

Assessment of Student's Learning and Perception towards Case-based Learning Supplemented with Laboratory Reports in Biochemistry: A Cross-sectional Study

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ABSTRACT

Introduction: Case-based Learning (CBL) is found to be one of the best approaches to promote students' learning in clinical biochemistry which help them to understand clinical diseases. Moreover, exposure of interpreting Laboratory Reports (LR) in CBL session helps students in learning clinical diagnosis, treatment and prognosis of disease.

Aim: To assess students' learning and perception towards CBL supplemented with LR in biochemistry and also to compare the performance of students with pretest and post-test on a topic taught by Didactic Lecture (DL) and CBL supplemented with LR.

Materials and Methods: This cross-sectional study was conducted at Biochemistry Department, Smt. B. K. Shah Medical College and Research Centre, Sumandeep Vidyapeeth, Vadodara, Gujarat, India, from November 2019 to April 2020, after prior permission of Institutional Ethics Committee. Total 60 first year Bachelor of Medicine and Bachelor of Surgery (MBBS) students were enrolled voluntarily and were divided into two groups: group A (30) and group B (30) by lottery method. The study process included pretest for all students, DL session for group A and CBL supplemented with

LR session for group B on selected topic followed by the post-test after one week. Crossover was done in which group B was exposed to DL and group A was exposed to CBL supplemented with LR. Perception of both groups about CBL supplemented with LR was taken by prevalidated questionnaire based on five-point Likert scale. Data were analysed by paired and unpaired (independent) t-test.

Results: Total 59 students attended teaching sessions, submitted pre and post-test and gave feedback (response rate was 98.33%). Out of 59, 24 were males and 35 were females. Statistically significant difference was observed in pre and post-tests performance of students for topics taught by CBL with LR method than DL ($p < 0.0001$). All (100%) students felt that CBL supplemented with LR method was very helpful, interesting and improved their interpretation skills.

Conclusion: The CBL supplemented with LR proved to be a very good student-centric teaching-learning tool in biochemistry as compared to DL method. Students who were exposed to CBL supplemented with LR had better understanding of biochemistry and performed better in post-test than those who were exposed to DL method.

Keywords: Clinical biochemistry, Diagnosis of disease, Didactic lecture

INTRODUCTION

Biochemistry is one of the foundation subjects taught in first year of MBBS curriculum. Biochemistry and medicine are intimately related and the former has immense importance in understanding clinical sciences. However, it is considering by students merely a subject of just chemical compounds, their structures, functions and metabolism in which such chemicals take part in the form of pathways and reactions. Beside this, biochemistry is considered as a highly theoretical subject with minimal clinical relevance by students. The major reason behind such consideration is the traditional methodology by which biochemistry is taught to the student i.e., DL, tutorials and practical classes along with anatomy and physiology [1-4].

Moreover, inspite of the recent innovations and paradigm shift in medical education, the bulk of undergraduate teaching is still delivering in the form of traditional DL in majority of the medical schools all over the world. Hence, it was teacher-centered approach, with mainly passive participation from the students and therefore the students lack the basic critical analysis skills, which are important for understanding the clinical diseases. Nevertheless, recent reforms in the medical education change the teacher-centric approach to student-centric approach by incorporating various innovative teaching-learning methodologies. This makes the students actively involved in the process of learning and it thus prepares them for a lifelong self-directed learning process. One such effective and interesting method introduced and currently in practice, is CBL [1-4].

In fact, it proved to be an active learning tool, which aims at developing reasoning skills, based on the clinical scenarios. Hence, a medical student understands the importance of the biochemistry as one of the basic medical science subjects [5]. The clinical case including laboratory findings are based on real life scenario of a patient which act as a stimulus and motivation for students to learn Biochemistry. Interpretation of biochemical tests reports performed on body fluids and tissues help to support diagnosis, treatment and monitoring of disease. Enhancing the interpretation skills of laboratory investigation report during pre and paraclinical medical curriculum is of great significance for appropriate healthcare delivery. Learning to interpret biochemistry LR not only develops mental skills and the acquisition of knowledge (Knowledge category of cognitive domain) but also enhances the ability to utilise the knowledge in a new situation (Analysis category of cognitive domain) [6,7].

The LR has been used by few studies as a tool to enhance active learning during DL and Early Clinical Exposure (ECE) sessions to assess interpretation skills [8,9]. But they did not use real clinical lab reports during CBL. Therefore, this study was undertaken to supplement actual patient's LR during CBL among the first year medical students in biochemistry. The objective of the study was to compare the performance of first year MBBS students in pretest and pretest on topics taught by DL and CBL with help of actual LR and to assess students' perception on the usefulness of CBL supplemented with actual patient's LR.

MATERIALS AND METHODS

This cross-sectional study was conducted at Biochemistry Department, Smt. B. K. Shah Medical College and Research Centre, Sumandeep Vidyapeeth, Vadodara, Gujarat, India, from November 2019 to April 2020, after prior permission of Institutional Ethics Committee (IEC) (SVIEC/ON/MEDI/RP/20003, dated 30/01/2020).

Inclusion criteria: All the first year MBBS students, both male and female, admitted in academic year 2019-20 and who have voluntarily provided informed consent were included.

Exclusion criteria: First year MBBS students, admitted in academic year 2019-20, who have not volunteered to take part in the study and did provide the consent were excluded.

Sample size calculation: By using purposive sampling method, total 60 first year MBBS students were enrolled out of total 150 students. Initial sensitisation of all the enrolled students regarding study objectives and design was carried out. Departmental meeting of all faculties was organised for sensitisation and selection of topics. Two topics namely hyperbilirubinaemias (Topic-1) and Liver Function Tests (LFTs) (Topic-2) were selected for teaching-learning purpose.

Study Procedure

The study participants were drawn randomly by lottery method and allocated into two groups:

Group A: Thirty students in group A were exposed to DL.

Group B: Thirty students in group B were, exposed to CBL supplemented with LR, for topic 1 (hyperbilirubinaemias). As this was the "cross over type of experimental design" to remove bias, in halfway of the study the groups were interchanged i.e., group A was exposed to CBL supplemented with LR and group B was exposed to DL for topic 2 (LFTs).

CBL supplemented with LR: Real case-based scenarios of selected topics along with actual laboratory reports (Biochemistry, Pathology and Microbiology) were made available with consultation from clinical and laboratory faculties [Appendix-A,B] (for real case-based scenarios of topic 1 and 2 respectively). The details of patients on LR were hidden to maintain the confidentiality and integrity.

Didactic lecture: Power point presentations of same selected topics in context to biochemistry were also prepared by faculty for DL.

The time duration for both session was one hour. As both the groups were exposed to DL and CBL sessions, total two DL sessions and two CBL sessions were conducted. For both the groups, pretest was conducted about understanding of selected topic in the form of structured Multiple Choice Questions (MCQs) test of 20 marks each. Questionnaire was devised by one of the researcher which included 20 MCQs. Out of 20 MCQs, 10 were recall/remembering type questions, five were understanding and application-based questions, five were analysing and evaluation-based questions. Two internal subject experts validated MCQs. The content validity ratio was 1.00 and the reliability was calculated, where the Cronbach's alpha was 0.92 (p-value was 0.01) suggested acceptable tool. One mark was assigned for each correct answer and 0 for incorrect answer. Out of total 20 marks, the scores obtained were taken into consideration and comparison. Passing criteria was kept at scores achieved 50% and above. The effect of teaching-learning methods was analysed by assessing performance of students in pre and post MCQs test for both topics.

Topic-1 (hyperbilirubinemia): After pretest, group A (30) was exposed to DL method. Group B students were divided into three subgroups B1, B2 and B3 each comprised of 10 students. They were exposed to CBL supplemented with LR method. Each student of group B was provided case-based scenario of real patient with actual LR. They were also provided the predetermined learning objectives and questions for critical thinking. During discussion, principles of group dynamics and small group teaching were

followed and observed by the faculty [10]. At the end, student from each subgroup presented the conclusion of group discussion followed by final compilation of session by faculty. Post-test was conducted for both groups after one week of sessions to assess the understanding of the learned topic/s.

Topic-2 (LFTs): For topic-2 crossover was done. Here, group B was exposed to DL method and group A was exposed to CBL supplemented with LR method as described above for topic 1. For topic 2, pre and post-test were also taken as explained earlier.

The students were asked to fill the prevalidated structured questionnaire. Questionnaire was devised by the researcher after reviewing the literature [1,8,9]. It comprised of 12 statements, about their views and perception of usefulness of CBL supplemented with LR [Appendix-C]. Validation of questionnaire was done by incorporating suggestions of four internal and four external subject experts. The internal consistency of feedback questionnaire was found to be acceptable (Cronbach's alpha was 0.782). Feedback of the students was taken on five-point Likert scale (strongly agree-5, agree-4, can not say-3, disagree-2 and strongly disagree-1). Minimum score was 12 and maximum score was 70. Anonymity was maintained during taking feedback. Only those students who attended the teaching sessions for both selected topics, submitted pre and post-tests and gave feedback were considered as study population.

STATISTICAL ANALYSIS

The statistical analysis was done by using International Business Machines (IBM) Statistical Package for the Social Sciences (SPSS) version 27.0 software. Results were expressed as mean and Standard Deviation (SD). Paired t-test was used to compare the results of pre and post-tests within the groups. Unpaired (independent) t-test was used to compare the results of pre and post-tests across the groups. To simplify the reporting of findings of students' perception received on five-point Likert scale, % agreement (strongly agree+agree) and % disagreement (strongly disagree+disagree) categories were combined. The statistical significance was defined as a p-value of <0.05.

RESULTS

Total 60 students enrolled, 59 students attended teaching sessions for both selected topics, submitted pre and post-test and gave feedback (response rate was 98.33%). Hence, total study population was 59. Out of total 59, 24 were males and 35 were females. The age of the students ranged from 17-21 years with mean age 18.29±1.00 years. The [Table/Fig-1] depicted the comparison of pre and post-test for DL method in both groups and the difference was found non significant (p>0.05). The [Table/Fig-2] showed comparison of pre and post-test for CBL supplemented with LR method in both groups and the difference was found highly significant (p-value=0.001).

Group	Test	Mean±SD	Paired t-test	p-value
A (topic-1)	Pretest	8.4±1.92	1.91	0.07
	Post-test	9.43±2.23		
B (topic-2)	Pretest	7.43±2.68	2.31	0.243
	Post-test	8.96±2.44		

[Table/Fig-1]: Comparison of pre and post-test for DL method in both groups.

Group	Test	Mean±SD	Paired t-test	p-value
A (topic-2)	Pretest	8.4±1.92	18.1	0.001*
	Post-test	15.73±1.11		
B (topic-1)	Pretest	8.86±1.69	21	0.001*
	Post-test	16.53±1.07		

[Table/Fig-2]: Comparison of pre and post-test for CBL supplemented with LR method in both groups.

*Significant results at 95% confidence interval and p<0.05

In [Table/Fig-3], comparison of mean of differences in pre and post-tests of both learning methods was shown and the difference was found highly significant for both the topics ($p < 0.001$).

Topic	Method	Mean of differences of pre and post-tests	Unpaired (independent) t-test	p-value
Hyper-bilirubinemias	DL	1.03	52.46	0.001*
	CBL supplemented with LR	7.67		
LFTs	DL	1.53	37.6	0.001*
	CBL supplemented with LR	7.33		

[Table/Fig-3]: Comparison of mean of differences of pre and post-tests for both learning methods.

*Significant results at 95% confidence interval and $p < 0.05$

The [Table/Fig-4] depicted overall comparison of mean of difference of pre and post-test between two teaching-learning methods and the difference was found highly significant ($p < 0.001$).

Particulars	DL	CBL supplemented with LR
Mean of difference of pre and post-test	1.28	7.50
SD of difference of pre and post-test	0.275	0.715
p-value	<0.0001*	

[Table/Fig-4]: Overall comparison of mean of difference of pre and post-test between two teaching-learning methods.

*Significant results at 95% confidence interval and $p < 0.05$

The [Table/Fig-5] showed the percentage of students responded through feedback questionnaire ($n=59$). It was evident from the [Table/Fig-5], that combined percentage of students agreeing to most of the questions was ranging from 79-100% ($n=49$ to 59). All the students felt that CBL supplemented with LR method was useful, interesting and helped to improve their interpretation skills. About 56 (94.92%) of students felt that CBL supplemented with LR method helped them to understand the topics in biochemistry and stimulated them to do critical thinking. Regarding session on CBL supplemented with LR, 47 (79.66%) of students agreed that sessions encouraged and brought more interaction with their peers and faculty, 49 (83.05%) of students perceived enough opportunity to express themselves and 54 (91.53%) of students reported that they felt motivated to learn biochemistry. About 53 (89.83%) of students felt that CBL supplemented with LR should be used as a supplementary method and 52 (88.13%) of students felt that it would

help them to perform better in examinations. About 58 (98.30%) of students were in the agreement that exposure to CBL supplemented with LR in their first professional year would help them to manage clinical cases in the proceeding professional years.

DISCUSSION

In first year MBBS, biochemistry is one of the basic and fundamental subjects which plays a very important role in laboratory medicine and in turn helps in management of diseases. CBL is well established teaching learning methodology which enhances students' active participation and makes learning more enjoyable. In the present study, innovative approach was made in the form of providing students the actual patient's LR during CBL sessions and comparison was done with DL method. This study demonstrated that use of actual patient's LR in CBL sessions in biochemistry was very helpful and interesting as compared to the traditional DL methodology. Without adding clinical relevance to learning will make the subject disinteresting and boring to students and learn biochemistry by repetitions of facts [11]. Cases helped learners to develop problem solving skills and collaborative skills that are recognised as key outcome skills that students will need in their future professional lives [7,12,13].

It was also observed that the performance of students in the post-test administered one week after conducting CBL supplemented with LR was better than after DL ($p < 0.001$), which revealed that learning by CBL supplemented with LR method enhanced their critical thinking and their understanding on the topic became better. These findings were in accordance with the studies carried out by Kulak V et al., Kaur S and Sharma R and Kulak V and Newton G, [14-16]. Kulak V et al., had conducted directed type of CBL to 104 undergraduate students to determine whether the use of CBL in a biochemistry course would improve the retention of basic concepts. They demonstrated a significant difference in the retention test scores of CBL students compared to the non CBL students [14]. Kaur S and Sharma R had used CBL to integrate topics in biochemistry [15]. They observed that the ability of students for clinical reasoning, diagnostic interpretations and think logically was improved with CBL. CBL also enhances the ability of the students to work as a team and by using patient's actual LR in CBL help them to identify and critically analyse case histories find out solution to increase physician competencies [15].

This was supported by 79.66% students' response to feedback regarding CBL with LR method stating that it provided enough opportunity to express and interaction with peers and faculty. All

Statements	Strongly agree n (%)	Agree n (%)	Can't say n (%)	Disagree n (%)	Strongly disagree n (%)	Combined agreement n (%)	Combined disagreement n (%)
Case based learning (CBL) with help of actual laboratory report in biochemistry....							
1. Was useful and interesting	39 (66.10)	20 (33.90)	-	-	-	59 (100)	-
2. Helped me in understanding the topic in biochemistry	27 (45.76)	29 (49.15)	3 (5.08)	-	-	56 (94.92)	-
3. Helped to improve my interpretation skills	34 (57.63)	25 (42.37)	-	-	-	59 (100)	-
4. Has stimulated to do critical thinking	38 (64.41)	18 (30.51)	3 (5.08)	-	-	56 (94.92)	-
5. Session encouraged and brought more interaction with my peers and faculty	27 (45.76)	20 (33.90)	11 (18.64)	1 (1.69)	-	47 (79.66)	1 (1.69)
6. Improved my problem solving ability	25 (42.37)	24 (40.68)	9 (15.25)	1 (1.69)	-	49 (83.05)	1 (1.69)
7. Has given enough opportunities to express myself	11 (18.64)	38 (64.41)	7 (11.86)	2 (3.39)	1 (1.69)	49 (83.05)	3 (5.08)
8. Presentation and discussion at the end of session helped me to learn better	30 (50.85)	24 (40.68)	5 (8.47)	-	-	54 (91.53)	-
9. Motivated me to learn Biochemistry	30 (50.85)	24 (40.68)	4 (6.78)	1 (1.69)	-	54 (91.53)	1 (1.69)
10. Can be used as a supplementary method	35 (59.32)	18 (30.51)	5 (8.47)	1 (1.69)	-	53 (89.83)	1 (1.69)
11. Will help me to perform better in internal and University examinations	27 (45.76)	25 (42.37)	7 (11.86)	-	-	52 (88.13)	-
12. I expect that exposure to CBL with laboratory report in the first professional year would help me to manage clinical cases in the proceeding professional years	47 (79.66)	11 (18.64)	1 (1.69)	-	-	58 (98.30)	-

[Table/Fig-5]: Students' response to feedback questionnaire about CBL supplemented with LR ($n=59$).

the students felt that use of LR in CBL session was interesting, helped them to improve their interpretation and analysing skills and motivated them to learn biochemistry. These findings were supported by the studies conducted by Mallick AK and Ahsan M and Suganthy K et al., [8,9]. However, the study conducted by Suganthy K et al., has used only biochemistry LR based on single topic LFTs and interpretation skill of the students was assessed [9]. In his study, Mallick AK and Ahsan M, has given assignments with LR to study participants and then it was followed by DL. He also undertook only one topic for the same. In contrast, the present study has used two topics, real case-based scenarios with actual patient's laboratory reports of biochemistry, pathology and microbiology which has provided 360 degree view of lab investigations [8].

This kind of exposure helped students not only to have real case-based learning but also to make differential diagnosis. CBL supplemented with LR proved to be an interesting concept and it helped the students in improving their academic performances, as 58 (98.30%) students felt that this methodology would help them in managing clinical cases in proceeding professional years. These findings were also observed in the study conducted by Kulak V and Newton G, where they demonstrated that use of CBL can prevent surface approach towards learning and improved performance of students in the course [16]. Care that should be taken during the selection of the case, in that it should reinforce the students' understanding of the key concepts, fundamentals and the mechanistic processes of biochemistry [7]. It has also been observed during the study that students who were not volunteered for study showed interest to participate in the study. The results of the present study and feedback of students encouraged us to incorporate CBL supplemented with actual LR as an active teaching-learning tool that enhances clinical correlation and critical thinking, encourages team participation, group discussions and motivates students to become lifelong learners.

Limitation(s)

The duration of the study was six months, so only two topics were covered and only 59 students were enrolled. Due to time constrain and availability of slots for carrying out teaching sessions, only volunteered students were enrolled. As preparation for CBL with actual LR required more efforts, it is difficult to cover all relevant topics. Besides, this study was done as a pilot project therefore it has to be done for a longer period to see what final impact such intervention has on students' performance.

CONCLUSION(S)

The CBL supplemented with actual LR proved to be a very good student-centric teaching-learning tool in biochemistry as compared to traditional DL method. Students who have undergone CBL supplemented with actual LR have better understanding of biochemistry and performed better in written tests than those who have undergone DL method. CBL supplemented with actual LR can be used as a supplementary method of teaching-learning. It

has been suggested from the present study that actual LR should be provided to students in CBL sessions, so that students get real experience of seeing reports which help them to analyse and interpret properly. They also get used to the system of laboratory medicine at the beginning of first year.

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APPENDIX A: Real case-based scenario for topic 1 Hyperbilirubinemia

A 9 years old male boy came to the paediatric OPD of Dhiraj Hospital, Vadodara with complaints of decreased appetite for last 15 days, fever for last 4-5 days, pain in abdomen for last 4-5 days and yellowish discoloration of eyes for 2-3 days. On examination, pediatrician revealed yellowish sclera, tenderness in right hypochondriac and epigastric region of abdomen and soft hepatomegaly. He diagnosed a case of Jaundice. He advised following investigations:

1. Complete blood count
2. Urine analysis
3. Serum bilirubin level
4. SGPT (ALT)

After seeing the first report (Referred laboratory report 1), diagnosis of jaundice was confirmed. To rule out the reason for fever, pediatrician advised further investigation. After seeing report-2 (referred laboratory report 2), diagnosis was confirmed Acute Viral Hepatitis.

Learning Objectives

1. Explain uptake, conjugation and excretion of bilirubin in our body.
2. Describe principle of method for bilirubin estimation.
3. Explain direct and indirect bilirubin.
4. Describe hyperbilirubinaemias.
5. Describe differential diagnosis of jaundice based on biochemical tests.

Questions for critical thinking

1. What is the case and justify your answer?
2. What are the other causes of this clinical condition?
3. How will you differentiate this case from other types of jaundice?
4. Why direct and indirect bilirubins were increased in this case?
5. Why bilirubin was present in the urine?
6. Write normal value of direct, indirect and total bilirubin.
7. What is your interpretation of antibody test as per report-2?
8. What other investigations can be done in this case?

APPENDIX B: Real case-based scenario for topic 2 Liver Function Tests (LFTs)

A 60 years old male chronic alcoholic patient was presented to Dhiraj Hospital with complaints of abdominal distension, yellowish

discoloration of skin and sclera, swelling in bilateral lower limbs since 15 days. On examination, icterus was present, tense dilated abdomen with fluid thrill and shifting dullness was present. Patient was advised for investigations like complete blood count, urine analysis, liver function tests with enzymes, total protein and albumin, Prothrombin time INR, HbsAg, HCV. The laboratory report was enclosed with this case (refer laboratory reports). After reviewing the reports, patient was diagnosed with decompensated alcoholic/viral (HbsAg +ve) liver disease with portal hypertension, jaundice and coagulopathy with anemia of chronic disease.

Learning Objectives

1. List the functions of liver
2. Classify and group liver function tests according to function and pathological change in the organ
3. Enumerate the tests based on pigment metabolism
4. List the tests of synthetic function and interpret the results
5. Explain the relevance of measuring hepatic enzyme panel
6. List special tests of liver function and their interpretation
7. Differentiate types of jaundice based on the results of LFTs including enzyme profile

Questions for critical thinking

1. What is the case and justify your answer?
2. What are the functions of liver affected in this case?
3. Give biochemical justification of
 - Abdominal distension (ascites)
 - Yellowish discoloration of skin and sclera
 - Swelling of lower limbs
4. Explain the basis of each investigation advised in this case.
5. What is portal hypertension? Explain in brief
6. Interpret the laboratory reports provided to you
7. What will be effect of vitamin K administration on prothrombin time in this case?
8. What will be the suggestive line of treatment in this case?

APPENDIX C: Prevalidated Feedback Questionnaire

Please give your opinion by circling the numerical value for each of the following questions regarding your experience of learning biochemistry using Case Based Learning with help of actual laboratory reports.

S. No.	Statements	Strongly agree	Agree	Can't say	Disagree	Strongly disagree
Case based learning (CBL) with help of Actual laboratory reports in biochemistry....						
1.	Was useful and interesting	5	4	3	2	1
2.	Helped me in understanding the topic in biochemistry	5	4	3	2	1
3.	Helped to improve my interpretation skills	5	4	3	2	1
4.	Has stimulated to do critical thinking	5	4	3	2	1
5.	Session encouraged and brought more interaction with my peers and faculty	5	4	3	2	1
6.	Improved my problem-solving ability	5	4	3	2	1
7.	Has given enough opportunities to express myself	5	4	3	2	1
8.	Presentation and discussion at the end of first session helped me to learn better	5	4	3	2	1
9.	Motivated me to learn Biochemistry	5	4	3	2	1
10.	Can be used as a supplementary method	5	4	3	2	1
11.	Will help me to perform better in internal and University examinations	5	4	3	2	1
12.	I expect that exposure to CBL with laboratory report in the first professional year would help me to manage clinical cases in the proceeding professional years	5	4	3	2	1