Original Article

Program Evaluation of Problem-Based Learning Tutorial of Clinical Reasoning with Simulated Patients and Simulators by Medical Students in Japan

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ABSTRACT

Introduction: We conducted problem-based learning (PBL) with simulated patients (SPs) and simulators in a regular class. We obtained evaluation questionnaires from the students and analyzed them to gauge PBL by incorporating the simulator from the student's perspective.

Methods: The students were administered two kinds of questionnaires after completing their third-year of clinical reasoning PBL in fiscal year (FY) 2018. The students conducted medical interviews with SPs during both PBL sessions and used the simulator for either PBL. We compared the evaluations with and without the simulator.

Results: There were no significant differences in the 17 PBL learning scores and satisfaction levels of both groups. However, there were differences in the reasons for satisfaction and the comments about the PBL forms.

Conclusions: There was a certain degree of intellectual satisfaction because SPs participated on both days. We were able to discern the students' motives and expectations according to the lesson format and understand the improvements.

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KEYWORDS: simulator, simulated patient, clinical reasoning, problem-based learning

Introduction

In a problem-based learning (PBL) tutorial in medical education, there were challenges like "stereotyped" and "Insufficient knowledge may be acquired".[1)] We thought discussing the task repeatedly seemed repetitious to students, making them less motivated to learn. Therefore, we had considered this a problem with the PBL system and had been exploring countermeasures for it.

The PBL tutorial is an educational method adopted by

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medical schools and many medical universities. For medical staff to be able to provide stable performance, it is necessary to practice many times in a realistic environment.[2] PBL tutorial is a learning method that motivates students and is suitable for developing the ability to find problems in problem cases and the ability to solve problems as undergraduates.[3] By conducting the PBL tutorial in an environment close to the actual medical field, students should be more motivated and active, making effective training possible. Although clinical reasoning PBL with simulated patients was mentioned in texts from overseas,[4] there was no report on efforts to build clinical reasoning PBL tutorials in Japanese medical schools. Hence, we believed students would actively engage in classes if elements of practice were added with simulated patients (SPs) in a Japanese PBL tutorial.

In April 2015, we conducted a PBL tutorial pilot study of clinical reasoning, with or without SPs, with 17 multi-year students at the Toho University School of Medicine.[5] Although there were biases in the multi-year students' discussions and willingness, we considered the PBL with SPs to be highly useful based on the students' opinions via free descriptions.[5]

In January 2016, we conducted a clinical reasoning PBL tutorial with SPs as a regular class for third-year medical students. We carried out clinical inference PBL with/without SPs and compared the results of the questionnaire survey on learning evaluation, satisfaction, and reasons behind the PBL tutorial after each implementation.[6] Although there was no statistically significant difference in class satisfaction, the reasons for satisfaction differed. In the PBL with SPs, tension and realism were cited as grounds for satisfaction, indicating that PBL with SP was an inspiring educational method for medical students.[6]

In January 2017, we held the clinical reasoning PBL tutorial with SPs and a simulator as a regular class for third-year medical students.[7] We thought that using a simulator in addition to a simulated patient was closer to clinical practice. In the clinical reasoning PBL tutorial, students listened to the patient's symptoms, current medical history, psychosocial background, etc. from the SP. Half of the students obtained physical findings from the simulator (another half did not use it). Next, they conducted an exercise to tell the SP about their diagnosis and future treatment policy after the discussion. From the evaluation questionnaire at the end of these classes, improvement points, such as strengthening information transmission to the tutor, became clear.

This time around, we revised the improvements that emerged in fiscal year (FY) 2016. We implemented the clinical inference PBL tutorial with SPs, incorporating the simulator twice as much in regular classes during FY 2017. Although the students met the SPs during the two PBL lessons, they used the simulator for one of two PBLs. Thus, we were able to obtain class evaluations with and without the simulator. In this study, we retrospectively analyzed the lesson assessment questionnaire of two clinical reasoning PBLs to consider more effective PBL methods.

Methods

1) Subjects

We conducted an observational study that examines the questionnaire for the implemented PBL retrospectively. After finishing the clinical reasoning PBL tutorial for 119 third-year students at the School of Medicine in FY 2017, the students submitted the questionnaire as part of their class evaluation. We excluded students who refused to participate and those who could not be linked without submitting a class evaluation. We also made the data anonymous for analysis.

2) Research design

The outline of the classes conducted over the two days is as follows (January 16th and 23rd, 2018): We divided the clinical reasoning PBL tutorials into 18 groups (6-7 people/group). Since the university has a limited number of simulators, we split the class into two clusters, and when one cluster used simulators, the other did not (Fig. 1). Also, one SP participated in each group, and we arranged for the students to be able to hold simulated medical interviews in both classes (Fig. 2). After the discussion, the students explained their diagnoses to the SP and received feedback on the medical interview. During the exercise, we provided opportunities for first-time interviews, additional interviews, and explanations of the treatment policy, so that all students had a chance to talk directly by dealing with SPs with multiple students. Participating SPs were trained members of Toho University's SP Research Group (from the Faculty of Medicine).

The first day scenario was a palpitation case, while the second day was chest pain. Although the simulator used for each scenario was different, and the SP was not the same person, we designed the PBL tutorial such that all students had an equal chance to take part in two-day

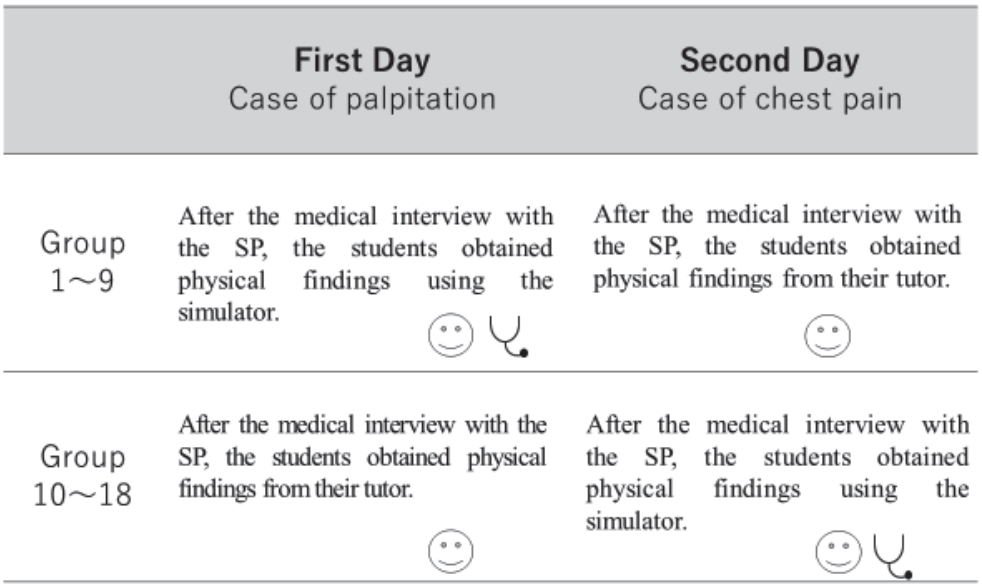

Fig. 1 Design of the clinical reasoning PBL with SPs incorporating simulators

learning opportunities.

We distributed the questionnaire for class evaluation at the end of each class and collected it via the indwelling method. We administered the registered questionnaire using 18 PBL learning assessment scales (1 = *not applicable at all*; 6 = *methods are very applicable*) and measured satisfaction (1 = *very dissatisfied*; 6 = *very satisfied*), as well as the students' reasons (which consisted of free descriptions). Next, we asked them whether they thought PBL with SPs and/or simulators fostered their clinical skills. We partially modified the PBL learning evaluation scale of 18 items based on the PBL tutorial evaluation items created by Suzuki et al.[8)]

3) Analysis

We used the data that could be linked as the analysis target, but the missing values were excluded and tabulated. Also, if the evaluation was answered across two locations, we used the score from the lower evaluation.

To analyze satisfaction and the first 17 (out of 18) items, we looked at statistical significance, using descriptive statistics and the Wilcoxon signed-rank test (significance level $<.05$). We employed descriptive statistics for the 18 th item and response of clinical ability.

At same times in the simulator, the students worked on both the SP and the simulator. Therefore, to investigate the usefulness of these stimuli, we employed the Wilcoxon signed-rank test to compare the mean scores of Q17 and Q 18 in the group with the simulator (significance level $<.05$). We used IBM's SPSSver.25 for statistical analysis.

We scrutinized the opinions obtained from the free description column using the KJ method; one researcher categorized and then reviewed this technique with another researcher and looked at the naming of categories. We classified those whose learning expression was not concrete (e.g., the only description was "I learned") as "Other." When one person had multiple answers, we placed them in each category and counted them as having one comment each.

4) Ethical considerations

We performed this study with approval from the Ethics Committee of Toho University School of Medicine (Project No. A17091). Since it was an analytical investigation with a registered class evaluation questionnaire, we explained that it would also be used for research when the questionnaire was distributed, that non-participation would not affect students' grades, and that we would begin the analysis after anonymization. Also, we explained that students should circle "I don't agree" on the questionnaire if they did not want their data used for research. We care about students who did not wish to be involved.

Results

We received a total of 96 (80.7%) responses from 57 men and 39 women; 69 people in the group with the simulator and 66 people in the group without it gave their opinions. In the group with the simulator, 69 respondents provided 69 responses, but in the group without the simulator, two respondents offered comments that fell into two catego-

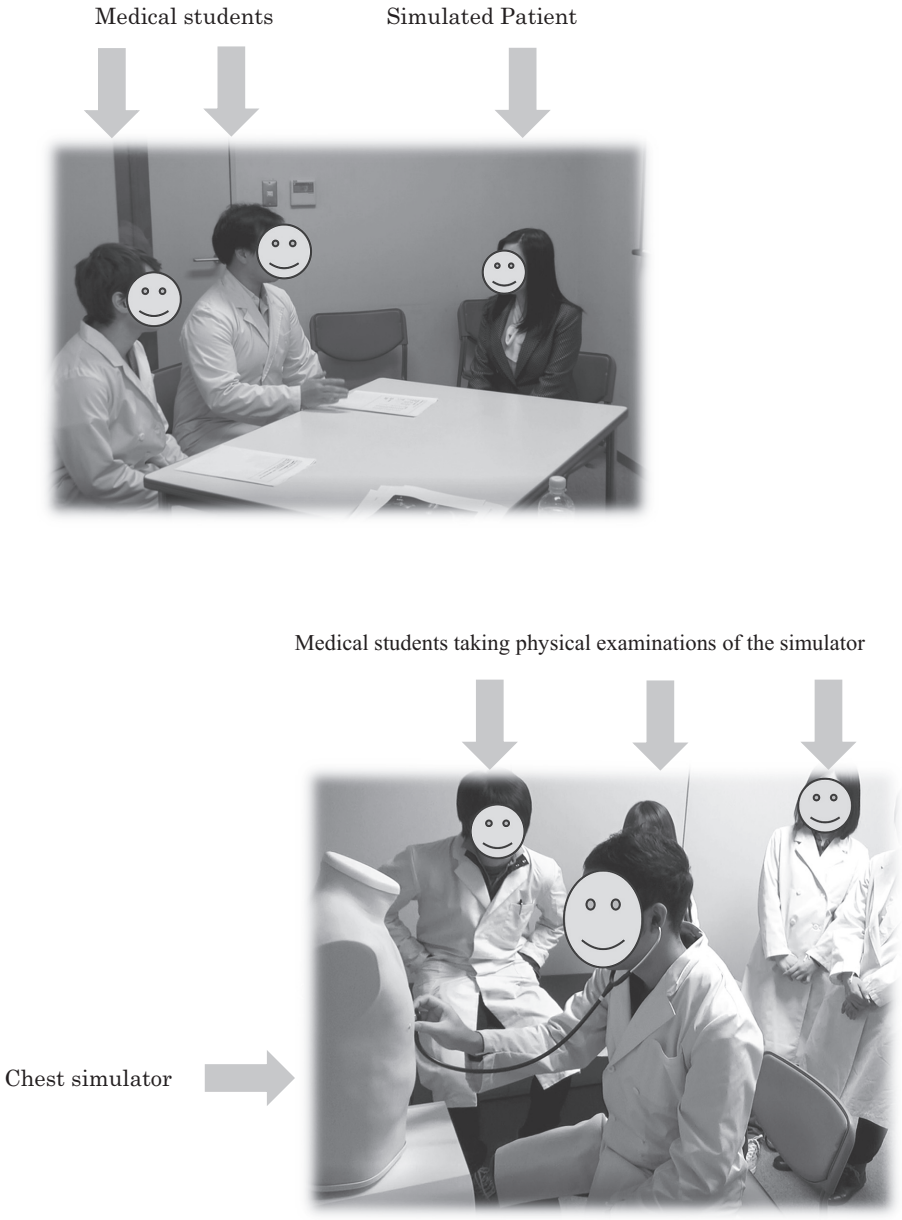

Fig. 2 Scenes of the clinical reasoning PBL with the SP using the simulator

ries, amounting to 66 respondents with 68 responses.

Table 1 displays the class evaluation. There were no significant differences in satisfaction and 17 PBL learning assessment items. On the other hand, regarding the scores for Q17 with the simulator (I think the PBL tutorial learning with an SP is helpful for learning clinical reasoning) and Q18 with simulator (I think the PBL tutorial learning using a simulator is useful for learning clinical reasoning), the score for Q17 was statistically significantly higher ($p = .017$, $< .05$). Due to summarizing the contents described as reasons for satisfaction via the KJ method, we derived six categories from the group with the simulator and seven categories from the group without them (Table 2). Although the number of responses did not deviate significantly between the groups with and without the simulator, there was a difference in the descriptions.

Specifically, in the group with the simulator, although many students thought that the simulators were easy to understand, there were also expressions of dissatisfaction, such as "I couldn't do it" or "The scenario doesn't match the simulator [however, this is based on the student's subjectivity]." Also, among the 15 responses classified as "practical learning experience," five responses mentioned specific learning via the SP instead of the simulator, re-

Table 1 Result of PBL evaluation scale
* Questions were quoted by modifying the PBL class evaluation items of Suzuki et al. (2009) [8]

	simulator	Mean ± SD		p-value
		With (n)	Without (n)	
Q1	I was able to speculate on the patient's condition by analyzing the information.	4.56 ± .88 (n = 96)	4.51 ± .78 (n = 96)	.47
Q2	I was able to capture the overall picture of the patient.	4.44 ± .83 (n = 96)	4.46 ± .81 (n = 96)	.78
Q3	I was able to extract medical problems based on assessments and present them in appropriate forms.	4.47 ± .85 (n = 96)	4.43 ± .82 (n = 96)	.57
Q4	I was able to achieve the aims of the PBL curriculum by using knowledge already acquired before the PBL tutorials.	4.49 ± .81 (n = 96)	4.50 ± .82 (n = 96)	.88
Q5	In the group discussion, I was able to explain my ideas logically.	4.39 ± .85 (n = 96)	4.52 ± .82 (n = 96)	.08
Q6	In the group discussion, I made an effort to understand other members' opinions.	4.76 ± .79 (n = 96)	4.65 ± .89 (n = 96)	.21
Q7	In the group discussion, I made an effort to promote active dialog in the group.	4.47 ± .77 (n = 96)	4.56 ± .81 (n = 96)	.20
Q8	I was able to participate in the group discussion with consideration for time management.	4.39 ± .84 (n = 96)	4.45 ± .88 (n = 96)	.40
Q9	I was able to select learning topics of higher priority.	4.51 ± .87 (n = 95)	4.53 ± .78 (n = 96)	.77
Q10	I was able to deepen my understanding of the learning topics I was engaged in.	4.68 ± .96 (n = 94)	4.71 ± .79 (n = 96)	.59
Q11	The tutor could serve as a resource (a person with expertise in case studies).	4.74 ± .99 (n = 96)	4.81 ± .85 (n = 96)	.52
Q12	I made great efforts regarding time and content in the self-learning process.	4.51 ± .88 (n = 96)	4.62 ± .88 (n = 96)	.20
Q13	The case was interesting.	4.65 ± .83 (n = 96)	4.56 ± .89 (n = 96)	.31
Q14	The PBL hours were appropriate.	4.50 ± .91 (n = 94)	4.44 ± .97 (n = 96)	.50
Q15	I think the PBL method increases our total learning time outside the class.	4.20 ± 1.01 (n = 95)	4.25 ± 1.02 (n = 96)	.69
Q16	I am satisfied with the learning process in the PBL tutorial.	4.49 ± .91 (n = 95)	4.54 ± .91 (n = 96)	.68
Q17	I think the PBL tutorial learning with an SP is helpful for learning clinical reasoning.	4.69 ± .92 (n = 96)	4.74 ± .91 (n = 96)	.54
Q18	I think the PBL tutorial learning using a simulator is useful for learning clinical reasoning. ※	4.47 ± 1.01 (n = 96)	—	—
	Levels of satisfaction after PBL[1-6].	4.60 ± .81 (n = 96)	4.71 ± .77 (n = 96)	.25

Q1 ～ 18): 1 = does not apply at all…6 = very applicable
Levels of satisfaction: 1 = extremely unsatisfied…6 = extremely satisfied
Significance level＜.05
※Q18: We only analyzed responses using the simulator on the day of the class evaluation.

gardless of the group with the simulator. In the group without the simulator, many students stated that explanations to SPs led to learning. And it was characteristic that there were many references to scenarios and tutors.

For the question "Do you think today's class will cultivate clinical ability?" only one student said "No" in each group (with and without the simulator); these were responses from different students.

Discussion

We analyzed students' class evaluations for a clinical reasoning PBL tutorial with SPs and one with/without the simulators, and examined how the students assessed the program.

Students' PBL evaluations were almost the same with and without simulators. By comparing the scores for Q17

Table 2 Categories obtained by classifying reasons for satisfaction

	Category name (n)	Chunk name (n)	Comment content (excerpt)
With simulator (n=69)	Easy to understand (34)	Using the five senses (18)	I heard a sound close to the actual one.
		Reconfirm procedure (7)	I was able to review how to take vitals.
		Easy to understand (9)	I gained a better understanding of the disease by looking at the difference between the left and right auscultation.
	Practical learning experience (15)	Practical (10)	It was good because it was made in a very clinical form.
		Stimulation with SP (5)	We received a good indication from the SP.
	Dissatisfaction with settings and time allocation (10)	Dissatisfied with PBL settings (8)	There was nothing unusual. It was not suitable as a simulator for the subject's disease.
		Lack of time (2)	I wanted to spend a little more time.
	Learning through PBL (3)	Satisfaction with the study itself (3)	I understood thyrotoxicosis.
	Influence of tutor (2)	Good tutor (1)	Our tutor was good.
		Dissatisfaction with the tutor (1)	The learning time was limited due to the inadequacy at the beginning.
	Others (5)		It became profitable. It had been enhanced.
Without simulator (n=66 ※)	Practical learning experience (22)	Learning effect by SP (12)	I was able to learn how to explain things to patients.
		Tension (4)	I was able to work with more tension.
		Practical (3)	It was more practical.
		Making use of what I learned (3)	It was a good review of what I had studied so far.
	Learning through PBL (14)	Opinions about learning itself (10)	I learned the difficulty of diagnosis. I thought it would be useful in the future to think about the disease from scratch.
		Satisfaction with remarks and discussions (4)	I had a fruitful discussion and learned.
	Influence of scenario (10)	Good scenario (8)	Various interesting diseases were considered.
		The scenario was too easy (2)	The case was too simple.
	The value of experiencing (7)	Medical interview practice (7)	It was a very good experience because I had a medical interview.
	Influence of tutor (6)	Good tutor (5)	It was moderately hinted at.
		Dissatisfaction with the tutor (1)	The tutor was non-cooperative and put a lot of pressure on the students.
	Dissatisfaction with time allocation (2)	Lack of time (1) Extended (1)	I needed as much time as the usual tutorial. I needed extended time.
	Others (7)		I learned. I could not use our room's mouse.

※Group without the simulators: 2 respondents commented in 2 categories.

and Q18, as well as the many mentions of SPs, we deduced that the SPs' participation contributed to satisfaction and the PBL learning evaluation scale, with, or without the simulator. However, there was no statistical difference in satisfaction in the comparison results of the clinical inference PBL tutorial with/without the SPs from two years before.[6] A series of studies (including this one) contain analyses of class evaluation questionnaires. Since the class scenarios and tutors are different each time, it is impossible to obtain statistically significant differences in PBL, which already involves active learning. This may be a research limitation.

On the other hand, examining the reasons for satisfaction (or dissatisfaction), each satisfaction (dissatisfaction)

point was different, reflecting the lesson design's characteristics. Satisfaction with PBL using the simulator with the SP were influenced by the reality the SP provided. In response to the opinion that the students were unable to see and hear, as well as the desire for more advanced learning, we believe this problem could be solved if the teacher responds to these issues after class. If a scenario-related simulator is prepared after the class, this may lead to learning outside the regular class. For Q15 (I think the PBL method increases our total learning time outside the class), the score was lower than for the other items. We speculated that the students had been satisfied with learning by using SPs and simulators in PBL or might not have thought to review their learning using simulators after PBL. According to a survey of weekly preparatory/review times for university students by field (for first and second-year students), the students in the School of Medicine, Dentistry, and Pharmacy did not have enough time to prepare and review for attending classes.[9] For any of the above possibilities, our university would not be considered an exception. This is a future matter in terms of exploring ways to provide support for learning outside of class.

The students who used the simulator gave many opinions about the "ease of understanding." Even if there were no simulator, they gave many opinions about the learning results obtained from communication with the SP. Barrows et al. (1980) described the SP's participation in a student's clinical reasoning PBL: "The students have to be sensitive to the patient's concerns and his responses to their ministrations, and must evaluate and deal with the patient's total problem, medical, and psychosocial. As a last grand rule, therefore, the students must behave during 'time in' as they would in the presence of a real patient, so that interpersonal skills and sensitives can be studied and critiqued by the group." In our study, it seemed that we obtained the learning effect suggested above. Also, the lesson format had an aspect of simulation-based training,[10] aiming to integrate thinking and behavior and clinical application. The students expressed opinions commensurate with the purpose as reasons for satisfaction. In other words, it seemed there was a certain educational effect regarding simulation-based training.

On the other hand, in the PBL without the simulators, we inferred from the freely written opinion that the students paid attention to other elements that make up the lesson (such as scenarios and tutors) because there were no simulators. Focusing on improvements such as "the case is too simple" and "the tutor was non-cooperative and put a lot of pressure on the students," we have the challenge of equalizing the quality of scenarios and tutors.

About 99% of students answered "Yes" to the question, "Do you think today's class will cultivate clinical ability?" We speculate that students found significance in the clinical reasoning PBL tutorial with performance. Simulation learning resembles an environment that is close to actual clinical practice; as in real clinical practice, psychological pressure is applied to learners, and emotions increase.[2] It is possible to fill the "gap between behavior and knowledge" by providing education that matches the actual situation, making judgments under pressure, and repeating actions.[2] We believe the exercises in the form of this lesson lead to "fostering better clinicians," which is the educational goal of the Faculty of Medicine at this university.

This study was a retrospective analysis of students' evaluation questionnaires. There was an undeniable bias because the answers were to be read by teachers and they were limited to the answers from the students who submitted them. Also, due to the limited number of simulators, we assigned simulators to one group on the first day and another group on the second day. We also took into account differences in background, such as order effects and discrepancies between tutors and scenarios. However, because the PBL of our study was part of the regular lesson, we were unable to eliminate these biases.

Conclusion

For this research, we found that there was no significant difference in the PBL learning evaluation scale between the groups with and without the simulator, and there was no significant difference in satisfaction. However, from the free description, when using a simulator, there were many references to "ease of understanding" and "practical learning experience." Even without a simulator, there were opinions of "practical learning experience" and "learning through PBL," and we were able to read the students' motives and expectations according to each PBL format. And we were able to grasp the points of improvement.

Repeated practices are required in medical training. PBL provides a learning experience similar to actual clinical practice. Also, many opinions were obtained from the students in this study that this approach will help to develop clinical ability. Thus, it is meaningful to continue the

"the clinical reasoning PBL tutorial class that incorporates performance."

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Conflicts of interest: None declared.

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