

PRE-ANALYTICAL VARIABLES IN CLINICAL CHEMISTRY: TRAINING MEDICAL UNDERGRADUATES THROUGH CASE BASED DISCUSSION

Nimesh Archana, Mehndiratta Mohit, Agarwal Vibhuti, Garg Seema, Puri Dinesh

Department of Biochemistry, University College of Medical Sciences, Delhi, India .

ABSTRACT

Background: Pre-analytical variables in clinical chemistry are factors prior to the biochemical analysis of samples affecting laboratory test results accounting for 32-75% of errors leading to misdiagnosis, decreased quality of medical care services and wastage of monetary resources. **Aim:** To educate first year medical undergraduates about pre-analytical variables through case based discussion and lecture method of teaching and assess the gain in knowledge by these methods. **Methods and material:** Two batches of medical students namely A (N=50) and B (N=52) were assessed for their background knowledge on the topic using an MCQ based questionnaire (pre-test). Batch A and B were taught through didactic lecture and case based discussion respectively. Post-test questionnaire was conducted to test the gain in knowledge of both batches. Delayed post-test was conducted after 2 weeks to assess retention of knowledge amongst students. **Results:** Pre-test scores of Batch A and B were not significantly different indicating that both batches had similar background knowledge of topic. Post-test scores vs. pre-test scores were significantly higher in both batches implying that both batches benefitted from their respective teaching sessions. But post-test score of Batch B was significantly higher than that of Batch A indicating higher gain of knowledge through case based discussion. Delayed post-test score was also significantly higher in Batch B vs. A implying better retention of knowledge through case based discussions. **Conclusion:** Topic 'Pre-analytical variables in clinical chemistry' must be included in undergraduate medical curriculum. Case based discussion could be an effective module for teaching the same.

Key words: Case based discussion, Didactic lecture, Medical education, Medical students, Pre-analytical variables.

INTRODUCTION

The undergraduate medical students in our country are taught usually through didactic lecture where they seldom get a chance to clarify their doubts and realize how important the topic is from a medical perspective. A didactic lecture primes the mind of the students to the topic in a way the teacher wants them to learn. Moreover, it hinders the critical thinking and deeper understanding of the topic that may have a practical implication to it [1]. Such topics may be poorly understood by some students.

Pre-analytical variables in clinical chemistry are factors prior to the biochemical analysis of the samples that can affect the laboratory test results. These variables account for 32-75% of errors in the results so generated [2]. These factors encompass the time frame starting from a test being or-

dered by the doctor until the sample is ready for analysis [3]. This topic is not included in the syllabus of undergraduate medical curriculum. Hence, the students are not taught this topic through lecture or any other teaching module. The students however, acquire some passive knowledge on this topic during their internship by observing the lab personnels or seniors or nursing staff who are usually not trained on this topic as well. Thus, the understanding of this topic remains poor amongst the medical and paramedical staff involved in delivery of patient care services. This is of great concern because the medical students in their future years would be entrusted with responsibility of requesting these laboratory tests for patients. Due to lack of knowledge about pre-analytical variables, the erratic results sometimes so generated from the labs may not be recognized as errors by the treating doctors. Hence, there may be misdiagnosis and mistreatment of the patients thereby, decreasing the quality of medical care delivered to the patients besides causing wastage of monetary resources [3].

Pre-analytical errors are largely attributable to human mistakes [4] and the majority of these errors are preventable [5-6].



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Correspondence: Dr. Mohit Mehndiratta, Department of Biochemistry,

University College of Medical Sciences, Dilshad garden, Delhi. Email: drmohitucms@gmail.com

Thus, through this study, we aimed to educate the undergraduate medical students about this topic and find an effective teaching method for the same. Being aware of the drawbacks of didactic lecture as a teaching method, we wanted to test case based discussion as an alternate teaching module to educate medical students on this topic. So far, this is the first study for testing the knowledge and retention of medical students on an important topic which is commonly ignored in almost all medical institutes and to suggest an effective teaching module for introducing this topic to students. Moreover, results of our previous studies have shown that around 98% of the students of the current academic batch and last three academic batches have requested us to introduce clinically oriented classes (the results are in the process of publication) in their curriculum. Hence, we decided to carry out this study.

Objective: To assess the background knowledge of 'pre-analytical variables in clinical chemistry' amongst first year medical students and testing the effectiveness of introducing this topic to them through case based discussion as a teaching module vs. didactic lecture.

MATERIALS AND METHODS

Study design: It is a cross sectional study.

Ethics approval: The study was carried out after seeking approval from the Ethics' Committee for Human Research of our institute. A written informed consent was taken from the students before proceeding ahead with the study.

Sample size: 50 students in Batch A and 52 students in Batch B.

Inclusion criteria: First year undergraduate medical students of 2nd semester were enrolled for the study. Results were computed only for those students who had participated in filling the pre-test, post-test and delayed post-test questionnaire forms. Hence, we could include 50 students in Batch A and 52 students in Batch B.

Exclusion criteria: Students who opted out or absented themselves from participating in either pre-test, post-test or delayed post-test were not considered for computation of results.

Study population: The study was carried out on first year medical students at the end of their second semester in the Department of Biochemistry.

Grouping: The medical students were divided into two batches of 75 students each, namely Batch A and Batch B and invited to participate in our study.

Methodology: On day 1, the Batch A students were distributed a questionnaire form comprising of 25 multiple choice questions (pre-test) to be solved by them in

a span of 15 minutes. This questionnaire was self-designed (validated by pilot study) on the topic 'Pre-analytical variables in clinical chemistry'. The pre-test questionnaire forms were collected once the students had marked their responses. The pre-test exercise was immediately followed by a one hour didactic lecture to the students on the topic 'Pre-analytical variables in clinical chemistry'. At the end of the lecture the students were again distributed a fresh questionnaire form (post-test) but consisting of same questions as pre-test form to be solved by them in a span of 15 minutes following which the forms were collected. This was done to help us evaluate the gain in knowledge of the students by using didactic lecture method.

On Day 2, Batch B students were also asked to solve the pre-test questionnaire in 15 minutes as done by Batch A to help us assess their background knowledge on the topic. After the pre-test exercise, the Batch B students were taught the topic 'Pre-analytical variables in clinical chemistry' using case based discussion method as described here.

A print-out was distributed to the students containing details of the cases. The cases (described in print out) to be discussed with students were designed such that it described a real life medical situation with a brief description of patients clinical condition and lab investigations that were carried out. The process of sample collection, transportation, storage, biochemical analysis with their results was also described clearly in the print-out. However, the given results of the lab investigations were not correlating with the patient's symptoms in the given case description. At the end of each case description in the print-out, the students were asked to think and solve the given questions and justify the reasons for non-coherent lab results.

These questions were pertaining to the pre-analytical variables (during the phase of sample collection, storage and transportation, biochemical analytical techniques etc.) that could have lead to generation of erroneous results thereby leading to inconsistency with the patient history. The students were asked to answer the questions verbally and participate in discussion with the teacher and clarify their doubts. Five such cases were discussed one by one at a time over a span of one hour. At the end of case discussion session, the students were again asked to solve the MCQ based questionnaire form (post-test).

It was taken care that the same teacher took the class for both the batches and the content of the topic remained same while teaching the students by two different methods i.e. same pre-analytical variables were discussed with both the batches. Only the teaching methodology used for teaching was different for the two batches. The time allotted for solving the questionnaire and duration of teaching session also remained same for both the batches.

After two weeks, the students of Batch A and Batch B were administered a surprise test using the same MCQ based questionnaire form (delayed post-test) to be solved in 15 minutes. The pre-test, post-test and delayed post-test questionnaire forms collected from students of Batch A and B were assessed. The scores of the students belonging to the two batches were compiled and statistically analyzed. The results of only those students who participated in all the three tests (pre-test, post-test and delayed post-test) were only included in the study. We could thus include results of 50 students in batch A and 52 students in Batch B out of 75 students enrolled in each batch initially.

Statistical Analysis: The data of pre-test, post-test and delayed post-test score was analyzed for normality and was found to be parametric in nature. Hence, the scores have been expressed as Mean ± SD. The minimum to maximum range of scores have also been mentioned. A comparison of pre-test score with post-test score using paired student t test was done for Batch A as well as Batch B (Table 1). The pre-test, post-test and delayed post-score test score of Batch A was compared with that of Batch B using independent student t-test (Table 2). The statistical work was carried out at 5% level of significance using the SPSS software (version 20) and P value ≤ 0.05 has been considered significant.

Table 1. A comparison of pre-test and post-test scores amongst the two study groups using paired student t test.

	Pre-test score Mean±SD (Min. to max. Range) (N=50)	Post-test score Mean±SD (Min. to max. Range) (N=52)	P-value
Batch A (Lecture based learning Group) (N=50)	10.22±2.44 (4-16)	11.62±2.07 (6-16)	0.002*
Batch B (Case based learning Group) (N=52)	10.16±3.01 (4-17)	14.28±2.75 (6-20)	0.000*

*P-value ≤ 0.05 is considered statistically significant

RESULTS

The results of our study show that the pre-test scores of Batch A compared with Batch B were not significantly different (Table 2). The post-test scores compared to pre-test scores were significantly higher in both the batches (A and B) as shown in table 1. But the post-test

Table 2. A comparison of pre-test, post-test, delayed post-test scores amongst the two study groups using independent student t test.

	Batch A (Lecture based learning group) (N=50)	Batch B (Case based learning group) (N=52)	P-value
Pre-test score Mean±SD (Min. to max. Range)	10.22±2.44 (4-16)	10.16±3.01 (4-17)	0.913
Post-test score Mean±SD (Min. to max. Range)	11.62±2.07 (6-16)	14.28±2.75 (6-20)	0.000*
Delayed Post-test score Mean±SD (Min. to max. Range)	10.46±2.92 (4-15)	12.52±3.12 (7-22)	0.001*

*P-value ≤ 0.05 is considered statistically significant

score of Batch B was significantly higher than the post-test score of Batch A (Table 2). The delayed post-test score was also significantly higher in Batch B vs. Batch A (Table 2).

DISCUSSION

The topic 'Pre-analytical variables in clinical chemistry' is not officially included in the syllabus of medical curriculum yet the students are constantly asked questions from this topic during their first professional year in the form of practical viva-voce and spotting exams conducted in Dept. of Biochemistry. It has been our observation over last few years that students answer questions from this topic poorly as they are not taught this topic formally through any teaching method. The real practical implication of this topic comes into play when medical students undergo internship. Due to lack of knowledge on this topic, the unexpected results of lab investigations are sometimes not recognised as errors by the medical students as well as the treating doctors. As a result of this, patients are subjected to misdiagnosis and mistreatment [3]. However, if the results are suspected to be unjustified and found to be not correlating with patients symptoms, then the laboratory tests are repeated which leads to wastage of financial resources [3] and further delay in the treatment of patients. Hence, we decided to test the background knowledge of medical students right at the end of the second semester where they are expected to know the

topic really well as biochemistry as a part of their first year syllabus is almost over. Moreover, by the end of second semester, the students should have acquired some knowledge on this topic as the questions from this topic are frequently asked during their practical classes. Having passed their first professional year (pre-clinical year) of 2 semesters, the students in future would encounter challenging situations in their medical practice where their concepts of biochemistry would have faded and their decision would affect the patient care. Hence, professional training on 'Pre-analytical variables in clinical chemistry' deserves better attention.

The results of our study show that the pre-test scores of Batch A compared with Batch B were not significantly different implying that both the batches had similar background knowledge of the topic acquired during their first year (Table 2). On formally delivering the teaching sessions on the topic 'Pre-analytical variables in clinical chemistry', an increase in the post-test scores w.r.t. pre-test score were observed in both the batches indicating that both the batches benefitted from our teaching exercise (Table 1). However, the post-test scores of Batch B were significantly higher than post-test scores of Batch A (Table 2). This means that gain in knowledge amongst Batch B students was more than that of Batch A students. In our study we have found that case based discussion was an effective method to teach the topic as obvious from their scores.

Didactic lecture has been an inherent mode of imparting knowledge to the medical student for time ever since but considering the need for integrating non clinical and clinical subjects, other alternate modules of teaching have to be given due consideration especially during the pre-clinical years (1st and 2nd professional years). Didactic lecture is a typical pedagogical approach [7] wherein the learner passively listens [8,9] to the teacher which he may or may not be able to understand and retain for long due to one way communication [9]. A lecture precisely is a monologue where there is hardly any interaction [10] between the learner and the teacher. Hence, the students hardly get a chance to clarify their doubts [11]. Moreover, the lectures are monotonous [12] and address a large number of students [9] at a time and hence the students find it difficult to focus on the topic being taught. Despite of these disadvantages, didactic lecture is a very good teaching method to convey large amount of information to a large group in a limited time span [9], yet at times there is need to resort to other teaching methods because adults have a different perspective of learning. Adults are interested in problem centered approach than subject centered one [13] and are motivated to learn from internal drives rather than external ones [13]. The adults try to learn things if they value the need to learn in connection with their practical day to day life [13].

There has been recent emphasis to introduce interactive teaching methodologies by MCI (Medical Council of India) [10]. CBL (case based learning) and problem based learning (PBL) are two interactive teaching methods [14-16] based on adult learning principles. We chose to teach the topic through case based discussions rather than PBL considering certain demerits of PBL sessions.

In PBL sessions, the students have the responsibility for their own learning [17]. In this self-directed learning approach, the facilitator's task is to introduce the topic and relevant triggers to be discussed by the students amongst themselves. The students have to identify their own learning needs and collect information on the topic by discussing with their peers. The students choose a group leader who would note down these keywords or learning needs. The facilitator keeps the students engaged in the exercise and brings the students back to track if discussions are deviating from topic. Upon dispersing at the end of PBL session, the students go back and read books and gather more information on the topic. The students assemble again the next day. The facilitator assesses the students on their learning needs at the end of the session. Though, PBL is an interactive way of learning with simultaneous development of their communication skills, a few disadvantages also needs a mention. The success behind PBL session lies in the internal drive of the students to learn (self-directed learning). If the topic is boring and students do not take initiative or are crunched up for time, then they may not benefit from the exercise much. PBL exercise is a team-work wherein a few students may dominate or over power others [18]. Moreover, conducting PBL sessions requires arrangement for multiple rooms and teachers [19]. To make the discussion be executed in smaller groups which is practically not feasible always. PBL sessions require comparatively more amount of time to teach the same topic via didactic lecture.

Hence, we used case based discussion as a teaching module to teach 'Pre-analytical variables in clinical chemistry'. Case based learning (CBL) in contrast to PBL sessions is teacher directed and learner centered approach [20,21] to project realistic medical situations [22] in the form of case descriptions for students to learn from. CBL involves medical case discussions in the form of a real life story and hence, arouses curiosity in the learners to listen and solve the problems being given to them [22]. The students try to analyze the given problems by applying their background knowledge to answer the questions [23]. At the end of CBL session, students eventually acquire accurate information on the topic through an interactive discussion with their teacher [22] rather than discussing with their peers. The content of case descriptions is conflict provoking, evokes reasoning [22] and places a student in dilemma to take decision promptly [21] if posed with such medi-

cal situations in reality. Thus, CBL exercise involves their cognitive functions being put to use to understand and retain the topic longer [24]. CBL provides students an opportunity to see theory into practice. Moreover, the drama component in the case description creates empathy in the students to make students realize the topic is worth studying further. CBL sessions is a method that can address a larger number of students, mentally engage them, develop their communication skills [25] and yet be managed by a single teacher in a single classroom. Multiple cases can be discussed in the given time limit [21]. The only probable disadvantage of this method that we see is that the entire pre-clinical syllabus cannot be taught in the form of cases [21]. Only those topics which have practical implications can be formulated into case descriptions. The CBL exercise requires a teacher expert [21] in the field who can design such cases. If cases are not interesting and realistic then the gain and retention of knowledge will not be adequate [21]. PBL exercise on the other hand doesn't involve students to solve problems at all [17]. In fact, the students through PBL sessions gather their fund of knowledge by identifying their own learning needs which requires self-motivation and time. PBL can also be used to teach this topic but considering the difficulties to arrange PBL sessions and other demerits of PBL method, case based learning method would be a better choice.

Thus, we want to highlight the fact 'Pre-analytical variables in clinical chemistry' is an extremely important topic which has been ignored so far in the undergraduate medical curriculum. Considering its serious repercussions in medical practice on patient care and knowing the fact that these errors can be controlled easily to a good extent, we recommend that this topic must be introduced in the syllabus of undergraduate medical students from first professional year itself. The medical curriculum needs to be reformed to adopt student centric and case based learning paradigm on topics that have practical utility. The case based discussions can be used to improve students' clinical reasoning and problem solving skills. This is the first time we have introduced and tested CBL in our department and have received an overwhelming response of the students requesting us to conduct further such sessions in future.

CONCLUSION

Topic 'Pre-analytical variables in clinical chemistry' must be included in undergraduate medical curriculum considering its medical implications. Case based discussion is as an effective teaching module to educate medical students on 'Pre-analytical variables in clinical chemistry' with long term memory potential.

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REFERENCES

1. Tiwari A, Lai P, So M, Yuen K. A comparison of the effects of problem-based learning and lecturing on the development of students' critical thinking. *Med Educ* 2006 Jun;40(6):547-54.
2. Bonini P, Plebani M, Ceriotti F, Rubboli F. Errors in laboratory medicine. *Clin Chem* 2002 May;48(5):691-8.
3. Goldschmidt HMJ, Lent RW. Gross errors and work flow analysis in the clinical laboratory. *Klin Biochem Metab.* 1995;3:131-140.
4. Kalra J. Medical errors: impact on clinical laboratories and other critical areas. *Clin Biochem* 2004 Dec;37(12):1052-62.
5. Carraro P, Plebani M. Errors in a stat laboratory: types and frequencies 10 years later. *Clin Chem* 2007 Jul;53(7):1338-42.
6. Astion ML, Shojania KG, Hamill TR, Kim S, Ng VL. Classifying laboratory incident reports to identify problems that jeopardize patient safety. *Am J Clin Pathol* 2003 Jul;120(1):18-26.
7. Richardson D, Birge B. Teaching physiology by combined passive (pedagogical) and active (andragogical) methods. *Am J Physiol* 1995 Jun;268 (6 Pt 3):S66-S74.
8. Jain A, Bansal R, Singh K, Kumar A. Attitude of medical and dental first year students towards teaching methods in a medical college of northern India. *J Clin Diagn Res* 2014 Dec;8(12):XC05-XC08.
9. Ahsan M, Mallick AK. Use of prelecture assignment to enhance learning in pharmacology lectures for the 2nd year medical students. *Indian J Pharmacol* 2016 Oct;48(Suppl 1):S65-S68.
10. Palocaren J, Pillai LS, Celine TM. Medical biochemistry: Is it time to change the teaching style? *Natl Med J India* 2016 Jul;29(4):222-4.
11. Bobby Z, Radhika MR, Nandeesh H, Balasubramanian A, Prerna S, Archana N, et al. Formulation of multiple choice questions as a revision exercise at the end of a teaching module in biochemistry. *Biochem Mol Biol Educ* 2012 May;40(3):169-73.
12. Mehta B, Bhandari B. Engaging medical undergraduates in question making: a novel way to reinforcing learning in physiology. *Adv Physiol Educ* 2016 Sep;40(3):398-401.
13. Kaufman DM. Applying educational theory in practice. *BMJ* 2003 Jan 25;326(7382):213-6.

14. Latif R. Impact of case-based lectures on students' performance in vascular physiology module. *Adv Physiol Educ* 2014 Sep;38(3):268-72.
15. Gupta K, Arora S, Kaushal S. Modified case based learning: Our experience with a new module for pharmacology undergraduate teaching. *Int J Appl Basic Med Res* 2014 Jul;4(2):90-4.
16. Al-Azri H, Ratnapalan S. Problem-based learning in continuing medical education: review of randomized controlled trials. *Can Fam Physician* 2014 Feb;60(2):157-65.
17. Wood DF. Problem based learning. *BMJ* 2003 Feb 8;326(7384):328-30.
18. Ramnanan CJ, Pound LD. Advances in medical education and practice: student perceptions of the flipped classroom. *Adv Med Educ Pract* 2017;8:63-73.
19. Meo SA. Basic steps in establishing effective small group teaching sessions in medical schools. *Pak J Med Sci* 2013 Jul;29(4):1071-6.
20. Allchin D. Problem- and case-based learning in science: an introduction to distinctions, values, and outcomes. *CBE Life Sci Educ* 2013;12(3):364-72.
21. Tarnvik A. Revival of the case method: a way to retain student-centred learning in a post-PBL era. *Med Teach* 2007 Feb;29(1):e32-e36.
22. Nair SP, Shah T, Seth S, Pandit N, Shah GV. Case based learning: a method for better understanding of biochemistry in medical students. *J Clin Diagn Res* 2013 Aug;7(8):1576-8.
23. Williams B. Case based learning-a review of the literature: is there scope for this educational paradigm in prehospital education? *Emerg Med J* 2005 Aug;22(8):577-81.
24. Malau-Aduli BS, Lee AY, Cooling N, Catchpole M, Jose M, Turner R. Retention of knowledge and perceived relevance of basic sciences in an integrated case-based learning (CBL) curriculum. *BMC Med Educ* 2013 Oct 8;13:139.
25. Tayem YI. The Impact of Small Group Case-based Learning on Traditional Pharmacology Teaching. *Sultan Qaboos Univ Med J* 2013 Feb;13(1):115-20.

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