Miller triangle-based model trains Chinese residents as confident "system-based practice" competency instructors

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Abstract

Junior members of medical system including residents and clerks should be trained early for ACGME system-based practice (SBP) competency to improve primary patient care quality. Twelve second-year (R_2), twelve first-year (R_1), and twelve postgraduate year-1 (PGY_1) residents were enrolled into group A, B and C, respectively, as trainees. After three training protocols had been completed, a writing test, self-assessed questionnaire and mini-OSTE and bedside-assessment were used in auditing the four Miller triangle levels of the SBP, namely competency, performance, and teaching ability. Baseline expert-assessed, faculty-assessed, self-assessed SBP proficiency were relatively low for the PGY_1 residents. After three training protocols, SBP proficiencies, performance, and teaching abilities were improved to similar levels cross the three training levels of residents based on the expert-assessed writing test-audited assessments and on the faculty and standardized clerk-assessed bedside-/mini-OSTE-audited assessments. Overall, this study is characterized by its use of a multi-faceted approach to the training and auditing of the SBP competency across different levels of residents. The Miller triangle-based different protocols used to teach group A, B and C were equally beneficial and fitted their needs; namely the different levels of the trainees; specifically, each level was able to augment their SBP proficiency.

Keywords: bedside-assessment**,** mini-OSTE, Miller triangle, residents, system-based practice

Introduction

The Accreditation Council for Graduate Medical Education and American Board of Medical Specialties require the system-based practice (SBP) competency for board certification in residency [1]. Improving familiarity with the SBP competency requires repeated trainings. Resident spends 20-25% of the average clinical working week supervising and/or teaching clerks.[2] Thus, optimizing the resident's mastery of the SBP competency and helping the residents as teachers might help to solve the poor promotion of that among clerks.
Using a comprehensive approach, our study aims to establish and validate a strategy for training and auditing the teaching abilities of residents for SBP competency.

Methods

Consultation with residency directors and experts helped us identify the required "SBP" competency-related

teaching skills that needed to be augmented.

Grouping

From 2013 January to 2014 October, second-year, first-year (R_1) and postgraduate year-1 (PGY_1) residents (n=12 in each group) were enrolled to form groups A, B and C of this study, respectively (Fig. 1). The faculties whose were responsible for the teaching or auditing of the trainee′s SBP skill was totally different across the three groups and worked independently. The gender distribution (male to female ratio) did not differ between the three groups. Before workshop and mini-OSTE, trainees [PGY_1, R_1, R_2 residents] gave the pre-test self-evaluation of their teaching skills and familiarity for SBP competency.

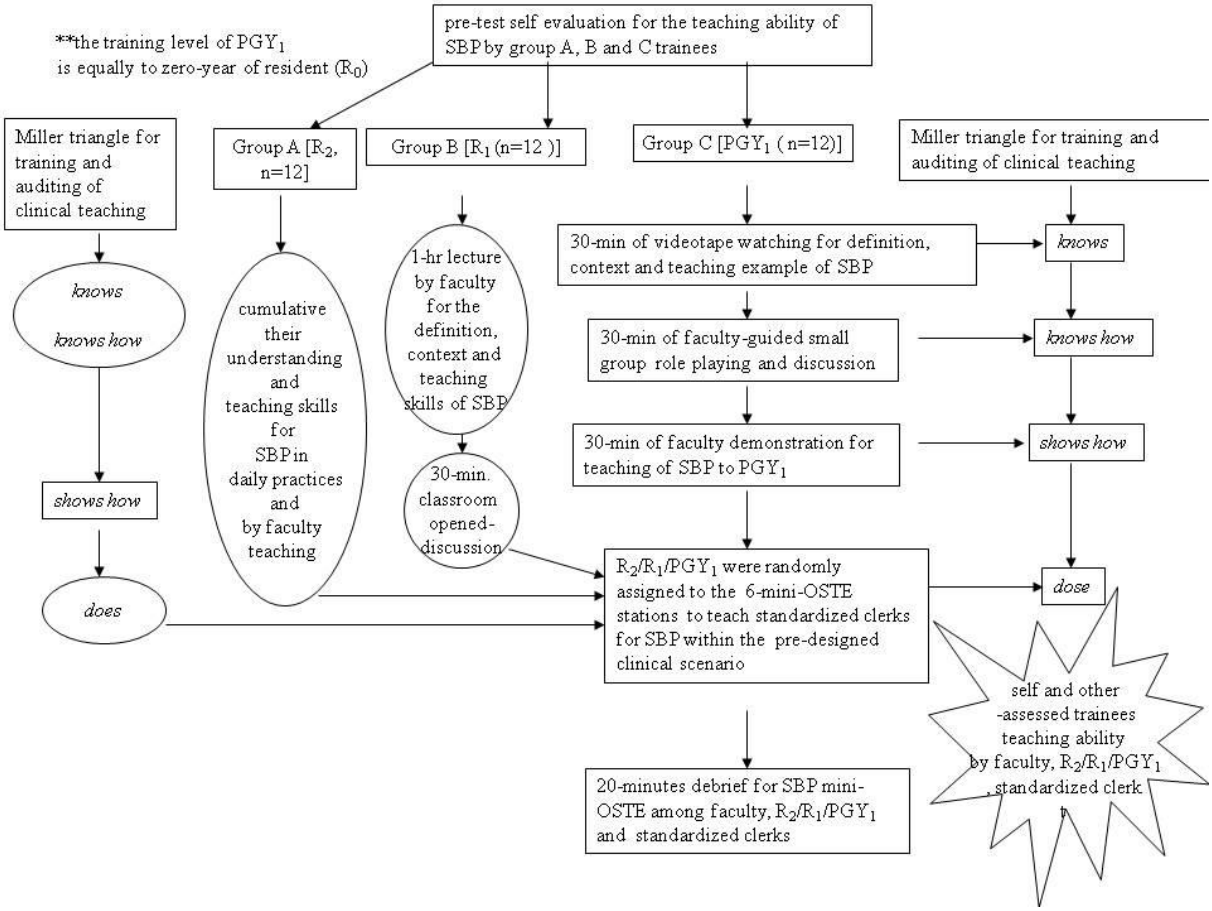

Figure 1: The training and auditing protocols for different trainees (group **A** for R_2 residents, group **B** for R_1 residents and group **C** for PGY_1 residents) according to the Miller triangle for clinical teaching.

Ethical approval was obtained from the Ethics committee of our institution, and care was taken to apply the World Medical Association Declaration of Helsinki principle of research. Fourteen experienced SBP faculty raters from another medical center and twelve standardized clerks were receiving 2-hour consensus sessions of viewing the videotapes of the pilot scenarios and role playing [2].

Recruitment and training of faculty raters and standardized clerks

Fourteen faculty raters who had wide experience of teaching and auditing SBP competency of trainees were invited from another medical center to take part in this study. Conflict of interest declaration forms were signed by all faculty raters. We recruited twelve standardized clerks and trained each for 2 hours in role playing in order to standardize their case portrayal and rating. Two of the fourteen faculties were in charge of training of the SBP teaching skills of the trainees via workshops. To enhance the faculty rater′s reliability, twelve of the fourteen invited faculty raters spent 2-hour sessions together in order to familiar themselves with the auditing form used by rating representative. They also viewed the videotapes of the pilot scenarios before starting the

formal mini-OSTE.

Four Miller triangle levels-based training

Our whole protocols were designed following the Miller triangle four "*knows*, *knows how*, *shows how* and *does*" levels. Within the "group B" protocol, the R_1 residents received a 1-hour interactive lecture and 30-minutes of opened discussion guided by two of the fourteen trained faculties (Fig. 1). After this, the group B trainees conducted 30-minutes of opened discussion; this explored how to develop their teaching ability with respect to the SBP competency. Within the "group C" protocol, the PGY_1 residents receiving a 30-minutes audio/visual presentation by qualified faculties (this targeted the "*knows*" level of the Miller triangle). Over the next 30-minutes, small group role playing and debriefing regarding the SBP teaching skills were undergone (this targeted the "*knows how*" level of the Miller triangle). Subsequently, a 30-min. real-time classroom demonstration were arranged (this targeted the "*shows how*" level of the Miller triangle). We believed that the group A trainee (R_2 residents) had undergone long-term exposure to clinical practice and this was able to drive them to learn and carry out SBP spontaneously. Based on the latter hypothesis, the senior group A trainees (R_2 residents) directly underwent auditing of their SBP teaching skills (this targeted the "*does*" level of the Miller triangle) via mini-OSTE, unlike the group B and C trainees who received training first (Fig. 1-3).

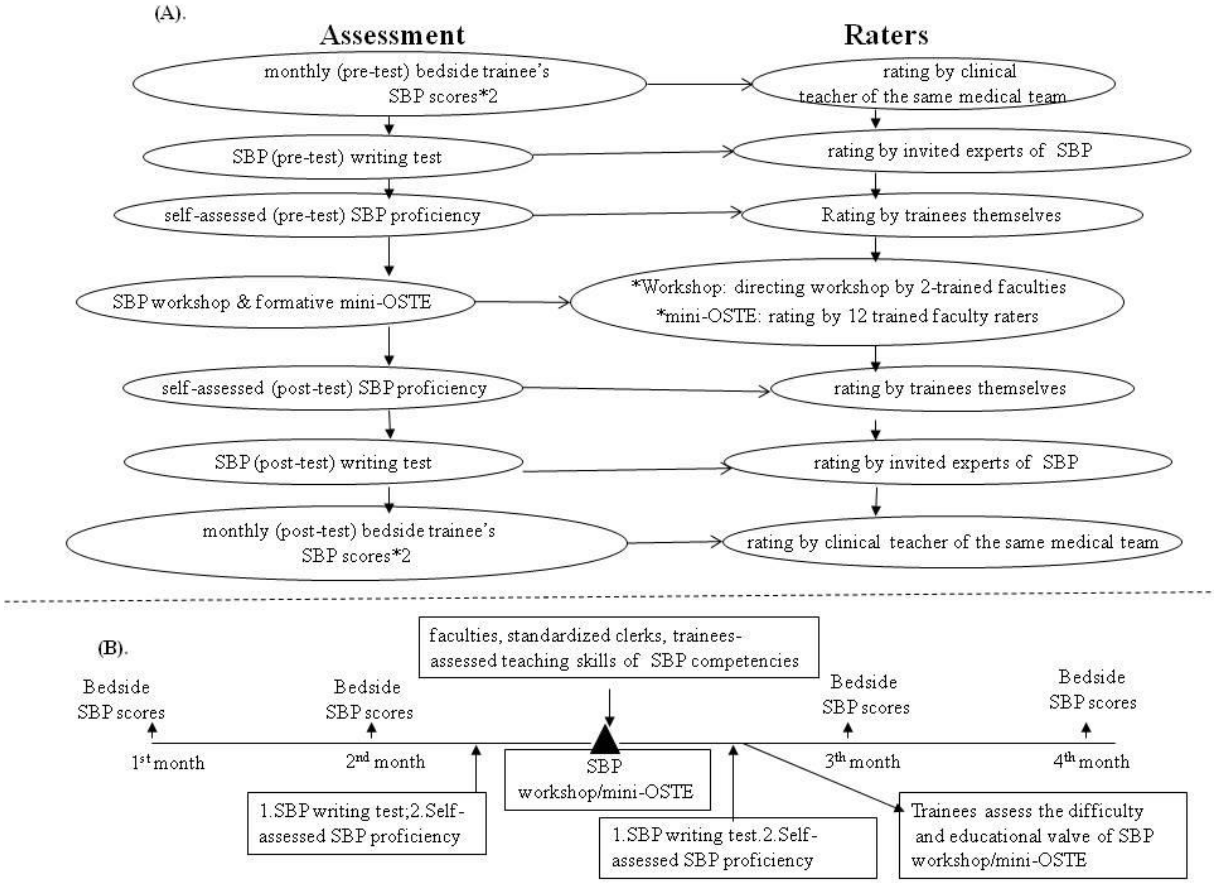

Figure 2: The detail flow chart **(A)** and time points for different auditings **(B)** throughout the whole study.

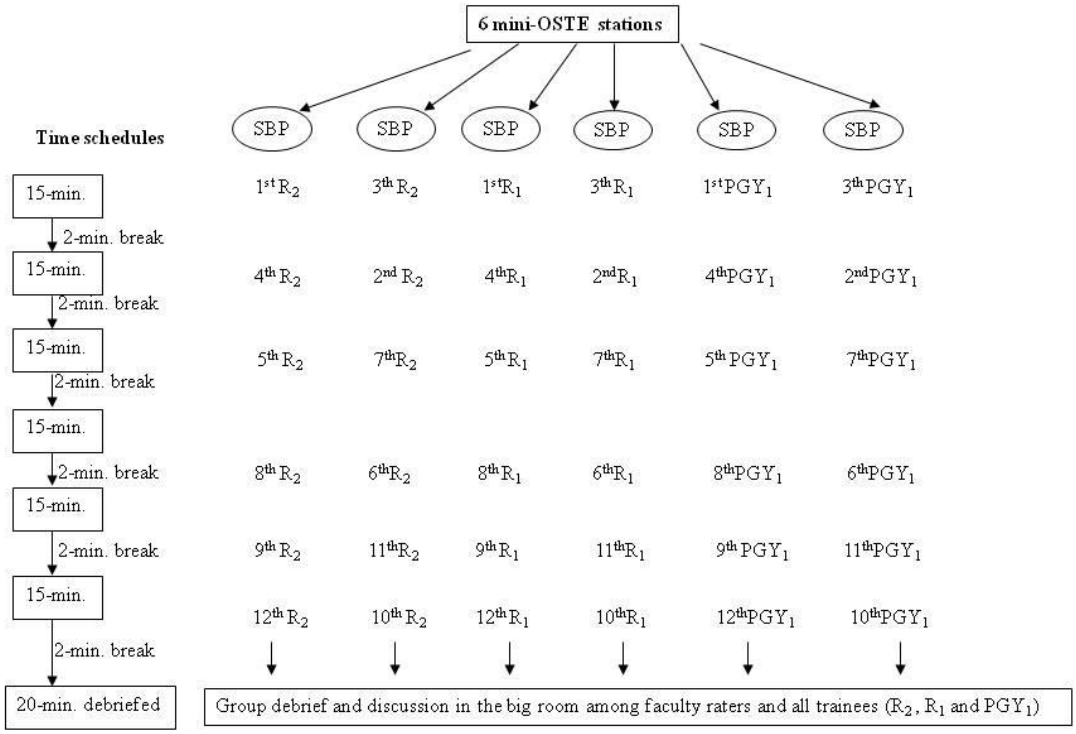

Figure 3: The time schedules for the formative mini-OSTE that providing all trainees opportunities (**A** for R_2 residents, **B** for R_1 residents and **C** for PGY_1 residents) to teach standardized clerks.

Miller triangle 1st&2nd levels auditing: Before and after finishing the SBP workshop and the mini-OSTE, all trainees ($PGY_1/R_1/R_2$) were asked to complete the SBP writing test within 15-minutes which including three questions related to two clinical scenarios (Table 1). Their answers were scored from 0 (low) to 5(high); thus the three answers generated a cumulative score that could range from 0 to 15 points.

Table 1. The items that multi-sources auditing of trainee's teaching skills in formative SBP mini-OSTE

Evaluation items	**Writing Test SBP Scenario # 1**.
[Part A]. Specific items of faculty-assessed teaching skills*	**Question:** A terminally ill cancer patient is brought to the emergency department with shortness of breath due to progression of his lung metastases. His family wants everything to be done but the patient just wants to "die in peace."
*(1). *Rapport building skills*	***The mission of the educator:***
1.Communicates non-judgmental, respectful, and supportive attitude (e.g. acknowledges challenge)	**1.** Please describe how many health care systems will involve solving this clinical encounter.
2. Exhibits appropriate nonverbal behavior	2. Please identify the questions that you can handle for this clinical condition according to the definition and principle of SBP.
*(2). *Needs assessment (reporter and interpreter skills)*	3**.** Please use the definition and principle of SBP to
a.Recognizes and names emotions (e.g., deorganized, insecurity, stress)/problems and responds with PEARLS or nonverbally	
b.Told intern what they did right or wrong	

c.Funding knowledge for the definition and context of "SBP" competency	teaching your learners who to handle this condition.
*(3).*Instructional skills (manager and educator skills)*	**Writing Test SBP Scenario # 2.**
a.Help learners to improve skills to apply SBP competency to deal with this setting clinical scenario and daily clinical work.	**Question:** An indigent, insulin-dependent, diabetic patient uses the emergency department for primary care issues and medication refill.
b.Check clerk′s understanding of what was taught and invites question from interns and feedbacks with constructive action plan.	***The mission of the educator:*** **1.** Please describe how many health care systems will involve solving this clinical encounter.
(4).Faculty global rating for $PGY_1/R_1/R_2$′s teaching skills	2. Please identify the questions that you can handle for this clinical condition according to the definition and principle of SBP.
[Part B].$PGY_1/R_1/R_2$ self-assessed overall mini-OSTE skills	3**.** Please use the definition and principle of SBP to teaching your learners who to handle this condition.
[Part C]. Standardized clerks (learners)-evaluated $PGY_1/R_1/R_2$′s teaching skills	
all the evaluation was done on a scale of 1 to 9, with 1-3=" unsatisfied/needs improvement/I would do my best to avoid working with this $PGY_1/R_1/R_2$ again", 4-6=" satisfied/done well", 7-9=" unsatisfied/done excellently/one of the best teachers, I would recommend to my colleagues". PEARLS, partnership, empathy, apology, respect, legitimization, and support	

Simultaneously, three experts individually scored each of the trainee′s 36 SBP responses to hypothetical clinical scenarios. After the initial scoring, the three experts met to resolve substantial differences in their assigned ratings. Weighted inter-rater agreement was calculated from the three experts using the raw scores. Following the completion of 30-minutes SBP proficiency writing tests before and after SBP workshop and mini-OSTE, all residents were asked to fill-in a self-assessed questionnaire, which are shown in Table 2.

Table 2. Self-assessed SBP proficiency before and after workshop and formative mini-OSTE

Statement for trainee′s (PGY_1, R_1 and R_2) pre-training (pre-) and post-training (post-) self-assessment	Group A trainees		Group B trainees		Group C trainees	
	R_2		R_1		PGY_1	
	Pre-	Post-	Pre-	Post-	Pre-	Post-
1.Understanding interaction of their practice with the other health care professionals/organization and larger society.	7.08±0.1	8.04±0.7	6.05±0.2	7.8±0.9$^{\#}$	5.2±0.6†	8.2±0.4*
2.Advocate for quality patient care and assist patients in dealing with health care system complexities.	7.1±0.3	8.2±0.4	5.5±0.2	7.5±0.3*	5.03±0.6†	8.6±0.5*
3.Know how types of medical practice and delivery systems differ from one another including methods of controlling health care costs and allocating resources.	6.7±0.1	7.8±0.3	5.6±0.2	8.1±0.5$^{\#}$	5.8±0.9	7.9±0.8$^{\#}$
Overall score	20.9±0.2	24.0±0.5*	17.2±0.9	23.4±0.6*	16.0±0.3†	24.7±0.8*
Overall score that transferred into 100%	77.8 ±6	88.8±11*	63.7±10	89.3 ±5*	59±8†	91.5±7*
Absolute overall change from pre-training scores		11		25.6†		32.5†

1-3:="needs improvement", 4-6=" done well", 7-9=" done excellently". Then, overall scores were transferred into 100 percentages for further analysis. †:p <0.05 *vs*. group A; $^{*}P < 0.01$; $^{\#}P < 0.05$ *vs*. pre-training score.

Miller triangle 3rd level auditing: Clinical scenarios of six min-OSTE were based on a definition of SBP that

reflects the resident′s daily realistic and reproducible responsibilities and could be observed in a limited time. These scenarios were, for "SBP" competence, teaching an overconfident clerk how to group together various health care professionals and organizations to help diabetic patients with poor glycermia control.
Within every 120-minute, twelve qualified faculty raters, whose blinded to the training levels of residents, were randomized and then audited the trainee′s SBP teaching abilities using twelve standardized clerks (Fig. 1-3).
At each mini-OSTE station, residents had 8 minutes to perform the teaching task to the standardized clerks within the SBP scenario. Faculty raters, the standardized clerks, and the $PGY_1/R_1/R_2$ residents themselves (post-training) all independently completed distinct rating forms over 2-minutes immediately following each encounter. After the rating forms were completed, the trainees received 5 minutes of feedback from faculty and standardized clerks. At the end of the 15-minutes mini-OSTE, all trainees and faculty raters carried out a debriefing on the SBP scenarios that lasted for 20-minutes. They then filled in a questionnaire that addressed the case difficulty (Table 3) and the educational value of the auditing. Finally, the trainees received relevant readings about SBP for further self-study

Table 3. The detail assessment of the trainees′ perception for difficulties and educational values of SBP clinical scenario in workshop and mini-OSTE

Name of competence	Definition and content
difficulties of SBP clinical scenario	***1-3: not difficult (appropriate), 4-6: a little difficult, 7-9: very difficult.
educational values of SBP clinical scenario	1. It helps me familiar with the definition/context of SBP. 2. It helps me familiar with how to apply SBP skills in daily clinical work. 3. It helps me familiar with how to teach SBP competency to younger learner. ***1-3: low educational values, 4-6: moderate educational values], 7-9: high educational values

Miller triangle 4th level auditing: Thirty-six clinical teachers that the PGY_1, R_1 and R_2 residents worked with were asked to rating the pre-training and post-training bedside end-of-rotation SBP scores every month according to the definition shown in Table 4.

Table 4. The definition and context of SBP competency for clinical teacher′s end-of-rotation beside rating of residents

Name of competence	Definition and content
Systems-based practice skills	1.Understanding interaction of their practice with the other health care professionals/organization and larger society. 2.Advocate for quality patient care and assist patients in dealing with health care system complexities. 3.Know how types of medical practice and delivery systems differ from one another including methods of controlling health care costs and allocating resources.
*all the evaluation was done on a scale of 1 to 9, with 1-3="unsatisfied/needs improvement", 4-6="satisfied/done well", 7-9="unsatisfied/done excellently". Accordingly, the SBP and PBLI scores were calculated as the summation of each three items in SBP skills. So, the bedside SBP scores were ranged from 3-27 for each trainee.	

Basically, the clinical teacher′s ratings were according to the overall "patient care' performance, mini-CEX and case-based discussion evaluations of these enrolled trainees (PGY_1, R_1 and R_2 residents) at monthly intervals.

Before analysis, the average of two monthly bedside SBP scores was converted into a percentage.
Data Analysis: We compared the global scores by resident training level ($PGY_1/R_1/R_2$) using independent *t* tests and between raters using χ^2 tests [3].

Results

Miller triangle 1st&2nd "knows/knows how" levels auditing: In Fig. 4A, the baseline *expert-assessed* SBP writing test scores were significantly lower for the PGY_1 residents than R_2 residents. Despite using different protocols, the post-training SBP scores were similarly improved across $PGY_1/R_1/R_2$ residents.

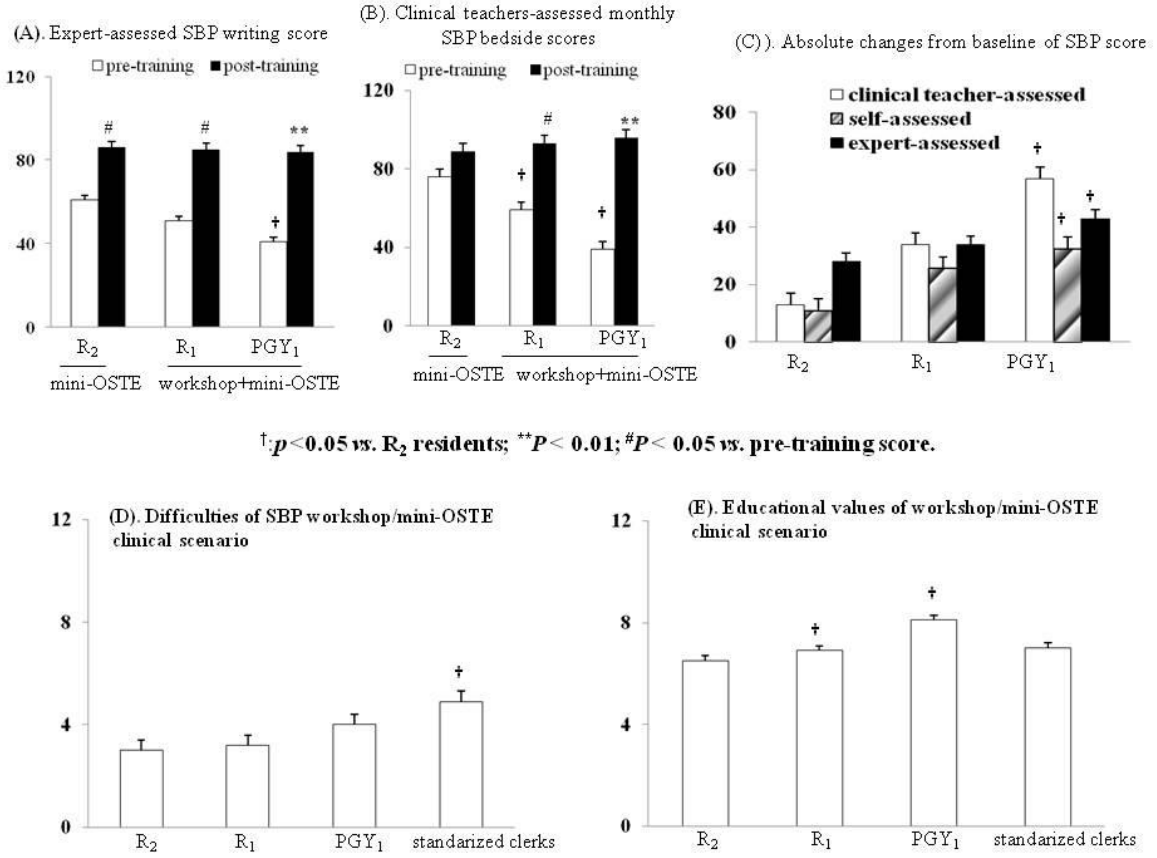

Figure 4: Comparison of the expert-assessed **(A).**SBP writing scores**,** (B).clinical teacher′s bedside SBP scores before and after (pre-training/post-training) SBP workshop/mini-OSTE, **(C).** The improvement trend of bedside-, self- and expert-assessed SBP scores through different training protocol; (**D,E**). Trainees′ perception for the difficulties and educational values of SBP clinical scenario, 1-3: not difficult (appropriate), 4-6: a little difficult, 7-9: very difficult.

Miller triangle 3rd&4th "show how" level auditing: Significantly, the pre-training self-assessed SBP proficiency, SBP mini-OSTE and average SBP bedside scores were lower in the PGY_1 residents compared to the R_2 residents (Table 2,5& Fig. 4B). Fig. 4C displayed a higher degree of improvement among the PGY_1 compared to the R_1 residents. Even though different training/auditing protocols were used, the similar improving trend was noted in clinical teacher-assessed, self-assessed and expert-assessed SBP scores for different levels of trainees ($PGY_1/R_1/R_2$ residents) (Fig. 4C). It is obvious that the PGY_1 residents benefited the most from the SBP training/auditing protocol due to their participation in the workshop and formative mini-OSTE compared to the R_2 residents who received their training in real clinical environment.

Table 5. Multi-sources auditing of trainee's teaching skills in formative SBP mini-OSTE

	Group A trainees	Group B trainees	Group C trainees
	R_2	R_1	PGY_1
[Part A]. Faculty audited teaching skills scores			
(1).rapport building	7.0±0.2	7.6±0.2	8.5±0.3†
(2).Needs assessment	7.5±0.3	5.4±0.3	4.8±0.2†
(3).Instructural skills	8.6±0.4	7.0±0.4	5.1±0.3†
(4).global performance	7.8±0.6	7.5±0.2	7.7±0.4
[Part B]. Trainee's self-assessed overall mini-OSTE performance	8.3±0.4	7.9±0.5	6.2±0.4†
[Part C]. Standardized clerks-evaluated satisfaction for teaching by trainees	7.1±0.3	7.2±0.4	8.3±0.5

*$p < 0.05$ *vs*. PGY_1/ R_1; the individual SBP scores were ranking with 1-9 point scale; 1-3:="needs improvement", 4-6=" done well", 7-9=" done excellently" (n=12 in each group), †:$p < 0.05$ *vs*. group A.

The standardized clerks reported that the SBP clinical scenario was a little difficult for them whereas all PGY_1/R_1/R_2 residents reported that the difficulty of SBP clinical scenario was appropriate (Fig. 4D). Notably, the PGY_1 residents gave the highest educational value to SBP clinical scenario compared to the R_1/R_2 residents and standardized clerks (Fig. 4E).

Discussion

Based on the premise "to really know a subject, teach it", we designed teaching skills OSTE stations for all residents [4]. They reported that the mini-OSTE teaching and application simulations facilitated their ability to transfer workshop-trained SBP knowledge/skills into the clerks in real clinical settings.

The immediate post-training bedside clinical teacher evaluations provide an opportunity to check the long-term effects of SBP knowledge transfer and retention on the daily practice.[5] Our trainees reported that the post-training assessment and feedback provide self-reflection opportunities related to their readiness for practicing and teaching SBP [5,6].

In our study, self-reported confidence, formally assessed competence (what trainees can do in a controlled situation) and performance (what trainees really do in actual practice) were simultaneously evaluated to avoid single observer bias [7]. In comparison with our largely lecture-based approach (group B, R_1 residents) and the small group role playing and videotape watching approach (group C, PGY_1 residents), the formative mini-OSTE encourages more young residents to teach junior members at their hospital [8]. Additionally, we avoid the possible confounding effects by consensus building calibration, and standardization of the faculty rating system using a checklist of videotapes examples of appropriate SBP performance during clinical practice [9,10].

This educational intervention helps medical institutions to identify residents as SBP instructors. Based on our initial positive results, a large-scale study can be undertaken in the future to validate the efficiency of this Miller triangle-based training and auditing approach.

In conclusion, both junior and senior residents can be effectively trained to teach the elements of SBP using a comprehensive Miller triangle-based approach.

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