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Case-based learning for teaching pharmacology to pharmacy students

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Abstract

Objective: To evaluate the use of Case-Based Learning as a pharmacology learning method for pharmacy students at a Brazilian public university. **Methods:** A qualitative/quantitative study with pharmacy students enrolled in a pharmacology course using Case-Based Learning. A clinical case and a focus group were used to analyze the cognitive outcomes, as well as a questionnaire based on the Likert scale to evaluate students' perception of the methodology. **Results.** From the 45 pharmacy undergraduate students invited, 33 agreed to participate in the study. Most of participants presented good academic performance related to knowledge acquisition, application and conviction during the application of a clinical case, with or without the bibliography support. They also reported a positive overall impression of Case-Based Learning and reported that this learning method should be applied as a teaching methodology in other subjects. **Conclusion:** Case-based Learning showed a positive effect on the cognitive level and students' acceptability evaluated.

Keywords: Active learning, pharmacology, pharmacy students.

Aprendizagem baseada em casos no ensino de farmacologia para estudantes de Farmácia

Resumo

Objetivo: Avaliar o uso da Aprendizagem Baseada em Casos como método de ensino de farmacologia para estudantes de farmácia de uma universidade pública brasileira. **Métodos:** Estudo qualitativo/quantitativo, com estudantes de farmácia matriculados na disciplina de farmacologia, utilizando a Aprendizagem Baseada em Casos. Um caso clínico e um grupo focal foram utilizados para analisar os resultados cognitivos, bem como um questionário baseado na escala Likert para avaliar a percepção dos alunos sobre a metodologia. Resultados. Dos 45 alunos de graduação em farmácia convidados, 33 aceitaram participar do estudo. A maioria dos participantes apresentou bom desempenho acadêmico relacionado à aquisição de conhecimento, aplicação e convicção durante a aplicação de um caso clínico, com ou sem o suporte bibliográfico. Eles também relataram uma impressão geral positiva da Aprendizagem Baseada em Casos e relataram que essa metodologia de aprendizagem deveria ser aplicada em outras disciplinas. **Conclusão:** A Aprendizagem Baseada em Casos mostrou um efeito positivo no nível cognitivo e na aceitabilidade dos alunos avaliados.

Palavras-chave: Aprendizado ativo, farmacologia, estudantes de farmácia.

Introduction

Active methodologies in healthcare teaching have shown consistent results over time when compared to the traditional Lecture-Based Teaching[1]. The contrast observed between those methodologies has been supported by students' passive condition in the traditional teaching while active teaching induces students to greater participation during classes and a continuous search for knowledge[2].

Among the existing active methodologies, two have stood out in the teaching of future health professionals: Case-Based Learning (CBL) and Problem-Based Learning (PBL)[3]. In the CBL, students search databases and apply their knowledge in the resolution of the cases. Moreover, for healthcare teaching, it provides a great learning potential, since students focus the learning process on the patient, taking into account all related factors, such as social issues and the past medical history, to evaluate the patient as a whole and define the most appropriate conduct[4]. Thus, students learn by solving situations similar to reality, which makes it possible to acquire important skills for the development as professionals[5].

There are few reports on the teaching of pharmacology through active methodologies. A study conducted with medical students at Wuhan University (China), between 2011 and 2012, demonstrated that the performance of students who used CBL for pharmacology was better than the control group that used Lecture-Based

Learning[6]. Another study carried out in Al Quds University Medical School (Palestine) presented results regarding students' perception of the CBL methodology for pharmacology where 82% of students approved CBL as a great learning method and approximately 70% reported that their exam preparation skills improved. In addition, students reported that CBL improved their communication and ability to work in teams and that this methodology should be applied to other disciplines (68% and 79%, respectively)[7].

According to the Brazilian National Curricular Guidelines for Pharmacy Undergraduate Program (DCN), the program must have a pedagogical project in which the teaching is student-centered and allows students' integral qualification[8]. DCNs' definitions are supported by data that evidence the expected health care impact of pharmacists with solid and health-centered training, such as prevention and monitoring of drug-related adverse events, reduction of hospitalization time, mortality, drug and healthcare costs[9]. Therefore, this study aimed to evaluate the use of CBL as a pharmacology teaching method for pharmacy students at a Brazilian public university.

Methods

This was quali-quantitative study conducted in one of the Federal University of Bahia campuses, located in Brazil's Northeast Region, which offers around 40 slots annually for the pharmacy program. During the undergraduate program, pharmacy students have three semiannual curricular components dedicated to the teaching of pharmacology.

The CBL teaching method started in 2013 in one of the curricular components of pharmacology. In this period, the following contents were addressed: Antibiotics, Antiparasitics, Immunomodulators and Chemotherapeutics agents. At the beginning of the components, students received training on Evidence-Based Medicine searching methods and the main health databases usage. Primary databases such as Medline (via PubMed), Scopus, Cochrane Library, Lilacs and Scielo, and some tertiary online sources such as Medscape, Micromedex and pharmacotherapy textbooks were introduced to students. This training was carried out in a computer lab where students performed teacher-directed searches. The following step was an oriented case solved in the classroom, where each problem was discussed with the group to clarify the systematics for case resolution and the learning objectives.

After the initial training, students were divided into groups of 5 or 6 components. Classes had twice a week periodicity and lasted for two hours. Students received a weekly document, via e-mail, with the cases elaborated by the teacher. Cases contained key issues to guide learners on the important aspects that should be addressed. After resolution, a group presented the cases in the subsequent class and the teacher encouraged the discussion of the answers between the groups.

This study included all students from the 2013 and 2014 pharmacy classes, with, respectively 23 and 22 students enrolled.

This study focused on the knowledge acquisition, capacity and conviction in the application and the perception of students regarding antimicrobials. This drug class was considered because of its clinical relevance associated with the rational use of antimicrobial and its impact on the reduction of bacterial resistance. Moreover, it is the main part of the programmatic content.

Data collection occurred between November and December of 2015. In the first phase, the capacity and conviction in the application of the knowledge acquired were assessed. Therefore, participants were separated into two groups, according to the year they fulfilled the curricular component. The participants received a clinical case that was applied in two different moments. The case included key issues, such as the pathophysiology, diagnosis, indication for antimicrobial use, posology, route of administration, effectiveness and safety monitoring. To avoid different levels of difficulty, the clinical case applied was the same for both groups.

Participants were initially subdivided into groups of three or four components to solve the clinical case without bibliography consultation. After the case resolution, they were invited to participate in a focus group in which the researcher mobilized them to comment on the proposed case. Sessions occurred in a private room, lasted one hour and the discussions were recorded, with the participants' authorization, assuring anonymity and exclusive use of recordings for research purposes. The focus group discussion notes included verbal and nonverbal behaviors.

In the case resolution analysis, the responses obtained during the discussion in the focal group were added to the written and analyzed as a single response. Thus, trends and patterns of the presented responses were observed, with a contrast between the answers given by the groups and the correct answers previously defined by the research team. Groups were assigned scores for each correctly answered question, with zero as the minimum value and eight as the maximum.

Conviction in the application of the acquired knowledge was assessed while the treatment choice was orally presented. For this assessment, the researcher presented an alternative treatment to provide the respondent with the opportunity to choose between the original response and an alternative.

After the focus groups, the participants received the same case in digital copy and were asked to answer it using bibliography support. Participants had 24 hours to answer and were requested handwritten responses with the references consulted for the resolution. In the response analysis, quality of evidence and strength of recommendation were considered.

Students' perception of the CBL methodology was assessed through a questionnaire. The questionnaire was composed of ten objective questions, in which responses were structured according to the classic 5-point Likert scale (strongly agree -> strongly disagree) and reflected to what degree the student agreed or disagreed with the statement regarding learning, communication, conviction and quality of teaching. The answers were analyzed with simple and relative frequencies.

The professor of the curricular component did not participate in any phase of this study, except the planning.

Ethical approval: This study was approved by the local IRB with number 49916015.5.0000.5556. All participants agreed to the research terms and signed a consent form.

Results

Among the 45 invited students, 33 agreed to participate in the study, of which 17 completed the curricular component in 2013 and 16 in 2014. Twenty-four of the 33 participants attended the clinical case resolution meeting and the focus group. Of these, 11 were from the 2013 class and 13 were from 2014. Table 1 shows the data analyzed for this phase.

In the focal group, five of the six groups maintained the initially proposed therapy and presented plausible justifications, such as antimicrobials spectrum of activity and adverse effects. Students from the 2013 class were more emphatic about the characteristics of the medical history and the clinical/laboratory data that supported therapeutic decision-making.

The main discrepancy observed during the analysis of the focal groups' trends and patterns were related to pharmacokinetic knowledge of the drugs chosen. Although the written answers were partially correct, greater insecurity regarding the orally presented answers was observed, which could be noticed by the gestures and expressions transmitted through the discussion.

Data from case resolution with bibliography support are presented in Table 2. All groups used at least one of the tertiary bibliography bases presented at the beginning of the course (Medscape and Micromedex). In addition, other research sources were reported, such as Dipiro's pharmacotherapy book, national guidelines and the website of the National Agency of Sanitary Regulation (ANVISA), but only the class of 2013 used the last two. However, no original study was cited in the solutions presented.

Data on the perception about the CBL of the two groups, 2013 and 2014, are presented in Table 3. All participants who agreed to participate answered this part of the study.

When asked about CBL effectiveness, 32 (97%) answered positively and 30 (90.9%) stated that CBL improved their ability to memorize information. In addition, 32 (97%) believed that this methodology expanded their search for knowledge and that the aspects addressed were relevant to learning. Of all participants, 31 (93.9%) said their academic performance had improved.

In regards to teamwork, 31 (93.9%) of the participants said that there was an improvement in this ability, and 33 (12.1%) reported that they did not agree or were not convinced that this methodology had improved their competence in public presentations. All the students who answered the questionnaire reported that CBL allowed for a greater association between theory and practice. Finally, the students were asked whether this methodology should be applied in other subjects and 30 participants (90.3%) answered positively.

Discussion

This study demonstrated that the application of CBL in pharmacology for pharmacy students was effective in the learning process and had great acceptance among participants.

The data obtained through the Likert scale-based questionnaire revealed that the methodology was widely accepted among students who affirmed that CBL was effective for knowledge acquisition and that their academic performance had improved, as observed in previous studies[10]. The acceptance observed may be related to students' greater interest in resolving the situations that are presented and to the critical thinking process developed during the cases resolution, as suggested in a previous study with CBL[11]. Moreover, multiple skills are also acquired in the CBL, such as complete patient analysis, relevance of the chronology of events, interpretation and reflection of data, and decision making[12].

The rationale for an empirical antimicrobial scheme, such as the one proposed in the clinical case of this study, is a complex process that requires the coordination of several fields of knowledge and abilities, which will define what we call "clinical reasoning". Therefore, it is necessary to know the infection severity level, the pathophysiology, clinical and laboratory evolution of the infectious process, the most prevalent etiological agents (which may vary according to the environment where the patient is submitted), the local antibiotic sensitivity profile, the most effective anti-infective agents for the treatment of each type of infection, as well as the pharmacodynamics and pharmacokinetic parameters of these drugs to ensure that the antibiotic spectrum is adequate and that the minimum inhibitory concentration is achieved in the site of infection. Thus, students' capacity for case evaluation and resolution, in groups formed exclusively by students, shows that the use of CBL produces consistent knowledge and stimulates the capacity to elaborate reasoning from the concepts learned, which is essential in the teaching-learning process.

Students' conviction to apply the knowledge also presented significant results, even as factors to assess the patient were thoroughly understood and the caution to define the best treatment to be introduced was evident in this study. CBL is an improvement in the ability of antimicrobial rational prescription for medical students, compared to the traditional method of lectures[13]. Therefore, the development of the ability for the rational use of antibiotics empowers pharmacists, as a member of the health care team, to contribute significantly in reducing bacterial resistance.

The comparison between the groups showed that the group of 2014 obtained an overall mean higher (5.4) than the class of 2013 (3.55), regarding the acquisition and application of the knowledge acquired (Table 1). As the study was carried out at the end of 2015, there was an approximate period of two years, for the group of 2013 and about one year for the group of 2014, from the conclusion of the curricular component evaluated until this study. In addition, the class of 2013 had not had prior contact with the CBL methodology. However, the group of 2014 had already

Table 1. Scores reached by 2013 e 2014 classes in case resolution without bibliography support, measured through approximated accurate answer. (0 to 8 score)

Assessed competences	Group 01 n (%)		Group 02 n (%)		Group 03 n (%)		General result Mean (SDa)	
	2013b	2014c	2013b	2014c	2013b	2014c	2013b	2014c
Clinical investigation	6 (75)	3 (37.5)	2 (25)	1 (12.5)	4 (50)	5 (62.5)	4 (2)	3 (2)
Treatment	5.5 (68.8)	7.8 (97.5)	2.5 (31.3)	8 (100)	7 (87.5)	4.8 (60)	5 (2.9)	6.9 (1.8)
Mechanism of action	8 (37.5)	7 (87.5)	0	6 (75)	7 (87.5)	6 (75)	3.3 (3.5)	6.3 (0.5)
Pharmacokinetics	8 (50)	4 (50)	0	3 (37.5)	4 (50)	4 (50)	2.7 (2.3)	3.6 (0.5)
Adverse effects and monitoring	8 (62.5)	7 (87.5)	3 (37.5)	7 (87.5)	6 (75)	7 (87.5)	4.7 (1.5)	7 (0)
Total - Mean (SDa)	4.7 (1.0)	5.8 (1.9)	1.5 (1.3)	5 (2.6)	5.6 (1.4)	5.4 (1.0)	3.55 (2.9)	5.4 (0.4)

a SD- Standard deviation; b Students who studied the subject in 2013; c Students who studied the subject in 2014

Table 2. Scores reached by 2013 e 2014 classes in case resolution with reference support. measured through approximated accurate answer. (0 to 8 score)

Assessed competences	Group 01		Group 02		Group 03		General result	
	n (%)		n (%)		n (%)		Mean (SDa)	
	2013b	2014c	2013b	2014c	2013b	2014c	2013b	2014c
Clinical investigation	6 (75)	1 (12.5)	2 (25)	2 (25)	6 (75)	6 (75)	4.7 (2.3)	3 (2.6)
Treatment	6 (75)	8 (100)	5.5 (68.8)	8 (100)	6 (75)	7.5 (93.8)	5.8 (0.3)	7.8 (0.3)
Mechanism of action	8 (100)	7 (87.5)	8 (100)	8 (100)	8 (100)	8 (100)	8 (0)	7.7 (0.6)
Pharmacokinetics	8 (100)	6 (75)	7.5 (93.8)	8 (100)	8 (100)	8 (100)	7.8 (0.3)	7.3 (1.1)
Adverse effects and monitoring	8 (100)	7 (87.5)	6 (75)	8 (100)	8 (100)	8 (100)	7.3 (1.1)	7.7 (0.6)
Total - Mean (SDa)	7.2 (1.1)	5.8 (2.8)	5.8 (2.4)	6.8 (2.7)	7.2 (1.1)	7.5 (0.9)	6.7 (0.8)	6.7 (0.9)

a SD- Standard deviation; b Students who studied the subject in 2013; c Students who studied the subject in 2014

been exposed to this methodology in the previous semester, in a previous pharmacology component, which part of the content used CBL. Period of study gap and familiarity with the methodology may have influenced the superior results obtained by the class of 2014 compared to the class of 2013.

During the resolution of the clinical case, a broader clinical view was noticed in the class of 2013, with greater care in the investigation of the multiple factors involved in the therapeutic decision-making. One of the possible explanations for this difference is related to the experiences and internships during these two years, to which students of 2014 were not exposed. This information highlights the importance of continuous practice in the development of the student, instead of pedagogical projects based on subjects decontextualized and isolated in time and space. The presence of critical clinical thinking is observed and diffused among students who have the opportunity to learn through CBL[14, 15].

The difficulty found in pharmacokinetic parameters assessment, by the students, is associated with the focus of the curricular component that focuses on other points of pharmacology teaching, such as pharmacodynamics and the application of these concepts directed to pharmacotherapy. This becomes evident when we observe data from a study in which students of pharmacy in the United States[5], used CBL methodology to learn clinical pharmacokinetics. In this case, students satisfactorily understood the concepts of pharmacokinetics through CBL as they reported that the discussions of the cases facilitated the learning. Two factors were important to achieve these results; the first is the relevance of the topics chosen for teaching pharmacokinetics, emphasizing special populations, such as pregnant, obese, elderly and children, which increased the interest of the class on the content and contributed to learning. The second point is that the curricular component was based on clinical pharmacokinetics only, which directed the teaching-learning process to this area. According to the perception of the participants of this study, CBL connects theory and practice, which encourages learning and consequently allows the student to develop skills for their professional future[12,16]. During the analysis, it was possible to observe that 97% of the students stated that their search for knowledge was amplified after the contact with the methodology, higher than that found in the study by Gupta *et al*[10], in which the percentage on the use of additional of research sources was 77.9%. This relates to the fact that most subjects throughout the course are based on the traditional method of lectures, with low stimulus to improved evidence search and critical analysis of the literature as part of the study routine.

In the analysis of the data contained in Table 3, it is possible to verify that a small portion of the participants reported that they did not believe or that they were not sure if the methodology had improved their conviction in public presentations. Therefore, other methodologies could be incorporated, such as role-playing, which was applied to pharmacy students at the University of Hawaii[17] and reported improvement in communication skills.

The vast majority (94%) of the participants agreed that their skills improved in teamwork. This finding is consistent with a study conducted with dentistry students in India[18], in which the rate of participants who agreed with this statement was 92%. Moreover, when questioned if this methodology satisfactorily fulfilled the content proposed during the semester, about 91% had a positive answer. Similar results were also obtained in the study conducted by Gupta *et al*.[10], in which the percentage of participants who agreed was 85.7%.

Most participants (90.9%) stated that the ability to memorize information was expanded and that this methodology addressed relevant points for content learning (97%). An Indian study[19], also evaluated this point, although the authors reported good results with the methodology, the percentage of students who agreed that this method helped to retain essential information was 77.1%, slightly lower than that observed in our study. The resolution of cases throughout the semester helped to consolidate the knowledge, which can be explained by how concepts are approached more than once in the proposed cases. In short, students understand and assimilate concepts in an easier way[10].

In the clinical case resolution with bibliographical consultation, an increase in the overall mean of the two classes was observed. Considering the evolution and similarity in the final averages, our results suggest that the methodology used was also effective in training the students to search the literature and, consequently, to solve the situations presented. A study conducted in the United Arab Emirates[20], showed that the first source of evidence-based research for pharmacy students before the introduction of an evidence-based health course was Google (85.9%). However, after the course, this percentage fell to almost 10% and PubMed became the first choice (79.7%). This information reinforces the importance of evidence-based search teaching, otherwise students are expected to fail in conducting searches in reliable sources. Nevertheless, the favored use of tertiary sources identified in our study seems to demonstrate a weakness in the planning of the strategies used in the methodology and deserves a revision to stimulate the search for primary sources.

A possible limitation of the study was the application of the case in groups, which made it impossible to evaluate individually the acquisition and application of the knowledge.

Table 3. Pharmacology students' perception about the CBL methodology (n = 17 and 16 students from 2013 and 12014 classes. respectively)

Assertive	Strongly agree n (%)	Agree n (%)	Strongly disagree n (%)	Disagree n (%)	Uncertain n (%)
CBL was an effective form of gaining knowledge	19 (57.6)	13 (39.4)	0	0	1 (3)
CBL improved your information memorizing capabilities	14 (42.4)	16 (48.5)	0	1 (3)	2 (6.1)
CBL contributed expanding your search for knowledge	22 (66.7)	10 (30.3)	0	0	1 (3)
Overall, CBL improved your academic performance	14 (42.4)	17 (51.5)	0	0	2 (6.1)
CBL improved your conviction in public presentations	14 (42.4)	15 (45.5)	1 (3)	2 (6.1)	1 (3)
CBL improved you team working abilities	14 (42.4)	17 (51.5)	0	0	2 (6.1)
CBL satisfactorily fulfilled the content proposed in the semester	13 (39.4)	17 (51.5)	0	2 (6.1)	1 (3)
CBL approached important aspects for content learning	19 (57.6)	13 (39.4)	0	1 (3)	0
CBL permitted a higher articulation between theory and practice	23 (69.7)	10 (30.3)	0	0	0
CBL should be applied as teaching methodology in other subjects	19 (57.6)	11 (33.3)	0	1 (3)	2 (6.1)

aCBL – Case-based learning

Conclusion

Pharmacology teaching based on CBL for pharmacy students had a positive effect on knowledge acquisition, application, conviction, and presented a high acceptance rate.

Some aspects of learning presented limitations, such as conviction in public presentations, the search for primary sources of information and knowledge about pharmacokinetic parameters. This indicates the need for association with other methodologies or adjustments in the current design.

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Collaborators

MM, SM, MC and EM - Conception and design, analysis and interpretation of data. MM, RS and MC- Writing of the article. SM – Review of the manuscript.

Declaration of conflict of interests

The authors declare that there are no conflicts of interest regarding this article.

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