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Research Article

Motivating First year medical students to learn biochemistry by Case based learning

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Abstract

Objectives: Innovative curriculum with case based learning (CBL) is proven to improve the academic performance of biochemistry in medical students. Thus it was of interest to see if students get motivated & understand the concepts of biochemistry better by CBL.

Materials & Methods: First year MBBS students (n=210) were divided into 2 groups. Biochemistry was reinforced to Group 1(Roll numbers 1-100, control) by regular teaching, and group 2 (Roll numbers 101-210, test) was exposed to CBL. Assessment was done by six case based questions. Feedback was obtained on a five point Likert scale about perception on CBL.

Results: Group 2 performed better in four questions than group 1 and showed similar performance in 1 question. 81.69 % agreed CBL motivated to learn Biochemistry, 79.07% agreed CBL helped understand the subject better, 79.07% stated CBL promoted meaningful learning, 75.15% agreed CBL helped in development of critical thinking, 88.23% said biochemistry is useful in diagnosis & care, 79.73% suggested CBL should be implemented to all topics of biochemistry, 78.42% voted interactive review sessions involving CBL would be more effective.

Conclusion: Reinforcing biochemistry by CBL motivates, promotes meaningful learning and helps development of critical thinking. First year medical students were convinced that biochemistry is helpful in patient diagnosis & care following CBL.

Keywords: Case based learning, Biochemistry, Integrated curriculum, Reinforcement, Motivation.

1. Background and Introduction

Biochemistry, one of the basic science subjects taught during first year of Medical course is proposed to be taught in correct perspective to medical students[1]. Advances in the field of medical science are overwhelming with biochemistry occupying the central place[2]. Learning & teaching biochemistry to students has become a strenuous task due to the rapid expansion of information & technical background in biochemistry/ molecular biology[3]. Basic science knowledge learned in the context of clinical cases is actually better comprehended & more easily applied by medical students than basic science knowledge learned in isolation[4]. Of the many approaches to integrate basic & clinical sciences and make learning more effective & interesting, case based learning (CBL) is highly recommended[5]. Innovative curriculum with case based learning (CBL) is shown to improve the academic performance of biochemistry in medical students and integrated learning of basic and clinical sciences is proven to enable students to link theory and practice[6].

Hence this study was aimed to appreciate if reinforcing biochemistry by case based problem solving sessions besides regular lectures to a group of students improves the better understanding of the subject compared to group of students who were not exposed to such sessions. It was also intended to see if students get motivated & understand the concepts of biochemistry better by CBL.

2. Materials & Methods

In AIMST University, MBBS is a 5 year course and integrated curriculum is followed by introducing all the basic science subjects (Anatomy, Physiology, Biochemistry, Pharmacology, Pathology, Microbiology and Community Medicine) from as early as 1st year of medicine. During first year, information is delivered mainly by didactic lectures, interactive review sessions (IRS) & practicals. Problem based learning (PBL), a part of integrated curriculum is introduced in the 2nd year when system based approach is followed.

First year MBBS students (n=210) were divided into 2 groups. Group 1(n=100) was considered as control & biochemistry was reinforced again by regular teaching. Group 2 (n=110) was considered as test group and biochemistry was reinforced by CBL. The Reinforcement sessions were conducted only after the topics were taught during scheduled regular biochemistry lectures. Each group was exposed to two such sessions one each on carbohydrate & lipid metabolism. Two different faculties handled individual groups.

The faculty not involved in these special sessions prepared case based questions: three each in carbohydrate & lipid metabolism (Appendix 1). The students were not intimated about the assessment and were subjected to the test as and when they walked into the class for regular lectures. On talking to some of the students after the test, most of them replied that they would not have studied any better even if they knew about the test, as the grades were not counted for their academic performance.

Students were briefed about the study and were informed that the assessment was to appreciate if CBL improved the understanding ability of the subject. It was ensured that participation is on voluntary basis and results obtained would be kept confidential and no individual identity would be disclosed. Informed consent was obtained from the students who volunteered for the study (80 students from group 1 and 78 from group 2). After the test was conducted, the control group was also exposed to the same cases on carbohydrate & lipid metabolism before the class took their continuous assessment (CA) examination. This avoided any bias and the whole class was uniformly educated before their academic exam (CA).

Results were analyzed using Chi square with Yates correction and *P* value <0.05 was considered statistically significant (Table 1). Feedback was also obtained by the participants (only 153 students gave feedback) on a five point Likert scale about the perception on CBL after continuous assessment examinations (Appendix 2).

The study was approved by The Institutional Research Review Board of AIMST University, Malaysia with internal grants number AURGC/45/FOM/2013.

APPENDIX 1

1. A 43 year old man presented with symptoms of weakness, fatigue, shortness of breath and dizziness. His hemoglobin level was less than 7gm/dl (normal for a male being greater than 13.5 gm/dl). Red blood cells isolated from the patient showed abnormally low level of lactate production. A deficiency of which of the following enzymes would be most likely cause of this patient's anemia?
    a. Phosphofructokinase
    b. Pyruvate kinase
    c. Hexokinase
    d. Lactate dehydrogenase
2. A 12 year old type 1 diabetic child taking insulin injection was admitted to the emergency with hypoglycemic shock. He was administered glucagon and rapidly recovers consciousness. Glucagon increases the activity of
    a. Glucokinase
    b. Hexokinase
    c. Glycogen synthase
    d. Glycogen phosphorylase
3. An alcoholic is brought to the emergency room with hypoglycemia coma. Because alcoholics are malnourished, which of the following enzymes can be used to test for thiamine deficiency?
    a. Aldolase
    b. Transaldolase
    c. Transketolase
    d. Glucose 6 phosphate dehydrogenase
4. A young girl with a history of severe abdominal pain was taken to hospital at 5 AM in severe distress. Blood was drawn and the plasma appeared milky, with the triacylglycerol level in excess of 2000mg/dl (normal: 40-150mg/dl). The patient was placed on a diet severely limited in fat, but supplemented with medium chain fatty acids. Which of the following lipoprotein particles are most likely responsible for the appearance of the patient's plasma?
    a. Chylomicrons
    b. Very low density lipoproteins
    c. Low density lipoproteins
    d. High density lipoproteins
5. A 4 month old baby is found to have low serum glucose and ketone body level. He is diagnosed to have medium chain acyl Co A dehydrogenase deficiency. What is the biochemical basis of infant's symptoms?
    a. Fatty acid synthesis is impaired
    b. TCA cycle is inhibited
    c. B-oxidation of fatty acid is impaired
    d. Cholesterol biosynthesis is increased
6. A 5 year old boy presents with altered mental status, heart failure and muscle weakness. His serum level of glucose and ketones were abnormally low. He is diagnosed with carnitine deficiency. In which of the following pathways is carnitine directly involved?
    a. Fatty acid synthesis
    b. B-oxidation
    c. Ketogenesis
    d. Cholesterol synthesis

APPENDIX 2: Feedback Form using Likert Scale

Instructions to candidates: Please tick any one of the appropriate response for each statement given below.

		Strongly agree (%)	Agree (%)	Strongly agree + agree (%)	Not sure (%)	Disagree (%)	Strongly disagree (%)
Revising carbohydrate & lipid metabolism by Case Based Learning (CBL)							
1	Motivated you to learn Biochemistry	30 (19.6)	95 (62.09)	125 (81.69)	19 (12.41)	8 (5.22)	1 (0.65)
2	Helped you in better understanding the subject	36 (23.52)	85 (55.55)	121 (79.07)	29 (18.95)	3 (1.96)	0
3	Promoted meaningful learning than regular teaching	38 (24.83)	83 (54.24)	121 (79.07)	27 (17.64)	5 (3.26)	0
4	Helped you perform better in the CA3 exam	17 (11.11)	44 (28.75)	61 (39.86)	82 (53.59)	8 (5.22)	2 (1.30)
5	Helped you a lot in terms of development of critical thinking.	36 (23.52)	79 (51.63)	115 (75.15)	35 (22.87)	2 (1.30)	1 (0.65)
6	Made you clear that biochemistry is helpful in patient diagnosis & care.	51 (33.33)	84 (54.9)	135 (88.23)	16 (10.45)	1 (0.65)	1 (0.65)
7	Revision by CBL should be implemented to all topics of Biochemistry.	51 (33.33)	71 (46.4)	122 (79.73)	25 (16.33)	4 (2.61)	2 (1.30)
8	Interactive review sessions (IRS) involving CBL will be more effective.	58 (37.9)	62 (40.52)	120 (78.42)	27 (17.64)	2 (1.30)	4 (2.61)
9	**Please write your comments here regarding the overall study, CBL sessions, usefulness and views on future implementation of the same to all topics of biochemistry**.						

3. Results

When the performance of the groups in individual questions was analyzed, group 2 performed better in one out of three questions on carbohydrate metabolism and all questions on lipid metabolism which was highly significant (Table 1). Performance in one question on carbohydrate metabolism was equal in both groups.

In a feedback obtained through 5 point Likert scale, 81.69 % agreed CBL motivated to learn Biochemistry, 79.07% agreed CBL helped to understand the subject better, 79.07% stated CBL promoted meaningful learning, 75.15% agreed CBL helped in development of critical thinking, 88.23% said biochemistry is useful in diagnosis & care, 79.73% suggested CBL should be implemented to all topics of biochemistry and 78.42% voted interactive review sessions involving CBL would be more effective.

Table 1: Comparison of performance of students in six questions (three carbohydrate and three lipid metabolism related)

Parameter	Number of students with Correct answers (%)		*P*value
	Group 1 (n=80)	Group 2 (n= 78)	
Q1	19 (23.8%)	31 (39.7%)	0.04
Q2	47 (58.8%)	49 (62.8%)	0.72
Q3	28 (35%)	28 (35%)	0.90
Q4	25 (31.3%)	41 (52.6%)	0.01
Q5	52 (65%)	63 (80.8%)	0.04
Q6	51 (63.8%)	64 (82.1%)	0.01

4. Discussion

Most of the medical colleges around the world are incorporating integrated curriculum which is student centered and promotes self directed learning. PBL an important part of integrated curriculum has its own demerits: students tend to jump to diagnostic conclusions and treatment options rather than understanding the basic anatomy, physiology & biochemistry of the disease and then arrive at conclusions. Case study in preclinical medical school curriculum is proposed to overcome these[7].

Studies have shown that students get very less opportunity & time to clarify their doubts & reinforce concepts learned during lectures. As a result of this, they struggle to relate a clinical condition with its basic biochemical concepts during clinical training[3]. Carbohydrate & lipid metabolism constitute a large portion in Medical biochemistry & they are integrated & interlinked. Understanding carbohydrate metabolism is the foundation for meaningful understanding of lipid metabolism and lipid metabolism makes more sense when carbohydrate metabolism is understood. Since the metabolism of these elements is full of pathways, students tend to get confused and thus incline to memorize the concepts rather than understanding them, and complete the course without gaining knowledge on the subject. According to them, biochemistry is in no way useful in future for clinical practice. Hence, it was aimed to assess if reinforcing concepts learnt in regular biochemistry lectures by using cases and trying to explain the mechanisms/pathways based on the clinical cases helps students understand, appreciate the importance & retain biochemistry better.

One example is the role of pyruvate dehydrogenase (PDH) complex & citric acid cycle (TCA) in oxidative decarboxylation of pyruvate during carbohydrate metabolism. Students always feel memorizing these pathways would help them only to answer the questions in exam & finish the course, but in no way helps for future clinical practice. During this study, when the importance of these two concepts was explained and emphasized using a case scenario, how/why defective functioning of these pathways leads to weakness, ataxia, ophthalmoplegia in patients/alcoholics with B-complex vitamin deficiency, they felt excited & found the subject more interesting. In a feed back form obtained after CBL exposure, 88.23% of students admitted that biochemistry knowledge is helpful in diagnosis and care of patients.

It has been proposed that medical undergraduates acquire knowledge not only through listening to lectures and reading recommended textbooks but also solving scientific problems in the process of becoming an expert clinician[8]. Even though no single teaching method has been observed to adequately ensure growth of critical thinking as well as clinical reasoning skills for students, incorporation of clinical case histories in tutorial classes along with other T-L methods like didactic lectures has been proven to be important in improvement of problem solving & decision analysis[4]. Clinical case based learning creates an active learning environment along with other teaching methods [9].

A recent study by Salgar involves all the students in first year MBBS as test group with no control group. Also, the study involved discussing only two cases followed by assessing the perception of students regarding CBL in terms of agreed, disagreed or neutral response. He has proposed CBL to be an innovative teaching method that helps better application of biochemistry in medicine[10].Our study intended to appreciate the usefulness of CBL in understanding biochemistry compared to regular teaching. Thus, first year MBBS students (n=210) were divided into Group 1 (n=100, control) and were exposed to reinforcement sessions by regular teaching whereas group 2 (n=110, test) was exposed to reinforcement sessions by case based learning. The reinforcement sessions were one each on carbohydrate and lipid metabolism.

The results of our present study are convincing that explaining concepts & mechanisms in carbohydrate and lipid metabolism using case based approach, helped students in group 2 perform better in four out of six questions. Significantly better performance in all the questions on lipid metabolism by group 2 may be due to their competence to appreciate concepts in lipid metabolism better based on the principles of carbohydrate metabolism. This might have helped group 2 perform better in answering the questions even though they were formulated by faculty not involved in the reinforcing sessions (Table 1). Significant performance in only one of three questions on carbohydrate metabolism by group 2 might be due to too many pathways in carbohydrate metabolism which is always confusing, added to which they were reinforced in one session.

Since most of the competitive/qualifying exams in present education system are objective oriented with case scenarios, training the students by CBL is the need of the hour. The present study gives convincing evidence, wherein group 2 students exposed to CBL sessions, showed better performance in the assessment formulated by faculty not involved in reinforcement sessions compared to group 1 who only had reinforcing sessions similar to regular lectures. Thus, for students to perform better in case based objective type questions they should be explained about the concepts by case based learning and not just regular lectures which is evident.

Studies have stated that fundamental sciences should be integrated with clinical sciences as both are essential to progress in each[11]. Abraham fuks& others strongly recommend that critical thinking should be introduced as early as 1st year to medical students when they are learning basic sciences since it helps in creating a natural bridge to pathophysiology and clinical medicine taught later in the curriculum. They also state teaching clinical inference in the classroom & small group setting permits students to learn specific subject with the appropriate level of attention & intensity[12]. Difficulty of the students in listening to teachers continuously if there is no active participation has been projected and recommendations to engage the students in active learning has been proposed so that they retain what they learn longer. Difficulties of the faculty in holding the attention of students during lectures is quoted as well and suggestions to incorporate innovative active & interactive T-L method to overcome this difficulty is proposed[3].

78.42% students in the present study voted that interactive review sessions (IRS) involving CBL would be more effective. Hence the study proposes to incorporate case based discussions during revision/IRS as a mode of reinforcing the concepts of metabolism as well as to involve the students actively and make them understand the relevance & connection of biochemistry to clinical diagnosis in real situations.

It has been projected that case studies promote active learning, encourage the development of critical thinking skills, provide student centered instruction & help with problem solving all of which are valuable tools that prepare students to make better decision, become better students & ultimately better

employees. CBL is also proposed to facilitate & enhance student learning, help students to make meaning of knowledge in practical settings and give them opportunity to link theory to practice. Thus, educators are recommended to use case studies more widely[13].
Improvement in student's confidence & motivation levels with problem oriented learning is also proposed[14].

The students involved in this study agreed that reinforcing metabolic pathways using case scenarios motivated to learn Biochemistry (81.69%), helped to understand the subject better (79.07%), promoted meaningful learning (79.07%) and helped in development of critical thinking (75.15%). 79.73% suggested CBL should be implemented to all topics of biochemistry.

Hence it is proven in the present study that biochemistry, with which first year medical students struggle due to complicated pathways, can be made more meaningful by case based learning. Students can also be motivated and encouraged of critical thinking as and when metabolic pathways are discussed by using case based discussion.

One of the limitations of the present study was that, only one session each was used for carbohydrate and lipid metabolism due to tight schedules. Reinforcing the entire metabolism within these two sessions was exhausting to the students. This might be the reason for only 39.86% of students agreeing CBL helped to perform better in the CA exams. Because, even though CBL sessions motivated and helped them understand the subject better, they were not sure if it really helped them perform better in academic exams which comprise of objective as well as short and long answer questions. The exam also comprised of questions on other topics of biochemistry and thus the students were not sure of usefulness of CBL in gaining marks. Thus, based on the suggestions as well as feedback from the students, the researchers feel introducing case based discussions during all IRS sessions is worth to improve the perception of biochemistry in later years.

5. Conclusion

The present study concludes that reinforcing biochemistry by CBL motivates, helps development of critical thinking and assures first year medical students that biochemistry is helpful in patient diagnosis & care. Reinforcing complicated metabolic pathways by CBL also promotes meaningful learning and retention of biochemistry.

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