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PILOT STUDY

Modified problem-based learning in pharmacology

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Abstract: *Objective:* The aim of this study was to determine differences between PBL as compared to modified PBL with special focus on acquiring EBM principles.
Methods: Two groups consisted of total 152 students (139 respectively). The use of EBM principles means integrating individual expertise with the best available external clinical evidence by using available data sources and national guidelines.
Conclusion: Our findings suggest that modified PBL with extended EBM approach could be superior to "classical" PBL *(Fig. 3, Ref. 29)*. Full Text (Free, PDF) *www.bmj.sk.*
Key words: problem-based learning, evidence based medicine, pharmacology.

The last decade saw dramatic changes in medical education due to dissatisfaction with the way medical students were trained. A basically passive education has been replaced by a more active approach in a hope that this will train "better" doctors (1, 2, 3).

At the start of clinical training from pharmacology most medical students find that they don't have a very clear idea of how to prescribe a drug for their patients or what information they need to provide. This is usually because their earlier pharmacology learning had concentrated more on theory than on practice. Medical students must memorize numerous detailed facts about drugs and pharmacologically active substances without a direct clinical context. The pharmacology textbooks are often too drug-centered and clinical guidelines more disease-oriented and thus the reason why particular therapies are chosen remains unclear. Moreover there is an information explosion in science including medicine and medical therapy due to recent scientific progress. Therefore traditional learning strategies are no longer considered adequate to cope with these changing demands in medical education.

WHO, in reorientation program on medical education, suggested that the introduction of implementation of innovative, problem based learning methods would be preferable to conventional teaching by didactic lectures (4).

Problem based learning (PBL) as an educational method is gaining ground in higher education (5). It was originally introduced at McMaster University in Hamilton, Canada (6). Since learning in context is a major determinant of knowledge acquisition and retrieval, PBL provides students with realistic clinical cases that are designated for this purpose (7). This approach has also the benefit of lessening the potential of information overload which can be perceived when pharmacology is presented in a single discipline course format (8).

Extensive research has been carried out on the efficacy of PBL and the existing evidence is well summarized in a number of meta-analyzes and literature studies (5, 9, 10).

Recent studies indicate that success of tutorials depends on their interaction between students' and tutors' performance as well as on the quality of the problems (cases) being solved (11).

Evidence based medicine is the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence based medicine means integrating individual clinical expertise with the best available external clinical evidence of systematic research (12).

The aim of the study was to determine difference in student's performance when taught pharmacology in "classic" problem-based learning format as compared to modified problem-based learning format with special focus on acquiring and using EBM principles in pharmacology.

Methods

We compared the effectiveness of problem based learning (PBL) according to WHO Action Program on Essential Drugs, and PBL with accent on principles of evidence based medicine (EBM) in a general pharmacology class of third year medical students.

The use of EBM principles means integrating individual expertise with the best available external clinical evidence from systematic research by using available electronic data sources and national guidelines. During sessions the particular simple

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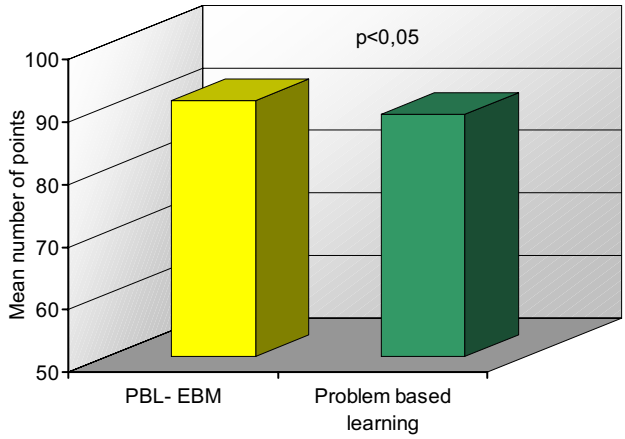

Fig. 1. Mean score (±SD) of students in the final examination test.

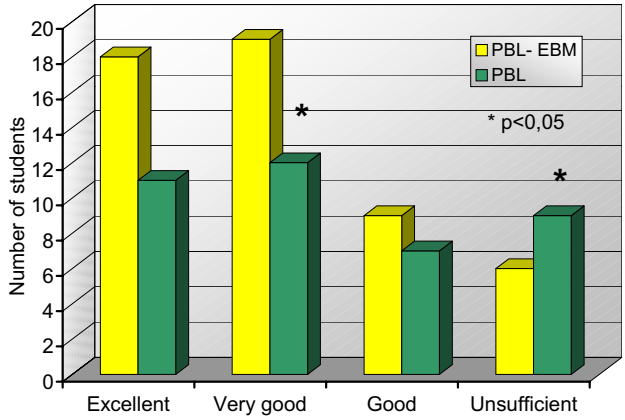

Fig. 2. Examination results [study (PBL-EBM) and control (PBL) group].

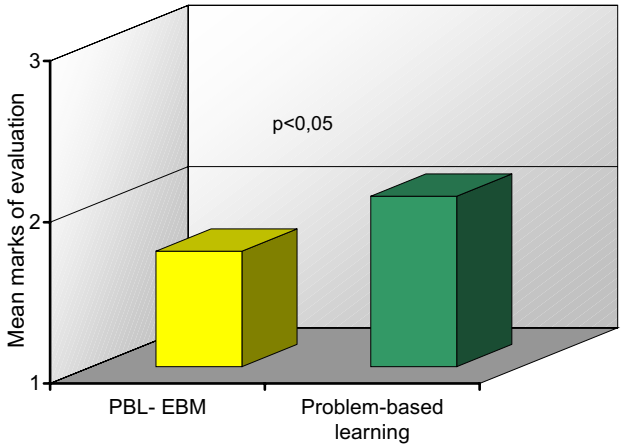

Fig. 3. Final evaluation (±SD).

didactic questions were discussed under supervision of tutor previously skilled in problem based approach.

Two groups of total 152 (139 respectively) students were randomized to PBL or PBL-EBM small groups. Students in small groups consisted of 6–9 students who received eleven 2-h and seven 3-h sessions during second pharmacology course.

During sessions in PBL groups the particular clinical cases in written form related to special topics in pharmacology were discussed. A tutor facilitated the discussion by providing direction and advice. Each case included patient's clinical features, pharmacotherapy, adverse effects and interactions.

Sessions in PBL-EBM group were similar to PBL group with special attention to the principles of EBM (evidence based medicine) in drug choice and evaluation.

The required extend of knowledge is equal to Katzung's textbook of pharmacology (Katzung, B., editor Basic and Clinical Pharmacology, McGrawHill; 2006). At the end of the semester all students participated in the same type of the final exam consisting of 25 multiple – choice questions test and 4 question in oral exam. The topics covered the standard extent of pharmacology obligatory for medical students. The scores obtained in our study were analyzed by the Student's t-test, Microsoft Excel 2000. We defined a one sided p-value <0.05 as significant.

We have also collected experience of implementation of PBL in the course of pharmacology within a traditional medical school in earlier projects.

Results

Students in PBL-EBM groups made fewer mistakes in their multiple-choice test and the mean number of false answers was 9.1 SD 5.6. PBL students made significantly more mistakes (11.4 SD 5.9 ($p<0.05$)) (Fig. 1). The determinant of a successful test was 70 % or above of correct answers, students who didn't pass the test were not allowed to oral exam.

The oral exam consisted of 4 questions: a) drug choice and prescription for defined diagnose and patient, b) general pharmacology question, c) special pharmacology question, d) detailed profile of essential drug.

The notes were 1 – excellent, 2 – very good, 3 – good, 4 – unsufficient (meaning failing the exam). Student's results (expressed as number of students in study and control group, respectively) are shown in Figure 2. The percentage of failing students (final result of both written and oral performance) was 11.5 % (23.08 % respectively), $p<0.05$.

Differences in the final evaluation (consisting of written and oral part of examination and active work during 2-semester course) – 1.7 SD 0.68 (2.1 SD 0.75, respectively) were also statistically significant ($p<0.05$) (Fig. 3).

Evaluation revealed that students participating in the PBL--EBM tutorial profited significantly in terms of their results in examination.

Discussion

The pharmacology learning belongs to the crucial subjects in medicine study inevitable for further progress in clinical sub-

jects and also in postgraduate medical practice. Different approaches of teaching pharmacology has been used and we want to determine if there would be a difference in students' performance when taught pharmacology in problem-based learning format with special attention on EBM principles compared to traditional problem-based learning format (13).

Our analysis demonstrates that PBL-EBM students pass standardized final exam better than those in control group (PBL). Our previous work showed students opinion, too (14).

Although the amount of knowledge required for the examination was equal, there was the difference in the motivation and form of teaching. Previous works showed that PBL, which promotes self-active learning and enhance motivation, will also help to exclude the irrelevant and useless parts of the learning curriculum (15–17).

Problem-based learning approach is focused on ameliorating the complex problems associated with information growth in medical education (8).

Today, experts in medical education largely agree that there are differences in the effects of PBL as compared with conventional, lecture-based medical curricula (5).

There is evidence that PBL students are better prepared to apply basic science concepts in clinical setting. In addition, graduates of PBL curricula may retain their knowledge over a longer period of time, and may be better prepared for life-long learning (18).

PBL requires an active participation of students. In the classical PBL model, the tutor of a session will restrict her or himself to moderating the discussion but will refrain from scientific interference. Initially, students tend to feel uneasy with this approach because often they are used to being told what is right and wrong (9).

While the overall data suggest that PBL bear on learning pharmacological facts at least as well as classical learning methods, it has been questioned whether PBL may occur the expense of excessive resource utilization (21, 22).

In a similar studies in another medical schools, however, the results of students who had participated in an optional PBL tutorial were not different from those of their classmates who had only taken the traditional course (5, 9). Another study showed that PBL students performed as well as or better than CL students (23). These differing results prompted the question, whether a possible advantage and disadvantage of PBL concerning students factual knowledge might depend on the assessment method used to measure the knowledge acquired by the students as indicated earlier (24, 25).

Early implementation of PBL in the teaching of pharmacology should make a significantly positive impact on the behavioral aspects of students. The general consensus suggest that PBL is a worthwhile pedagogic approach to bring professional relevance into the context of learning and teaching an enjoyable and satisfying experience for both students and teachers (26).

Evidence based medicine, whose philosophical origins extend back to mid-19th century Paris and earlier, remains a hot topic for clinicians. Clinical skill is essentially derived from experience and is expressed as judgment in decision making (12).

Evidence-based medicine is a multistep process and is not a "cookbook" medicine. Because it requires a bottom up approach that integrates the best external evidence with individual clinical expertise and patients' choice, it cannot result in slavish, cookbook approaches to individual patient care (12).

Many criticisms of evidence-based medicine stem from misperceptions or misrepresentations and may be answered by careful consideration of the definition of evidence-based medicine (27). Critics of evidence-based medicine have correctly pointed out that its practice may require time and resources unavailable to the busy clinician (28). But every doctor should know at least basic principles of EBM in the process of choosing right drug treatment.

The tutor role in problem-based learning (PBL) has attracted the interest of many researchers and has led to an abundance of studies (29). In our study, PBL-EBM group had always the same teacher and teachers of the second group varied.

It has to be discussed whether the power of our study is sufficient to assume that we did not miss a possibly relevant differences between the two groups. To calculate the power, it would be necessary to determine how large possibly relevant effects in terms of a difference between the two groups in their mean number of points would be.

Although the presentation of pharmacological facts in a clinical context is likely to enhance medical students' motivation to study pharmacology, based on learning theories a further enhancement of motivation can be expected by this increased responsibility and self determination (9).

Conclusion

Our findings suggest that PBL with a special focus at the EBM approach within particular sessions could be superior to "classical" problem based learning format. Advantages of problem-based learning are clearly documented in previously done studies. PBL teach students how to apply rational pharmacotherapy to clinical medicine and prepare them to become independent lifelong learners in therapeutics. There is need of implementation and training of EBM principles in order to acquire skills in drug choice and evaluation at the pre-gradual level.

Our results could be starting points for further studies exploring the role of problem-based learning and principles of EBM in the teaching not only pharmacology, but also other biomedical sciences.

Taken the presented data as well as data from previous studies (in other medical disciplines, too) suggest that PBL is associated with higher motivation and enjoyment on the sides of students and tutors. PBL appears to be a valuable contribution in solving problems associated with classical learning (e.g. receiving excessive information). EBM principles are crucial in the evaluation of drugs in creating therapeutic guidelines for medical practitioners.

We should remember the ancient adage: "In scientia est potentia" (English: The power is in knowledge).

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