J Med Dent Sci 2010; 57: 109–118

Original Article

Problem-based learning in a multidisciplinary group enhances clinical decision making by medical students: A randomized controlled trial

Eishu Nango and Yujiro Tanaka

Department of General Medicine, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University.

BACKGROUND: The effect of multidisciplinary education on clinical decision making by medical students is not well known. ***METHODS:*** Twenty of fourth, fifth or sixth year medical students were randomly assigned to multidisciplinary groups (MultiG, n = 7) with two medical, pharmacy and nursing students or medical student groups (MedG, n = 10) with six medical students only and given a two-day PBL program using evidence-based medicine (EBM) methodology. The main outcome measure is clinical decision making by medical students for the case, measured by a 100 mm visual analog scale (VAS). Additional patient information requested and self-evaluation of the PBL program were also measured. ***RESULTS:*** Correct answers to assess clinical epidemiology knowledge increased significantly in both groups (4.1 to 9.9 points in MultiG, $p < 0.001$: 3.6 to 9.7 points in MedG, $p = 0.002$), while scores at baseline and post-program were not significantly different. The number of additional patient information cards requested was not significantly different ($p = 0.10$). After the program, the VAS for clinical decision making was significantly different (54 mm and 89 mm, $p = 0.013$), although pre-program values for both groups were similar. ***CONCLUSION:*** Pharmacy and nursing students may have potential to change the clinical decision making by medical students.

Corresponding Author: Eishu Nango
1-5-45, Yushima, Bunkyo-ku, Tokyo, 113-8519, Japan.
Tel: +81-3-5803-4508 Fax: +81-3-5803-0281
E-mail: sulzberger@amy.hi-ho.ne.jp.
Received September 30 ; Accepted November 13, 2009

Keywords: randomized controlled trial; education, multidisciplinary; education, medical, undergraduate; problem-based learning; evidence-based medicine

INTRODUCTION

Recent studies[1,2] show that collaboration between physicians and nurses with close communication results in improved patient satisfaction, improved overall prognosis and reduced costs. Conferences including multidisciplinary members of the healthcare team are conducted routinely in many institutions to discuss patient care issues, and seminars with students from multiple disciplines or workshops in which multidisciplinary healthcare workers learn together have been organized. When multidisciplinary healthcare students learn together during their undergraduate education, they may realize the benefits of cooperation which can be put into practice later in their careers. In fact, multidisciplinary undergraduate medical education is widely conducted in Japan as well as in Europe and Northern America. However, systematic reviews evaluating the effects of multidisciplinary medical education found that preceding studies show some benefit in outcomes including knowledge, attitudes, skills and behavior, but most studies are inadequate to conclude a definite effect, especially in clinical outcome[3,4]. If the benefits of multidisciplinary undergraduate education are confirmed, it is of great significance to introduce multidisciplinary approach into undergraduate medical education widely.

The concepts of evidence based medicine (EBM) have been shown to be useful in improving the quality of clinical decision making[5]. The methodology of EBM is a four-step process including: formulating patients'

questions (step 1), searching for the best evidence (step 2), critical appraisal of the evidence (step 3), and application of the evidence to the patient (step 4)[5]. In step 4 of EBM, it is necessary to consider various factors regarding the patient's clinical and physical circumstances, research evidence, patient's preferences and actions, and clinical expertise[6]. Therefore, a wide-scope discussion including multidisciplinary healthcare workers could also result in the high-quality practice of EBM.

It has been advocated that problem-based learning (PBL) had to forge the ideas needed in actual practice when it was first developed at McMaster University[7]. In recent studies regarding PBL, most outcomes were surrogates such as the acquisition level of knowledge or students' attitudes and satisfaction[8,9]. Although the efficacy of PBL was proven in communicating skills and teamwork[10,11], recent studies showed no positive effect in medical judgment[12], and the level of evidence of PBL for problem-solving and critical thinking is also somewhat weak[8]. A positive effect on clinical reasoning may exist but has not been confirmed by a randomized controlled trial[13]. In conclusion, to date, no randomized controlled trial has demonstrated an effect of PBL using an outcome measure to demonstrate a change of physicians' medical decision making in clinical practice.

This randomized controlled trial was conducted to verify whether PBL with a team of multidisciplinary healthcare students can affect the clinical decision making by medical students when compared with a PBL program including medical students only.

MATERIAL and METHODS

Participants

Inclusion criteria for study participants were status as a fourth, fifth or sixth year medical student (of a six-year program) having passed the Common Achievement Tests (a Japanese nationwide examination similar to the USMLE Step 1 examination), and pharmacy and nursing students enrolled in a master's degree program. The first year of a master's program in pharmacy and nursing roughly corresponds to the fifth year of medical school in Japan. Medical students who have formally studied the critical appraisal of medical literature, have joined multidisciplinary education programs or graduated in other health care disciplines were excluded. This study conformed to the Declarations of Helsinki guidelines and all participants provided oral and written informed consent. The ethical review committee for clinical research of the School of Medicine, Tokyo Medical and Dental University, approved this study.

Intervention

Medical students were randomly assigned to either multidisciplinary groups (MultiG) that consisted of six multidisciplinary students (two medical students, two pharmacy students and two nursing students) or medical student groups (MedG) that consisted of six medical students only, in a ratio of 2:3 using computer generated random numbers (Figure 1). All pharmacy and nursing students were allocated to a MultiG group. Randomization was stratified by gender. Allocation of randomization was concealed until the randomization was completed.

PBL program

The PBL program was planned as a two-day session (Table 1). The purpose of the PBL program was to acquire the ability to construct an algorithm for clinical decision making to solve a patient's problem. All students received an original textbook that briefly explained the concepts of EBM by e-mail two to four days before the first day of the program. The program on Day 1 lasted three hours. First, students took a written test to evaluate their knowledge of clinical epidemiology. All students received a 15 minute lecture explaining the four steps of EBM. They were then separated into groups, and had a 90 minute small group discussion (SGD-1) for the case presentation and formulation of a clinical question.

The case scenario was designed to decide whether beta blocker treatment should be used for cardiac protection in a 79-year-old man who had diabetes, chronic obstructive lung disease, atrial fibrillation, and repeated hospitalizations with exacerbation of cardiac failure. The English translation of original case scenario is in appendix.

During SGD-1, clinical questions about the case scenario were generated and formulated as a four-part question of PICO (patient, intervention, comparison and outcome). At the beginning of the presentation, only the core information of the case was presented. The strategic inquiry method was used when additional information was provided on patient information cards prepared ahead of time, and given only when students requested this information during the SGD. Patient information was divided on 36 cards, 12 about bio-medical information, and 24 about psycho-social information. At the end of Day 1, they had a 30 minute small group discussion (SGD-2) to identify the best

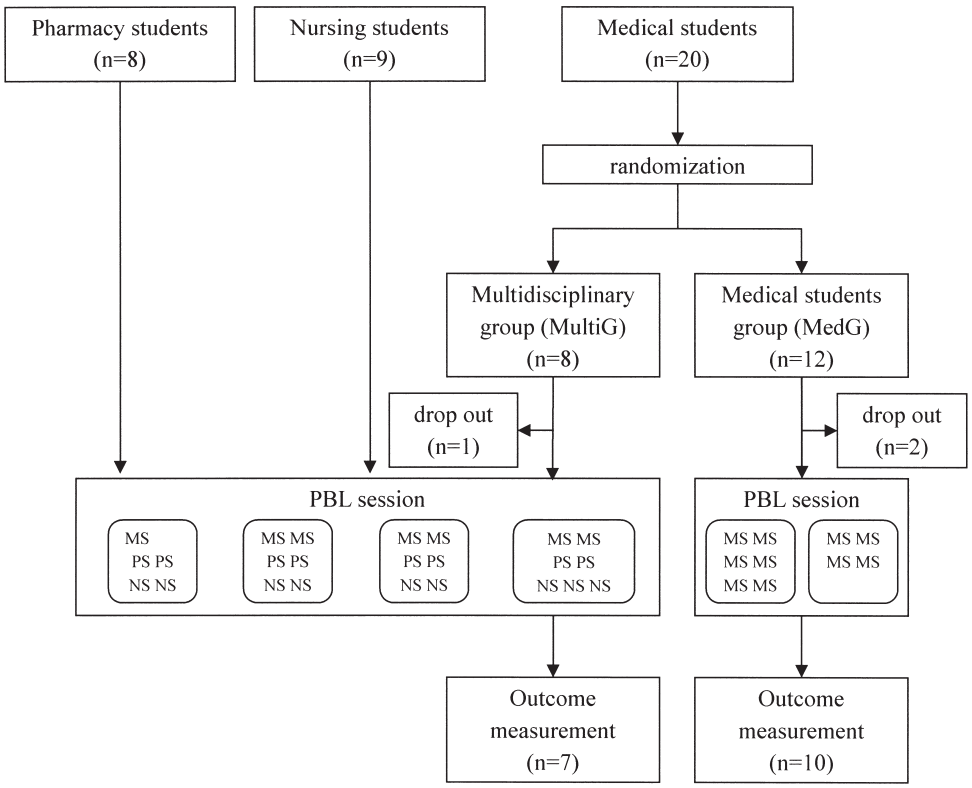

Figure 1 : Assignment of Study Participants to MultiG and MedG Groups

Table 1. Program Schedule

Day 1	20min	Test to evaluate knowledge of clinical epidemiology
	15min	orientation
	15min	Lecture: Four steps of EBM
	10min	Introduction
		← VAS I
	90min	SGD 1: step 1. Case presentation and formulating clinical questions
	30min	SGD 2: step 2. Finding the best evidence and showing CAT sheet
		← VAS II
Day 2		← VAS III
	30min	SGD 3: review of Day 1
	60min	SGD 4: step 3. Critical appraisal of the article
		← VASIV
	75min	SGD 5: step 4. Application to the patient in this case
		← VAS V
	15min	closing
	20min	Test to evaluate knowledge of clinical epidemiology

SGD: small group discussion, CAT: critically appraised topic

evidence. During SGD-2, students could access electronic information including UpToDate (http://www.uptodate.com) and the EBM Library for Cardiovascular Trials (http://www.ebm-library.jp/circ/index_top.html), a web-based database of structured abstract of cardiovascular trials for searching available evidence. The article used for the PBL program was available in the EBM Library for Cardiovascular Trials with a structured abstract in Japanese so that students could rapidly understand the material. Such structured abstract is so called Critically Appraised Topic(CAT) sheet.

Two weeks later, the Day 2 session was completed in four hours. Students had SGD-3 as review of the first day for 30 minutes and SGD-4 for critically appraising the article for 90 minutes. The article used during SGD-4 was a randomized controlled trial14 about the efficacy of carvedilol (a widely used oral beta blocker) in Japanese patients with chronic heart failure and was provided at this time. After SGD-4, SGD-5 was conducted to apply the information to the patient in this case specifically. The closing session was then conducted and again students took a test to evaluate their knowledge of clinical epidemiology.

A physician (EN), nurse or pharmacist with teaching experience during EBM workshops facilitated the discussions as a tutor for each group and supported student learning. Different tutors facilitated each group on Day 1 and Day 2 to avoid any bias of the tutor. However, based on study design, it was impossible to blind the nature of the intervention.

Measurement of Outcomes

At the beginning of the study, students' knowledge of clinical epidemiology was assessed on the following twelve items by free description and the number of correct answers counted: PICO, Medline and PubMed, MeSH, Bias, Randomized controlled trial, Random allocation, Intention-to-treat analysis, Masking, Sample size, Relative risk (RR), Relative risk reduction (RRR), Absolute risk reduction (ARR) and Number needed to treat (NNT), p value and 95% confidence interval.

The primary endpoint of the study was the clinical decision making by medical students at the end of the PBL program using a 100 mm visual analog scale (VAS), ranging from 0 (no desire to use at all) to 100 (absolutely want to use) to quantitate their likelihood to prescribe beta blocker therapy. Using a VAS can express the ambivalence of judgment of medical students because it is an analog scale. Clinical decision making was assessed not only at the end of the PBL program (VAS Ⅴ) for the primary endpoint, but also other points such as immediately after the case presentation (VAS Ⅰ), following review of the CAT sheet (VAS Ⅱ), before (VAS Ⅲ) and after (VAS Ⅳ) the critical appraisal (Table 1).

Secondary endpoints of the study were the students' comprehension of the case scenario, the change in knowledge of clinical epidemiology before and after the PBL program, attitude of the students and evaluation of the PBL program. To evaluate the students' comprehension of the case scenario, the numbers of additional patient information cards requested by students with strategic inquiry method were counted. The students' self-evaluation of the PBL was evaluated on a 5-point Likert scale ranging from 1 (not at all) to 5 (definite) for the following eight questions: whether they obtained knowledge; the knowledge was useful for the future; educational material was appropriate; the case scenario was appropriate; SGD was effective; students themselves could study enthusiastically; other group members study enthusiastically; and whether they wish to join a similar PBL program in the future.

Statistical Analysis

An estimated sample size of seven medical students in MultiG and 11 in MedG was calculated to detect a 25 mm difference between the groups on the 100 mm VAS. The calculation included an estimated standard deviation of two points for a two tailed test ($\alpha = 0.05$, power = 0.70). To create each group of six students, the medical students in the MultiG and MedG groups numbered eight students and 12 students in each group. As a result, the numbers of groups of MultiG and MedG are configured to four and two respectively. Results of the 100 mm VAS for clinical decision making by medical students, the score of knowledge of clinical epidemiology, and the number of additional patient information cards were analyzed by t-tests between MultiG medical students and MedG students. One-way ANOVA was used with the analysis between medical, pharmacy and nursing students comparison of the VAS, and MultiG medical, MedG medical, pharmacy and nursing students comparison of the score of knowledge of clinical epidemiology. All analyses were performed with SPSS 14.0 J for Windows statistical software (SPSS Japan Institute, Tokyo, Japan), and performed according to an intention - to - treat principle.

RESULTS

Participants

Of 20 medical students, eight were assigned to MultiG and 12 to MedG. One medical students assigned to MultiG and two assigned to MedG did not attend the PBL program, and were excluded from further analysis. Eight pharmacy students and nine nursing students were all assigned to MultiG. Final distribution of the students is shown in Figure 1. MultiG has one group of one medical student, two pharmacy students and two nursing students, two groups of two medical students, two pharmacy students and two nursing students, and one group of two medical students, two pharmacy students and three nursing students. On the other hand, MedG has one group of six medical students and one group of four medical students. All students who participated in Day 1 events also attended on Day 2. The baseline characteristics of medical students were well balanced between MultiG and MedG (Table 2).

VAS measurement of clinical decision making for the case scenario

Figure 2 and Table 3 show the results from the VAS for clinical decision making by medical students for the case scenario in each group based on the PBL program. The mean ± SD of clinical decision making after the case presentation (VAS Ⅰ) at the baseline was not significantly different between the MultiG and MedG groups at 35±22 mm vs. 40±20 mm, respectively ($p = 0.64$). The clinical decision making for all medical students was also similar to those for pharmacy and nursing students after the case presentation (VAS Ⅰ) at 38±20 mm, 29±23 mm and 46±17 mm ($p = 0.40$). The clinical decision making by medical students of both groups was similar after step 2 (VAS Ⅱ), at the beginning of Day 2 (VAS Ⅲ) and after step 3 (VAS Ⅳ) as well, and these judgments showed a tendency to use the beta blocker treatment as the PBL program advanced.

On the other hand, at the end of the PBL program (VAS Ⅴ), the VAS of medical students in the MultiG group at 54 ±39 mm showed a statistically significant tendency to avoid the beta blocker treatment as a result of clinical decision making than did the MedG group at 89±8 mm ($p = 0.013$). The clinical decision making by pharmacy and nursing students at the end of the PBL program (VAS Ⅴ) scored 53±29 mm and 70 ±23 mm. The differences in clinical decision making between the initial case presentation (VAS Ⅰ) and the end of the PBL program (VAS Ⅴ) were 18±50 mm in the MultiG group and 49±17 mm in the MedG group, but these differences were not significant ($p=0.096$). The difference in clinical decision making between before (VAS Ⅳ) and after (VAS Ⅴ) step 4 showed that medical students in the MultiG group changed toward not using the beta blocker treatment by a mean change on the VAS of 30±40 mm, while medical students in the MedG group changed significantly toward using the beta blocker treatment, with a mean change on the VAS scale of 13±14 mm ($p = 0.007$).

Knowledge of clinical epidemiology

The number of correct answers to assess the knowledge of clinical epidemiology of medical students in the MultiG group, those in the MedG group, and pharmacy and nursing students at the beginning of the PBL program were 4.1±2.7, 3.6±2.5, 4.6±1.5 and 4.7±1.9 points out of 12 and showed no significant differences between the groups ($p = 0.70$). At the end of the PBL program, the numbers of correct answers were 9.9±2.2, 9.7±1.5, 7.9±1.2 and 9.1±2.0 respectively, and these also were not significantly different ($p = 0.12$). However, the number of correct answers significantly increased from the beginning of the PBL program to the end of the PBL program for all groups tested ($p < 0.001$, $p = 0.002$, $p = 0.005$, $p = 0.004$).

Quantity and quality of additional patient information requested

No difference was found in the numbers of additional patient information cards that MultiG and MedG students requested (28±3.8 vs. 22±0, $p = 0.10$). Neither the number of bio-medical cards (10±1.8 vs. 12±0, $p = 0.2$) nor psycho-social cards (17.8±3.8 vs. 10±0, $p = 0.052$) showed a significant difference between the MultiG students and the MedG students.

Students' self-evaluation of the PBL program

In the self-evaluation of the PBL at the end of the program, all of the scores for the questions were similar between the MultiG group and the MedG group; whether they obtained knowledge (4.7±0.5 vs. 4.3±0.7, $p = 0.19$); usefulness for the future (4.9±0.4 vs. 4.7±0.5, $p = 0.48$); educational material was appropriate (4.3±0.8 vs. 4.5±0.8, $p = 0.6$); case scenario was appropriate (4.6±0.5 vs. 4.4±0.8, $p = 0.64$); SGD was effective (4.6±0.5 vs. 4.2±0.9, $p = 0.35$); students could study enthusiastically (4.1±0.9 vs. 4.3±0.7, $p = 0.69$); group members studied enthusiastically (4.7±0.5

Table 2. Baseline characteristics

	Medical students			Pharmacy students	Nursing students
	MultiG n=7	MedG n=10	Total n=17	n=8	n=9
Age (mean yr ± SD)	24 ± 1.4	25 ± 4.3	25 ± 3.4	23 ± 1.1	30 ± 5.5
Male : Female	4:3	5:5	9:8	2:6	0:9
Year in School					
First year of master's program (%)				8 (100)	9 (100)
Sixth year (%)	1 (14)	0(0)	1 (6)		
Fifth year (%)	5 (71)	8 (80)	13 (76)		
Fourth year (%)	1 (14)	2 (20)	3 (18)		
Clinical decision making after case presentation (mm)	35 ± 22	40 ± 20	38 ± 20	29 ± 23	46 ± 17

MultiG: multidisciplinary group, MedG: medical student group, SD: standard deviation

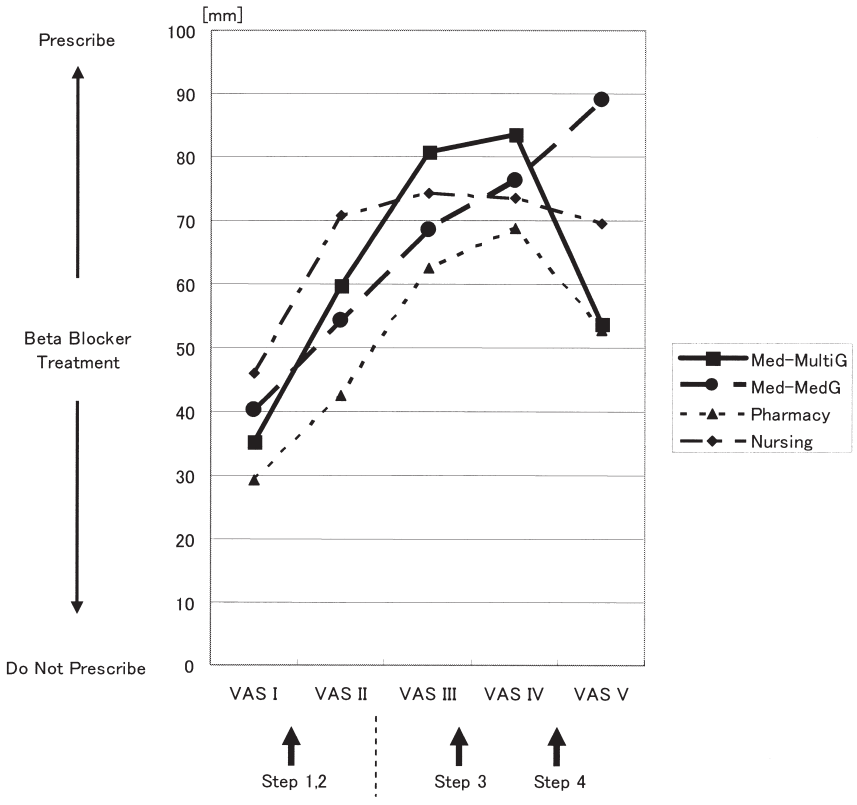

Figure 2 : VAS of clinical decision about case scenario during PBL
Med-MultiG: Medical students in a multidisciplinary student group,
Med-MedG: Medical students in a Medical student only group

Table 3. VAS of clinical decision about case scenario during PBL

VAS	Medical students		Pharmacy students n=8	Nursing students n=9	P value
	MultiG n=7	MedG n=10			
Ⅰ (mean±SD)	35±22	40±20	29±23	46±17	0.64 † 0.40 ‡
Ⅱ (mean±SD)	60±33	54±23	43±26	71±10	0.69 †
Ⅲ (mean±SD)	81±27	69±21	63±25	74±18	0.30 †
Ⅳ (mean±SD)	83±21	76±15	69±27	74±24	0.42 †
Ⅴ (mean±SD)	54±39	89±8	53±29	70±23	0.013 †

MultiG: multidisciplinary group, MedG: medical student group, SD: standard deviation
† comparison between the MultiG and MedG medical students
‡ comparison between medical (MultiG and MedG), pharmacy and nursing students

vs. 4.6±0.7, p = 0.72); and whether they wish to join a similar PBL program (4.4±0.5 vs. 4.3±0.7, p = 0.68).

DISCUSSIONS

This study demonstrates that the clinical decision making by medical students was affected through PBL programs with multidisciplinary healthcare students compared to those with medical students only. It is of value because there are few randomized controlled trials that evaluate the effect of medical education, especially on physicians' medical decision making, in clinical practice[8].

The case scenario used in this PBL was to decide whether beta blocker therapy should be used for cardiac protection in a 79-year-old man with diabetes, chronic obstructive lung disease, atrial fibrillation, and repeated hospitalizations with an exacerbation of cardiac failure. Although a randomized controlled trial[14] has shown that beta blocker treatment improves the prognosis of patients with chronic heart failure, there are many barriers to their use in actual medical practice.[15-17] Beta blockers require prolonged hospitalization because their dose must be adjusted gradually[18] and furthermore, beta blockers have to be discontinued with exacerbation of heart failure and re-starting the medication is then required. Additionally, the patient in the case scenario did not want to be hospitalized and was at high risk for exacerbation of heart failure because he could not comply with dietary restrictions. Medical students in the MedG groups decided to use the beta blocker treatment since they considered only part of the evidence. On the other hand, these results suggest that non-medical students valued this kind of information more than medical students did, because students in the MultiG requested a greater number of psycho-social cards. Furthermore, medical students in the MultiG groups tended not to use beta blocker treatment as a result of getting further information about the method of using beta blocker treatment, and the fact that it takes several weeks, based on information from the pharmacy students and of the patient's desires regarding their care from the nursing students. The change in clinical decision making by medical students may have great significance for their future practice of medicine when influenced by the opinions of pharmacy and nursing students.

In order to assess outcomes quantitatively, we used a VAS in this study. The VAS was originally developed for the diagnosis of psychiatric disease[19,20], and has been applied clinically to judge pain intensity.[21] Recent literature has described the VAS as a very sensitive scale to evaluate judgments.[22] Because we want to find a delicate change of clinical decision making by medical students through the PBL program, a sensitive scale such as the VAS was adopted.

After step 1 of EBM (formulating the patient's problem), the VAS (VAS Ⅱ) was still not different between the two groups. This may be due to the fact that the students' discussion was only based on patient information and lacked information about the beta blocker treatment. On the other hand, the judgment remained unchanged at step 2 (VAS Ⅱ) (searching for the best evidence) and step 3 (VAS Ⅳ) (critical appraisal of the evidence) perhaps because it had not been realized to be part of

the patient's problem despite appraising the evidence. Both patient-related factors and the clinical evidence for treating patients are necessary to appropriately apply clinical decision making, and it would be more effective when the process of EBM is introduced to the PBL program.

Learning alongside multidisciplinary healthcare students is meaningful to discuss at both steps 1 and 4 (applying the evidence to the patient) in depth. Since prescribing medication is permitted only for physicians in Japan, they tend to judge the value of treatment based on an isolated and sometimes arbitrary decision. Some physicians have a strong bias toward bio-medical information such as pathophysiologic effects. It is important for physicians to acquire information and ideas from other members of the healthcare team and for medical students to learn the importance of collaboration with healthcare workers during undergraduate medical education. Past studies evaluating the effectiveness of inter-professional collaboration were concerned mainly with the interactions between physicians and nurses[23-29] but little has been studied regarding physicians and pharmacists[29,30]. The findings in our study are also meaningful because the difference was seen not in the surrogate outcomes but in the important outcome of clinical decision making.

When PBL is performed with multidisciplinary healthcare students, it is necessary to prepare scenarios that allow students to apply knowledge from each of their own background. In situations very similar to actual practice, students can study using the strategic inquiry method which uses patient information cards to provide additional information, as was done in this study. This technique limits the information provided which the student considers important. Additionally, through the PBL, medical students can be aware of issues that are considered only by students with other background.

In the evaluation of PBL, it is difficult to determine the effect of learning on the quality of medical care. Thus, it may be more appropriate to evaluate how much information medical students receive from students with other background or how many social and psychological factors are included in the process of clinical reasoning after the PBL program.

Limitations of the study

Although the students in this study were randomly assigned, the interaction between the group members can not be excluded. This could be a limitation of this kind of educational researches by differing from animal studies.

The number of patient information cards students requested was greater in the MultiG group but this difference was not significant. This may be due to an insufficient number of groups since this study included only four MultiG groups and two MedG groups.

Organization of a PBL program with multidisciplinary healthcare students may not be well accepted, since it requires more effort, and avoided if there remains no clear advantage to students other than the medical students. Thus further study is necessary to examine whether the patient's compliance with instructions and the nursing care plan are changed similarly when pharmacy and nursing students learn during a PBL program with multidisciplinary healthcare students.

Conclusion

A PBL program with multidisciplinary healthcare students significantly affects the clinical decision making by medical students. This change in behavior may be partially due to the fact that the medical students seek more information from pharmacy and nursing students in evaluating the patient, especially regarding psycho-social information. Therefore, pharmacy and nursing students may have the potential to change the clinical decision making by medical students and it is valuable to organize multidisciplinary PBL.

ACKNOWLEDGEMENTS

The authors thank Prof. C Sato (Tokyo Medical and Dental University, Tokyo) for suggestions about study design; Ms. A Ninomiya (Tokyo Medical and Dental University, Tokyo) for recruitment of nursing students for study participants; Mr. S Igarashi (Pharmacist, Yokohama Municipal Citizen's Hospital, Kanagawa) and Ms. T Ikegame (Nurse, St. Lukes International Hospital, Tokyo) as tutors for PBL; Mr. Michio Shiibashi (Saitama Medical University, Saitama) for statistical advice; and Dr. H Yuasa (Department of Oral and Maxillofacial Surgery, Branch Hospital of Tokai Municipal Hospital, Aichi) and Prof. AT Lefor (Jichi Medical University, Tochigi) for their patience in assisting in the preparation of the manuscript. We would also like to thank the students as study participants.
Contributors: EN and YT participated in the conception and design of the study and recruitment of participants. EN participated in the acquisition, analysis and interpretation of data and drafting the manuscript. EN

and YT participated in revising the manuscript and final approval of the version to be published.

Funding: This study had no funding support.

Conflicts of interests: EN and YT received no financial support from any organization.

APPENDIX

The clinical scenario in the PBL session

Mr. U is a 79-year-old man with a history of heart failure, hypertension, type 2 diabetes, chronic renal failure and chronic obstructive pulmonary disease, and admitted to this hospital with exacerbation of heart failure. He has felt dyspnea and weight gain of eight kilograms since two weeks before admission and got better by furosemide. Although it is written that the beta-adrenergic antagonist is effective for heart failure on textbooks, there is no such medication in Mr. U's prescription. You are going to read the following paper to think of whether you should admit carvedilol or not to improve his prognosis.

Suggested Article :

Hori M, et al.; MUCHA Investigators.

Low-dose carvedilol improves left ventricular function and reduces cardiovascular hospitalization in Japanese patients with chronic heart failure: the Multicenter Carvedilol Heart Failure Dose Assessment (MUCHA) trial.

Am Heart J 2004;147:324-30.

PMID: 14760332

References

1. Zwarenstein M, Bryant W. Interventions to promote collaboration between nurses and doctors. *Cochrane Database Syst Rev* 2000;(2):CD000072.
2. Grumbach K, Bodenheimer T. Can health care teams improve primary care practice? *JAMA* 2004;291:1246-51.
3. Reeves S, Zwarenstein M, Goldman J, et al. Interprofessional education: effects on professional practice and health care outcomes. *Cochrane Database Syst Rev* 2008 ;(1):CD002213.
4. Chakraborti C, Boonyasai RT, Wright SM, et al. A systematic review of teamwork training interventions in medical student and resident education. J Gen Intern Med. 2008;23:846-53.
5. Straus SE, Richardson WS, Glasziou P, et al. *Evidence-based medicine: how to practice and teach EBM*. 3rd ed. London: Churchill Livingstone, 2005.
6. Haynes RB, Devereaux PJ, Guyatt GH. Physicians' and patients' choices in evidence based practice. *BMJ* 2002;324:1350.
7. Barrows H. *Authentic Problem-based Learning. Teaching and Learning in Medical and Surgical Education: Lessons learned for the 21st century*. (Distlehorst L, Dunnington G & Folse J eds.), Lawrence Erlbaum Associates, New Jersey, 2000.
8. Koh GC, Khoo HE, Wong ML, et al. The effects of problem-based learning during medical school on physician competency: a systematic review. *CMAJ* 2008;178:34-41.
9. Smits PB, Verbeek JH, de Buisonjé CD. Problem based learning in continuing medical education: a review of controlled evaluation studies. *BMJ* 2002;324:153-6.
10. Jones A, McArdles PJ, O'Neill PAO. Perceptions of how well graduates are prepared for the role of pre-registration house officer: a comparison of outcomes from a traditional and an integrated PBL curriculum. *Med Educ* 2002;36:16-25.
11. Watmough S, Taylor DC, Garden A, et al. Educational supervisors' views on the competencies of preregistration house officers. *Br J Hosp Med (Lond)* 2006;67:92-5.
12. Hoffman K, Hosokawa M, Blake R Jr, et al. Problem-based learning outcomes: Ten years of experience at the University of Missouri-Columbia School of Medicine. *Acad Med* 2006;81:617-25.
13. Mennin SP, Kalishman S, Friedman M, et al. A survey of graduates in practice from the University of New Mexico's conventional and community-oriented problem-based tracks. *Acad Med* 1996;71:1079-89.
14. Hori M, Sasayama S, Kitabatake A, et al.; MUCHA Investigators. Low-dose carvedilol improves left ventricular function and reduces cardiovascular hospitalization in Japanese patients with chronic heart failure: the Multicenter Carvedilol Heart Failure Dose Assessment (MUCHA) trial. *Am Heart J* 2004;147:324-30.
15. Haynes RB, Haines A. Barriers and bridges to evidence-based health care practice. *BMJ* 1998;317:2736.
16. Freeman AC, Sweeney K. Why general practitioners do not implement evidence: qualitative study. *BMJ* 2001;323:15.
17. Ely JW, Osheroff JA, Ebell MH, et al. Obstacles to answering doctors' questions about patient care with evidence: qualitative study. *BMJ* 2002;324:17.
18. National Institute for Clinical Excellence. *CG5—Chronic heart failure: management of chronic heart failure in adults in primary and secondary care (NICE guideline)* Available from: URL: http://www.nice.org.uk/Docref.asp?d=79726 (accessed 28 Sep 2009).
19. Freyd M, The graphic rating scale. *J Educ Psychol* 1923;14:83-102.
20. Aitken RC. Measurement of feelings using visual analogue scales. *Proc R Soc Med* 1969;62:989-93.
21. Huskisson EC. Measurement of pain. *Lancet* 1974;2:1127-31.
22. Chapman CR, Donaldson GW, Jacobson RC, *Handbook of Pain Assessment*. (Turk DC, Melzack R eds.), Guilford, New York, 1992, pp. 332-343.

23. Brown JB, Boles M, Mullooly JP, et al. Effect of clinician communication skills training on patient satisfaction: a randomized controlled trial. *Ann Intern Med* 1999;131:822-9.
24. Campbell JC, Coben JH, McLoughlin E, et al. An evaluation of a system-change training model to improve emergency department response to battered women. *Acad Emerg Med* 2001;8:131-8.
25. Morey JC, Simon R, Jay GD, et al. Error reduction and performance improvement in the emergency department through formal teamwork training: evaluation results of the MedTeams project. *Health Serv Res* 2002;37:1553-81.
26. Thompson C, Kinmonth AL, Stevens L, et al. Effects of a clinical-practice guideline and practice-based education on detection and outcome of depression in primary care: Hampshire depression project randomised controlled trial. *Lancet* 2000a;355:185-91.
27. Thompson RS, Rivara FP, Thompson DC, et al. Identification and management of domestic violence: a randomized trial. *Am J Prev Med* 2000b;19:253-63.
28. Young AS, Chinman M, Forquer SL, et al. Use of a consumer-led intervention to improve provider competencies. *Psychiatr Serv* 2005;56:967-75.
29. Horsburgh M, Lamdin R, Williamson E. Multiprofessional learning: the attitudes of medical, nursing and pharmacy students to shared learning. *Med Educ* 2001;35:876-83.
30. Beney J, Bero L, Bond CM. Expanding the roles of outpatient pharmacists: effects on health services utilisation, costs, and patient outcomes. *Cochrane Database Syst Rev* 2000;(2):CD000336.