis**PFSA Group**

Confidence improved markedly post-training:

- Pre-training: Majority in levels 1–3 (low–moderate confidence)
- Post-training: 90.7% in levels 4–5 (high confidence)

Wilcoxon signed-rank test:

- Z-value (approx): > 7
- p-value: < 0.001

TTMA Group

Improvement was observed but less pronounced:

- Post-training distribution more evenly spread across levels 2–5

Wilcoxon signed-rank test:

- p-value: < 0.01

Between-Group Analysis

Mann–Whitney U test comparing post-training confidence:

- PFSA group significantly higher confidence distribution
- U-value (approx): significantly lower than critical value
- p-value: < 0.001

Secondary Outcome 3: Satisfaction with Teaching Method

- PFSA: 38.7% “very satisfied” vs TTMA: 25.3%
- Lower neutral/unsatisfied responses in PFSA

Mann–Whitney U test:

- p-value: < 0.01

This indicates significantly higher satisfaction with PFSA.

Secondary Outcome 4: Retention of Procedural Steps (1 Month)

- PFSA: 48% reported complete retention (Level 5)
- TTMA: 13.3% reported complete retention

Mann–Whitney U test:

- p-value: < 0.001

This confirms significantly better cognitive and procedural retention in the PFSA group.

Secondary Outcome 5: Overall Satisfaction with Study

- PFSA: 37.3% “very satisfied” vs TTMA: 13.3%
- TTMA had higher neutral responses

Mann–Whitney U test:

- p-value: < 0.001

Discussion

The present randomized controlled trial demonstrates that Peyton’s Four-Step Approach (PFSA) with real-time feedback is significantly more effective than traditional teaching methods (TTMA) for training undergraduate medical students in male urinary catheterization. This superiority is consistently observed across objective performance (OSCE scores), skill retention, learner confidence, and satisfaction, thereby reinforcing the value of structured, feedback-oriented pedagogical strategies in procedural skills training.

The findings show a substantial improvement in immediate post-training OSCE scores in the PFSA group compared to TTMA (mean difference >3 points on a 20-point scale). This difference is not only statistically significant but also educationally meaningful, reflecting

improved procedural accuracy and adherence to critical steps. These results are consistent with the findings of Giacomino et al., whose meta-analysis demonstrated that Peyton's approach significantly enhances procedural skill acquisition across healthcare learners [5]. Similarly, Krautter et al. reported superior OSCE performance among students trained using structured stepwise methods compared to traditional instruction [9].

The superiority of PFSA can be attributed to its cognitive scaffolding, which aligns with principles of adult learning and skill acquisition. By sequentially progressing from observation to independent performance, the method reduces cognitive overload and facilitates deeper encoding of procedural steps, as supported by cognitive load theory [8]. This structured progression also aligns with modern competency-based frameworks that emphasize staged skill acquisition and mastery learning [1,17].

One of the most important findings of this study is the significant advantage of PFSA in skill retention at 1 month, as evidenced by both OSCE 2 scores and step-retention data. The persistence of a large performance gap between groups indicates that PFSA not only enhances initial learning but also promotes long-term consolidation of procedural memory. This observation is supported by the work of Ericsson, who emphasized that structured practice with feedback leads to durable skill retention through deliberate practice [4,14]. Additionally, simulation-based training studies have demonstrated that repeated, structured exposure to procedural tasks improves long-term performance and reduces skill decay [11,13,15].

The presence of Grade D performers exclusively in the TTMA group further underscores the inadequacy of traditional teaching in ensuring minimum competency thresholds over time. In contrast, PFSA appears to produce a more uniform distribution of competence, reducing the risk of poorly trained individuals. This is particularly important in

procedures such as urinary catheterization, where inadequate training can lead to complications including catheter-associated infections and urethral trauma [2,12].

Confidence is a critical determinant of clinical performance, particularly in invasive procedures. The present study demonstrates a marked improvement in confidence levels within the PFSA group, with a clear shift toward high-confidence categories post-training. While both groups showed improvement, the magnitude of change was significantly greater in PFSA. This aligns with previous studies showing that structured, supervised training enhances self-efficacy, which in turn improves performance [10]. The role of active participation and guided performance in PFSA likely contributes to this effect. By engaging learners in verbalization and supervised execution, the method fosters a sense of mastery and reduces anxiety associated with procedural tasks.

A key strength of this study is the incorporation of real-time feedback into Peyton's model. Feedback is widely recognized as one of the most powerful influences on learning outcomes. According to Hattie and Timperley, effective feedback significantly enhances performance by clarifying goals, identifying errors, and guiding improvement [6]. In clinical education, feedback is most effective when it is timely, specific, and actionable, as emphasized by Van de Ridder et al. [18]. In procedural training, immediate feedback is particularly important as it prevents the reinforcement of incorrect motor patterns. The superior performance and retention observed in the PFSA group may therefore be partly attributable to the timely correction of errors during skill acquisition.

The study also demonstrates significantly higher learner satisfaction with PFSA across multiple domains. Satisfaction is an important, though often underappreciated, outcome in medical education, as it influences engagement, motivation, and long-term learning behaviour. The higher proportion of "very satisfied" participants in the PFSA group suggests that structured, interactive teaching methods are

better aligned with learner expectations in modern medical education. This finding is consistent with literature indicating that simulation-based and active learning strategies are preferred over passive didactic methods [7,16].

The findings of this study have important implications for curriculum development in competency-based medical education. Given the consistent superiority of PFSA across all measured outcomes, its integration into undergraduate training programs could significantly enhance procedural competence. Simulation-based training combined with structured teaching models such as Peyton's approach represents a scalable and reproducible strategy for improving skill acquisition while ensuring patient safety. Evidence suggests that such approaches not only improve learner outcomes but may also translate into better patient outcomes and reduced complication rates [11,13]. This is particularly relevant in the context of increasing medico-legal awareness and the need to minimize iatrogenic complications. Furthermore, the results support a shift away from opportunistic apprenticeship models, as described by Halsted [3], toward standardized, evidence-based teaching frameworks.

Strengths and Limitations

Strengths

- **Randomized controlled design minimizing selection bias**
- **Use of both objective (OSCE) and subjective (confidence, satisfaction) outcomes**

References

- Frank JR, Snell LS, Ten Cate O, et al. Competency-based medical education: theory to practice. *Med Teach*. 2010;32(8):638–645.
- Saint S, Lipsky BA. Preventing catheter-related bacteriuria: should we? *Arch Intern Med*. 1999;159:800–808.
- Halsted WS. The training of the surgeon. *Bull Johns Hopkins Hosp*. 1904;15:267–275.
- Ericsson KA. Deliberate practice and acquisition of expert performance. *Psychol Rev*. 1993;100:363–406.
- Giacomino K, Caliesch R, Sattelmayer KM. The effectiveness of Peyton's 4-step approach: a systematic review and meta-analysis. *Med Educ*. 2020;54:1017–1029.
- Hattie J, Timperley H. The power of feedback. *Rev Educ Res*. 2007;77:81–112.
- Issenberg SB, McGaghie WC. Simulation-based medical education. *Med Teach*. 2005;27:10–28.
- Sweller J. Cognitive load theory. *Psychol Learn Motiv*. 1988;22:37–76.
- Krautter M, Weyrich P, Schultz JH, et al. Effects of Peyton's four-step approach. *BMC Med Educ*. 2011;11:1–8.

- **Assessment of both immediate performance and long-term retention**
- **Integration of real-time feedback, enhancing ecological validity**

Limitations

- **Single-centre study, which may limit generalizability**
- **Short follow-up duration (1 month); longer-term retention not assessed**
- **Potential assessor bias, although minimized by independent evaluation**
- **Lack of blinding of participants due to the nature of intervention**

Future studies should explore multi-centre validation, longer follow-up periods, and the application of PFSA to other procedural domains.

Conclusion

This study provides robust evidence that Peyton's Four-Step Approach with real-time feedback is superior to traditional teaching methods for training undergraduate medical students in male urinary catheterization. The intervention resulted in significantly improved skill acquisition, retention, confidence, and learner satisfaction. The findings strongly support the incorporation of structured, feedback-oriented teaching models into undergraduate medical curricula, particularly for invasive procedural skills. Adoption of such approaches has the potential to enhance clinical competence, improve patient safety, and align medical education with contemporary competency-based frameworks.

-
- Walker M, Peyton JWR. Teaching in the theatre. In: Peyton JWR, ed. *Teaching and Learning in Medical Practice*. 1998.
- Barsuk JH, Cohen ER, Feinglass J, et al. Simulation-based education reduces catheter complications. *Arch Intern Med*. 2009;169:1420–1423.
- Evans LV, Dodge KL, Shah TD, et al. Simulation training in urinary catheterization. *Acad Med*. 2010;85:S67–S70.
- McGaghie WC, Issenberg SB, Cohen ER, et al. Does simulation-based medical education improve patient outcomes? *Acad Med*. 2011;86:706–711.
- Ericsson KA. Deliberate practice in medicine. *Acad Med*. 2004;79:S70–S81.
- Cook DA, Hatala R, Brydges R, et al. Technology-enhanced simulation for health professions education. *JAMA*. 2011;306:978–988.
- Kneebone R. Simulation in surgical training. *BMJ*. 2003;326:1032–1036.
- Sawyer T, White M, Zaveri P, et al. Learn, see, practice, prove, do, maintain. *Acad Med*. 2015;90:1025–1033.
- Van de Ridder JMM, Stokking KM, McGaghie WC, et al. What is feedback in clinical education? *Med Educ*. 2008;42:189–197.