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Nicole Akar-Ghibril MD
Harvard School of Medicine

Cristina Carter MD
National Institutes of Health

Gabrina Dixon MD, MEd
George Washington University School of Medicine and Health Sciences

Ellen Goldman MEd, MBA
George Washington University School of Medicine and Health Sciences

Mary C. Ottolini MD, MPH, MEd
Maine Medical Center

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ORIGINAL RESEARCH

Virtual coaching and deliberate practice enhance medical students' clinical reasoning during oral case presentations

Nicole Akar-Ghibril MD,[1] Cristina Carter MD,[2] Gabrina Dixon MD, Med,[3] Ellen Goldman MEd, MBA,[3] Mary C. Ottolini MD, MPH, MEd[4]

[1]Department of Immunology, Harvard School of Medicine, Boston MA, [2]National Institutes of Health, Bethesda, MD, [3]Department of Pediatrics, George Washington University School of Medicine and Health Sciences, Washington, DC [4]Department of Pediatrics, Maine Medical Center, Portland, ME

Introduction: Oral case presentations (OP) provide opportunities for medical students to practice clinical reasoning and communication skills, and for faculty to assess these skills. Specific teaching strategies are needed to improve students' OP skills.

Objective: To compare the effectiveness of Virtual Coaching (VC) to Small Group (SG) discussion or Traditional Feedback (TF; control) in improving clinical reasoning during OP using the validated PBEAR (Problem Representation, Background Evidence, Analysis, Recommendation) tool.

Methods: Students from 2 medical schools were randomly assigned to 3 groups during their inpatient pediatric clerkship. All students completed an eLearning module about using illness scripts to promote clinical reasoning and how to present in the PBEAR format. TF students completed online "Aquifer" cases; VC students recorded abstracted data from the same cases with online faculty feedback and self-reflection; SG students attended faculty-facilitated discussions of the same cases. Students were video-recorded while presenting pre- and post-curriculum cases. Reviewers blinded to the assignment groups rated the videos with the PBEAR OP tool.

Results: The overall and sub-scale scores improved for all groups. VC students significantly improved in the Analysis subscale compared to SG and TF students. Students rated the SG teaching sessions as more enjoyable and effective in improving their clinical reasoning and presentation skills.

Conclusions: A blended learning curriculum using VC significantly improved students' clinical reasoning as assessed by the Analysis subscale.

Keywords: oral presentation, family centered rounds, clinical reasoning, coaching, student

Diagnostic error is a leading cause of serious medical errors. Thus, it is crucial for trainees to begin developing expertise in effectively communicating their clinical reasoning while in medical school. According to Ericsson,[2] to develop expertise, one needs to combine deliberate practice with expert coaching. Oral case presentations (OP) provide an opportunity for students to practice clinical reasoning and communication skills, and for faculty to assess and provide feedback on those skills. The best method to teach and assess clinical reasoning is still unclear. However, an important goal is to help novice trainees effectively store and organize their medical knowledge. Faculty can facilitate clinical reasoning during case presentations by providing a framework and opportunity for goal-directed practice with feedback.[3]

We developed the PBEAR (Problem Representation, Background Evidence, Analysis, Recommendation) framework[4] to organize presentations based on the illness-script framework. An illness script is patient data (i.e., predisposing conditions, pathophysiological insult, and clinical consequences) stored within a predictable structure. Bowen[5] provides a primer on teaching students how

Correspondence: Mary C. Ottolini MD, MPH, MEd
The Barbara Bush Children's Hospital at Maine Medical Center
22 Bramhall Street, Portland, ME 04102
Mottolini@mmc.org

to create "problem representation" (PR) statements by linking the illness scripts they are learning with their index patient. A PR statement is a one-sentence "illness script," or a summary statement for a case using key findings and specific semantic qualifiers. The purpose of a well-formulated PR statement is to link to specific illness scripts from memory and to create a reasonable differential and management plan.

To facilitate the development of clinical reasoning skills, we encouraged students to deliberately practice creating PR statements for their patients and connecting them to illness scripts using the PBEAR format (Figure 1). PBEAR is based on the widely used "SBAR" (Situation, Background, Assessment, Recommendation) structure for effectively communicating new information.[6] Other tools for OPs have been proposed, including the SNAPPS (Summarize, Narrow, Analyze, Probe, Plan, Select) model[7] and the Patient Presentation Rating Tool by Lewin.[8] PBEAR differs from these tools because it specifically focuses on teaching students how to identify, analyze, and present relevant patient information to promote clinical reasoning. The PBEAR model starts with a PR statement instead of a chief complaint, stimulating clinical reasoning from the beginning of the presentation. The student then presents pertinent positive and negative findings from the history and physical exam. They analyze the most likely diagnosis by interpreting key findings and then compare this diagnosis with alternative diagnoses. Students then conclude with a problem-based management plan. Although the analysis part of the framework most clearly articulates clinical reasoning, the entire presentation should reflect thoughtful selection and presentation of data that shapes the differential diagnosis.

Heiman et al demonstrated that deliberate practice is important to improve clinical reasoning and oral presentation skills.[9] Ideally, students present many patients and faculty provide coaching immediately after the presentation or at the end of rounds. Coaching is widely recognized as a tool to reinforce learning.[10] Good coaching is centered on the learner, experiential, and self-directed. According to Deiorio et al:

> An academic coach is a person assigned to facilitate learners achieving their fullest potential. Coaches work with learners by evaluating performance via review of objective assessments, assisting the learner to identify needs and create a plan to achieve these, and helping the learner to be accountable.[11]

Unfortunately, the reality is that students have limited numbers of new patients to present. It is also difficult for faculty to consistently provide specific feedback in real time while managing the patient, overseeing residents, and communicating with families. We evaluated alternative strategies for deliberate practice and coaching by comparing the effectiveness of Virtual Coaching (VC), Small Group (SG) case discussions, and Traditional Feedback (TF; control) in improving students' case presentations over a 2-week period.

METHODS

Between August 2014 to April 2015, 74 third-year medical students from 2 medical schools were assigned to one of 3 interventions during their required inpatient pediatric clerkship (a four-week rotation). For each rotation, students were assigned to 1 of 3 groups containing 3-5 individuals using a random-generator. Specifically, 27 students were assigned to the VC group, 25 to the SG group, and 21 to the TF group (Figure 2). After randomization, all students were required to complete assignments according to their group, but they could opt out of having their data included in the study. Seventy-three students consented to having their data included in the study. One student assigned to the small group refused consent. The study was deemed exempt by the Institutional Review Board.

Before starting their rotation, all students, regardless of intervention assigned, were instructed to complete an eLearning module. The module taught students how to present using the PBEAR framework and how to use the PBEAR assessment to rate 3 videos of case presentations that were included in the module. In a prior study, we developed and validated the PBEAR oral case presentation tool[4] in assessing diagnostic reasoning and providing feedback during rounds. All students were then given 1 of 4 pre-test cases to prepare and present

Problem Representation Statement:
1=Strongly Disagree 2= Somewhat Disagree 3= Somewhat Agree 4=Strongly Agree

For a **new patient:**	
Effectively selects the key HPI /PE Defining Features to present	1------2-----3-----4
Effectively transforms data and lay terms into semantic qualifiers	1------2-----3-----4
Overall states a well synthesized Problem Representation	1------2-----3-----4
For an **established patient:**	
States patient's name/age/hospital day/working diagnosis/progress (Better/Worse/Unchanged)	NO YES

Comments;

Background Evidence - Subjective (History):

Omits irrelevant data	1------2-----3-----4
Includes all relevant data	1------2-----3-----4
Easy to follow progression of events	1------2-----3-----4

Comments:

Background Evidence - Objective: (PE and Tests)

Omits irrelevant data	1------2-----3-----4
Includes all relevant data	1------2-----3-----4
Accurately reports the PE and test findings	NO YES

Comments:

Analysis:

For a **new patient:**	
Summarizes the syndrome including the key PE findings and test results	NO YES
Proposes an appropriate working diagnosis with rationale	1------2-----3-----4
Proposes an appropriate alternative diagnosis	NO YES
Compares and contrasts discriminating features of the two diagnoses	NO YES
Correctly interprets data (PE/Labs)	NO YES
Highlights any competing evidence that doesn't fit with working diagnosis	NO YES N/A
For an **established patient:**	
Correctly interprets the progress of problems (*Improving, Stable, Worsening)*	NO YES
Correctly interprets data	NO YES
Highlights any competing evidence that doesn't fit with working diagnoses	NO YES N/A

Comments:

Recommendation:

Addresses the main problem(s) - (NOT the symptoms or systems)	NO YES
Commits to a plan with the correct rationale	NO YES
Admits uncertainty and defers parts of the plan to other team members approprately	NO YES N/A

Comments:

Communication Skills:

Speaks clearly and audibly	NO YES
Avoids digression or repetition	NO YES
Uses notes minimally	1------2-----3-----4
Makes appropriate eye contact with the patient and family	1------2-----3-----4
Presents the information in the correct order	NO YES

Comments:

Overall:

This is an ideal presentation. (Beginning with a well synthesized problem representation; presenting pertinent information in a clear, well organized manner; providing accurate PE and test results; a thoughtful analysis with correct interpretation of findings leading to a well-reasoned differential diagnosis, comparing and contrasting illness scripts and a sound plan.)	1------2-----3-----4

Figure 1. PBEAR Oral case presentation assessment tool

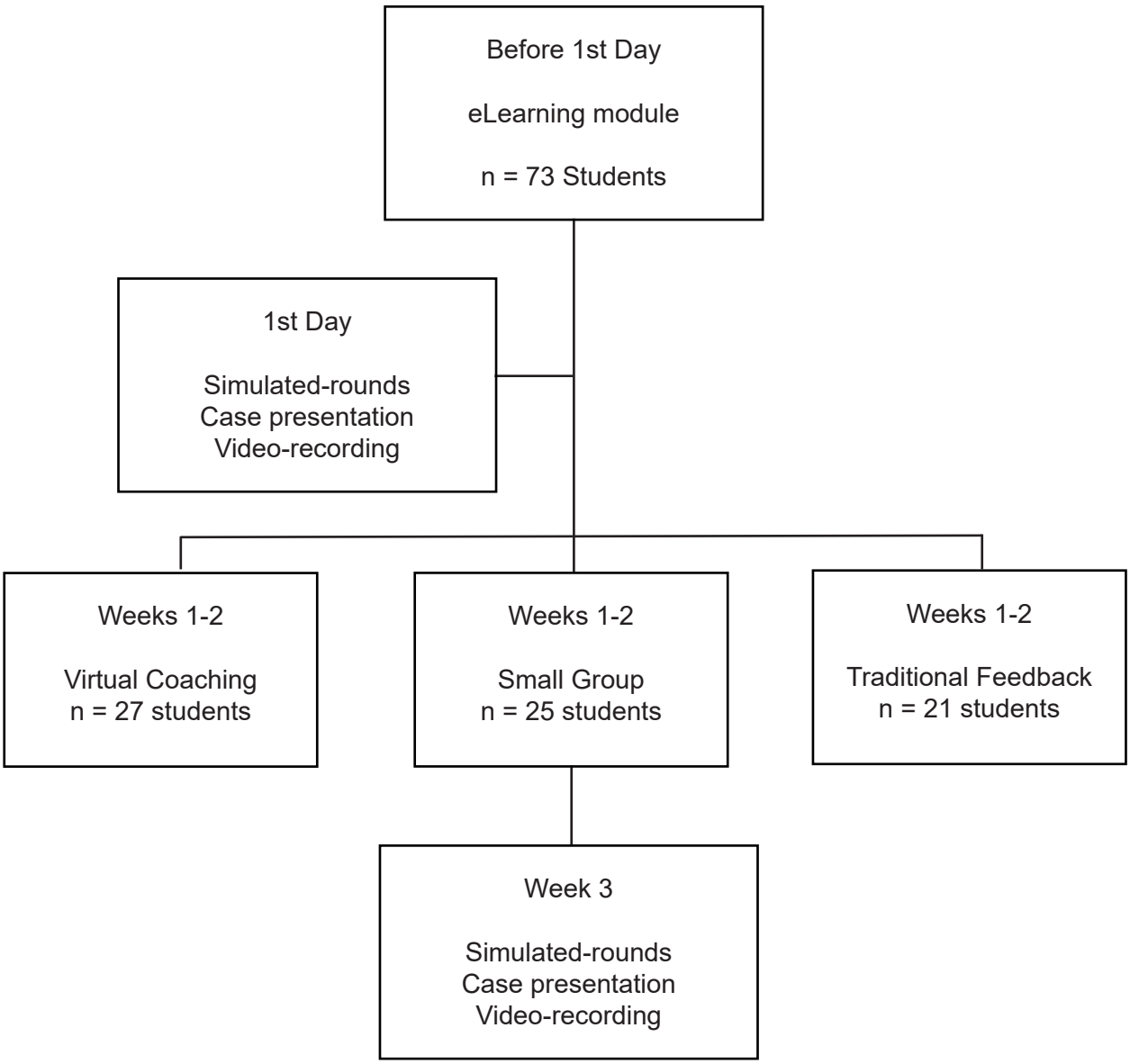

Figure 2. Intervention group assignment and expectations

in the PBEAR format during a simulated bedside presentation.

To standardize the pre- and post-case presentations, we wrote 8 cases for students to present at the beginning and end of the 2-week intervention period. The cases depicted the initial history, physical exam, and diagnostic-test results for a previously healthy pediatric patient with an undifferentiated common pediatric complaint (e.g., limp, abdominal pain, fever, rash, respiratory distress, neck swelling). The cases also included findings that were irrelevant to the diagnosis or management of the patient.

On the first day of the rotation, students were video-recorded while presenting the pre-test case during a simulated rounding exercise. Each video was assigned a code. Using the PBEAR assessment tool, faculty and peers provided feedback only on the presenter's communication skills. We piloted the rounding simulation sessions by having an investigator observe the faculty and peers to ensure they gave similar feedback to students.

Traditionally, students were required to complete 10 Aquifer[12] cases during the inpatient portion of the clerkship. Aquifer cases were developed by a national group of pediatric clerkship directors to address the learning objectives for the national COMSEP (Council on Medical Student Education in Pediatrics) curriculum and to encourage clinical reasoning. In these cases, students must identify the key features of the case and refine the differential diagnosis as new data is presented. We chose 4 of the 10 required cases to use in this study. Students in all 3 groups interacted with the same Aquifer cases during the first 2 weeks of the rotation, albeit differently. Those in the TF group completed 2 online Aquifer cases per week, as they had traditionally done. They also had access to the clinical reasoning instruction included with the Aquifer modules.

The students in the VC group read information abstracted from the Aquifer cases and then audio-recorded their presentations using a recording application embedded in our learning management system. One investigator, the "Virtual Coach", listened to the recording and texted feedback within 24 hours of the recording using the PBEAR tool. The students were asked to review texted feedback, listen to their recording, and reflect on how they could improve for the next presentation. One of the investigators sent weekly reminders to students to complete the interventions.

The students assigned to the small group attended teaching sessions twice per week with 3-5 students. Investigators facilitated the group discussion using the abstracted data from the Aquifer cases. The faculty member began the session with the chief complaint and then guided them to generate an Illness Script Table (Figure 3) with the 3 most-likely diagnoses. The faculty member then played the role of parent, providing the history based on questions asked by the students. Physical exam data and patient pictures were provided, and students were allowed to work as a group, using online resources to determine the most-likely diagnosis. They developed a PR statement as a group, and then presented the history and physical exam findings using the PBEAR model.

We developed instructor guides for the VC and for SG facilitators. The guides summarized the key points to emphasize in context of the PBEAR model.

On the inpatient unit, approximately 25 hospitalist faculty who rounded with all 3 groups of students received training to promote use of the PBEAR format. Faculty development included workshops at faculty meetings and an eLearning module.

During the third week, all students were assigned 1 of 4 post-test cases. These cases were of similar complexity to the pre-test cases but with differing presenting problems. Post-test presentations were also video-recorded and assigned a code. To keep reviewers blinded, pre-test cases were alternated with post-test cases for each rotation of students. At the end of the 4-week inpatient rotation, all students received a survey to assess their satisfaction with the eLearning module, presentation simulations, and opportunities for practice and feedback.

Two investigators rated pre- and post-test OP videos using the validated PBEAR tool. They did not participate in any student-training interventions in order to remain blinded to student group assignments and whether videos were before or after the intervention. The two investigators acheived 90% inter-rater reliability when iteratively reviewing a subset of training videos.

Scores from 73 students' pre- and post-test OPs were analyzed using a multivariate general linear model for repeated measures[13] to determine if pre- and post-test scores differed significantly between

Diagnosis	Timing and Progression	Risk Factors	Key Signs and Symptoms
Congestive heart failure (CHF)	Chronic – since birth	Patient age: early infancy Family history	Prolonged feeding time Sweating during feeding Heart murmur
Gastroesophageal reflux disease (GERD)	Chronic- since birth	Patient age: early infancy Family history Erythromycin	Non bilious emesis
Cystic fibrosis (CF)	Chronic - since birth	Patient age: early infancy Family history	Diarrhea History of meconium ileus

Figure 3. Illness-script table: Chief complaint: 9-week-old male not gaining weight

the groups. An answer of "yes" was scored as a 4 and an answer of "no" was scored as a 1 on the Likert scale. The F value is the test statistic that indicates whether the groups varied in the amount of change over time. The "between-subjects factor" was the intervention (VC versus SG versus TF), and the "within-subject factor" was the time of data collection (pre- versus post-intervention). The paired t-test statistic depicts whether the average pre-score differed significantly from the post-score. When there was a significant F value, we looked back at the t-tests to see which of the 3 groups experienced a significant change.

RESULTS

Students in all groups completed all interventions over the first 2 weeks of the rotation. SG sessions took approximately one hour of faculty time to prepare and facilitate the sessions. The logistics of finding an available conference room and a time when all students could meet were the biggest challenges to facilitating the sessions. Listening to recorded case presentations and providing individual feedback to students took an average of 15 minutes per student. Overall, all groups significantly improved between the pre- and post-intervention (Table 1). The subscale with significant differences between the groups was the Analysis subscale. VC students showed a significant improvement in the Analysis subscale compared to the SG or TF students.

We found that 68% (18/27) of VC students and 100% (25/25) of SG students rated the intervention as enjoyable, and 68% (18) of VC students and 80% (20) of SG students felt the intervention improved their clinical reasoning ability. Also, 63% (17) of VC students and 100% (25) of SG students agreed that practice with faculty coaching improved their presentation skills. Students commented that they would prefer practicing by recording their actual cases rather than the Aquifer cases in the future. SG students reported enjoying their interactions with each other and the faculty member. VC students commented that they would have liked protected time with privacy while at the hospital to record cases rather than recording at home. There were technical challenges for some students, such as not being able to access the recording application within the learning management system while at home. As an alternative, students used the voice recorder on the their smartphone to record the cases and emailed the recording to the virtual coach.

DISCUSSION

A goal for many faculty in both the inpatient and ambulatory settings is to enhance students' ability to present patients in a well-organized format that promotes clinical reasoning during rounds, especially patient- and family-centered rounds. In a previous study, we found that the student or

Table 1. Comparison of Paired Video Ratings for Pre-Post Intervention of Oral Case Presentations

	VC (n = 27)	SG (n = 25)	TF (n = 21)	Total (n =7 3)	Wave Group Effect	
Problem Representation					F=0.14	P=.87
Pre, mean (SD)	1.67 (0.73)	1.69 (0.84)	1.41 (0.48)	1.60 (.71)		
Post, mean (SD)	2.41 (0.91)	2.29 (0.99)	2.13 (0.85)	2.29 (.92)		
Paired t	-3.8	-2.93	-3.34	-5.89		
P value	.001	.007	.003	<.001		
Background Subjective					F=1.01	P=.37
Pre, mean (SD)	2.81 (0.55)	2.61 (0.60)	2.95 (0.46)	2.79 (0.55)		
Post, mean (SD)	3.23 (0.45)	3.20 (0.53)	3.24 (0.41)	3.22 (0.46)		
Paired t	-2.68	-4.3	-2.09	-5.2		
P value	.013	<.001	.05	<.001		
Background Objective					F=2.75	P=.07
Pre, mean (SD)	3.56 (0.58)	3.40 (0.56)	3.60 (0.41)	3.52 (0.46)		
Post, mean (SD)	3.62 (0.31)	3.75 (0.41)	3.62 (0.41)	3.66 (0.37)		
Paired t	-0.69	-3.03	-0.18	-2.3		
P value	.50	.006	.86	.03		
Analysis					F=3.55	p=.03
Pre, mean (SD)	2.44 (0.72)	2.43 (0.62)	2.84 (0.92)	2.55 (0.77)		
Post, mean (SD)	3.37 (0.63)	3.15 (0.76)	3.0 (0.74)	3.19 (0.71)		
Paired t	-5.06	-3.71	-0.6	-5.12		
P value	<.001	.001	.56	<.001		
Communication Skills					F=1.91	P=.16
Pre, mean (SD)	3.54 (0.48)	3.21 (0.67)	3.60 (0.45)	3.45 (0.56)		
Post, mean (SD)	3.77 (0.42)	3.73 (0.52)	3.71 (0.47)	3.74 (0.46)		
Paired t	-1.68	-3.17	-0.78	-3.39		
P value	.10	.004	.44	.001		
Overall					F=0.58	F=.56
Pre, mean (SD)	2.26 (0.90)	2.04 (0.79)	2.10 (0.77)	2.14 (0.82)		
Post, mean (SD)	3.15 (0.77)	2.96 (0.79)	2.71 (0.85)	2.96 (0.81)		
Paired t	-4.25	-5.66	-2.44	-6.9		
P value	<.001	<.001	.02	<.001		

SG, small group; TF, traditional feedback; VC, virtual coaching

intern presentation consumes about half of the rounding time.[14] Ineffective presentations prolong rounds and contribute to resident, nursing, and family dissatisfaction.[15] With the PBEAR format, presentations can be more effective because students are discouraged from mentioning data that is irrelevant to addressing the presenting problem.

We sought to determine if VC could enhance the effectiveness of real-time feedback from faculty. Faculty reported discomfort providing corrective feedback to students in front of the team.[16] Time constraints also make it difficult to consistently give one-on-one, specific, actionable feedback.

The literature supports the importance of expert coaching and deliberate practice in accelerating learners' progress toward mastering a skill.[2] Therefore, we sought to enhance opportunities for students to practice presenting cases using the PBEAR format in both of the intervention groups. The difference between the groups was that the VC students received specific individual coaching, while the SG students received group feedback. The amount of time that the investigators devoted to either intervention for the 3-5 students was approximately 1 hour per case.

We determined that, overall, students improved signifantly over the first 2 weeks, regardless of their group assignment. This improvement can be attributed to the eLearning module, the structure of the Aquifer online modules that promote clinical reasoning, the interventions provided to the SG and VC groups, and the feedback provided by faculty after rounds. However, we found that the VC group had a statistically significant improvement in the Analysis subscale. Providing a PR Statement and Analysis are most closely linked to diagnostic reasoning.[4] The Analysis subscale measures the student's ability to summarize the syndrome, propose an appropriate working diagnosis and alternative diagnosis with rationale, and compare and contrast thinking. VC has the benefit of providing individualized, "one-on-one" coaching for each student. When feedback specifically describes an individual's weaknesses and strengths, greater strides in diagnostic reasoning can be achieved.[17]

We found that students preferred the SG teaching sessions over the VC sessions. There are likely several reasons for this preference. First, the SG teaching sessions were conducted during the afternoon in a conference room on the inpatient unit, while the VC sessions were usually done after-hours because private rooms for recording were difficult to find on the unit. The SG sessions offered social interaction with the other students and the attending who was playing the role of the parent.[18] In contrast, the VC students worked through the cases in isolation and presented to a digital voice recorder with delayed feedback.

Although coaching is a relatively new approach to medical education, it has been widely used in the sports and business industries. Unlike mentors or advisors, coaches use objective data to determine specific actions to attain a desired result. Ideal coaching in medical education includes establishing an ongoing relationship of trust, conducting an objective assessment, developing and implementing an action plan, and assessing the results.[11]

We propose that to improve clinical reasoning and student satisfaction, faculty coaches should develop stronger long-term relationships with students during rotations. Because both interventions took 1 hour per case for 3-5 students, a combination of in-person SG and VG interventions might yield the best results. If time permits, the attending on service or a teaching attending (or teaching resident) could provide these structured coaching interventions. The advantage of VC is that it can be done asynchronously.

LIMITATIONS

We had a large number of faculty serving as the attending of record during the study. Not all faculty embraced the PBEAR feedback method to the same extent. We were unable to control for the quantity and quality of feedback that attendings gave students during the first 2 weeks of the rotation, which could have impacted the results. Although students were randomly assigned to teams, and each team had a different intervention, there may have been some cross-contamination across groups because all students were on the same 52-bed inpatient unit. This study was only conducted on a hospitalist inpatient service at a single institution, with a relatively small sample size of students. Case-presentation expectations in different settings may yield different results. To control for improvements that occur as a third-year

medical student progresses through rotations, we conducted the study throughout the academic year.

CONCLUSIONS

A blended-learning curriculum to enhance clinical reasoning during presentations was effective in a randomized, controlled trial with blinded reviewers using a validated assessment tool. Students perceived SG teaching as more enjoyable, but those in the VC group had greater improvements in clinical reasoning as assessed by the Analysis subscale.

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Conflicts of Interest: None

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