Original Article

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Education Section

Learnings and Reflections on Transition to New Competency-based Medical Education, MBBS Curriculum in Microbiology: A Cross-sectional Observational Study

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ABSTRACT

Introduction: Conventional teaching in microbiology revolved around the study of microorganisms without clinical relevance. Therefore, a New Competency-based Undergraduate (UG) Medical curriculum (New CBME) was rolled out in the academic year 2019 to make Indian Medical Graduates more clinically competent yet globally relevant.

Aim: To assess the impact of the change in curriculum on students' performance and desired educational outcomes before and after the implementation of the new curriculum. Likewise, the study aimed to analyse the experiences and reflections of medical teachers towards these amendments.

Materials and Methods: A cross-sectional observational study was conducted on 82 students from the second year Bachelor of Medicine, Bachelor of Surgery (MBBS) with a traditional curriculum and 74 with the new Competency-based Medical Education (CBME) curriculum at the Department of Microbiology, Smt. B.K. Shah Medical Institute and Research Centre, Piparia, Vadodara, Gujarat, India, between February 2020 and November 2021. In both batches, topics from core as well as non core areas of various systems were included along with the Attitude, Ethics and Communication (AETCOM) modules. A comparison of both groups was done, and Chi-square values and p-values were calculated.

Results: The batch with the new CBME curriculum was able to provide a provisional diagnosis for a case-based question better than the Traditional batch {n=60/74 (81%) vs n=44/82 (54%), p-value=0.0005, significant}. However, the correct aetiology, pathogenesis, and laboratory diagnosis were written better in the traditional batch compared to the new one, n=44/82 (54%) vs n=24/74 (32%). Regarding the AETCOM skills, the new batch had a better understanding of proper communication and ethics, i.e., 73/74 (99%), p-value <0.00001, Significant, while 66/82 students (80%) of the traditional batch and 67/74 (90%) of the new batch were aware of confidentiality issues. In viva voce, the new batch showed a lot of confusion regarding the names, types of micro-organisms, and the laboratory diagnosis of diseases caused by them compared to the traditional batch (p-value <0.00156, significant).

Conclusion: After implementing the new CBME curriculum to undergraduate students and analysing the feedback of teachers and the performance of students, it was felt that an appraisal of the new curriculum is required for a satisfactory outcome in microbiology so that microbiology content can be incorporated with clinical relevance.

Keywords: Bachelor of medicine and bachelor of surgery, Comparison, Competency based education, Microbiology

INTRODUCTION

The definition of health and disease has changed over the years, as have lifestyles, cultural, social contexts, geographical and demographic situations that influence health and illness. The medical field has expanded enormously, and these changes must be reflected in medical education, making it more meaningful in the current context. Therefore, a review of the medical curriculum in India was welcomed. A new CBME curriculum was introduced in 2019. Emerging widespread infectious diseases are growing universally and resulting in significant human morbidity and fatality. Additionally, medical microbiology-oriented questions in competitive examinations have gained importance [1]. This change in curriculum is unique for microbiology compared to other medical subjects in many ways. In the traditional curriculum [2], microbiology was taught broadly as bacteriology, virology, parasitology, and mycology with relevant clinical syndromes. However, the relevance of microbiology to clinical infectious diseases was not clearly understood by the students. A relevant association between knowledge of various aspects of microbiology and their role in understanding infectious diseases was lacking. In the previous attempts to improve learning, this was partly achieved by integrated teaching sessions and other innovative methods, like adding a part of clinical microbiology to the syllabus in the form of case-based problem-based sessions even before the CBME was implemented. The new CBME has addressed this problem and made certain changes [3]. The approach has now entirely changed to incorporating microbiology into a system-based learning program of clinical information. At the beginning, teachers had apprehensions regarding the course, its implementation, and outcome. It was also during the Coronavirus Disease 2019 (COVID-19) pandemic. While rolling out and implementing the new CBME in 2019, authors analysed the experiences and reflections of teachers through a questionnaire. Authors also noted the important changes in objectives, content, teaching-learning methodology, and assessment in the traditional and new curriculum of microbiology [3]. Any change in the curriculum needs to be evaluated. Authors closely observed all the changes and felt a need for a successful merger of core microbiology into clinical schemes. These changes prompted them to analyse there overall experience of teaching the competency-based curriculum of the microbiology course. The evaluation consists of a comparison of knowledge levels between the students of the traditional and new curricula [4,5]. With the above insights, the present study was designed to evaluate the impact of

this change on students' performance, analyse actual learning and desired educational outcomes before and after the implementation of the new curriculum, and similarly, to analyse the experiences and reflections of medical teachers towards these amendments. The challenges and solutions cited by the present study would surely assist in reviewing and amending certain areas in the new CBME curriculum for microbiology.

MATERIALS AND METHODS

The study was a cross-sectional observational study conducted for a period of one year and 10 months from February 2020 to November 2021 at the Department of Microbiology, Smt. B.K. Shah Medical Institute and Research Centre, Piparia, Vadodara, Gujarat, India. Ethical approval (SVIEC/ON/Medi/RP/20110) was obtained from the Sumandeep Vidyapeeth Institutional Ethical Committee (SVIEC). Informed consent was obtained from each student with a digital signature on their official email ID before initiating the study.

Inclusion criteria: Second-year MBBS students with a traditional curriculum and the New CBME batch of 2019 were included in the study.

Exclusion criteria: Second-year MBBS students who did not give consent and those appearing in University examinations for the first year MBBS and second year MBBS as casual students were excluded from the study.

Sample size: A total of 82 students from the second year MBBS batch of 2018 (Traditional curriculum) [2] and 74 from the batch of 2019 (New CBME curriculum) [3] were included for assessment analysis. The study was time-bound, so all the subjects who gave consent were part of the study.

Study Procedure

The various components such as objectives, content, teaching-learning methodology, assessment and time frame in both curricula were studied, and differences were noted. The outcome of the new curriculum was evaluated by noting the understanding and analytic ability of students in areas such as knows, knows how, shows, and shows how in selected topics through tests and viva. The study was conducted during the COVID-19 pandemic period, so classes were held on an online platform via Google Meet. The project was explained to all MBBS students with a traditional curriculum via Google Meet, while the batch with the new curriculum had offline teaching for almost one year. In both batches, topics from core as well as non core areas {Core: A competency that is necessary in order to complete the requirements of the subject (Traditional Must Know)} Non core: A competency that is optimal in order to complete the requirements of the subject (Traditional Nice To Know, Good To Know) of various systems was included. In addition, hospital acquired infection and control, recent advances, and AETCOM were also assessed. At the end of their respective terms, the traditional and new batches were given the same set of questions. Each time, three questions were given from the given topics [Table/Fig-1]. Answers were submitted in Portable Document Format (PDF) format to authors Email ID (Traditional curriculum batch, online mode, due to the COVID-19 pandemic) and hard copy (new curriculum batch, offline mode). At the end of the session, 50 medical teachers (professors to Assistant professors) from seven medical colleges in India completed a questionnaire regarding their challenges, apprehensions, revisions done, implementation, and training on the new CBME curriculum. The seven Medical Colleges were: Shantabaa Medical College and General Hospital, Amreli, Gujarat; Banas Medical College and Research Institute, Palanpur, Gujarat; Gujarat Cancer Research Institute (GCRI), Ahmedabad, Gujarat; CU Shah Medical College, Surendranagar, Gujarat; Government Medical College, Datia, Madhya Pradesh; Saveetha Medical College and Hospital, Chennai, Tamil Nadu; and Lokmanya Tilak Municipal Medical College, Mumbai.

General microbiology and Immunology	a. Role of micro-organisms in health and disease b. Mechanisms of antibiotic resistance c. Mechanism of host immune response.
Cardiovascular System (CVS) and Respiratory System (RS)	a. Case-based question on aetiopathogenesis and laboratory diagnosis of infective endocarditis b. Case-based question on patient with hemoptysis and low-grade fever since past 20 days. Write its provisional diagnosis and laboratory diagnosis of pulmonary tuberculosis and role of National Tuberculosis Elimination Program (NTEP) c. A detailed note on aetiology and Laboratory diagnosis of Bacterial Pneumonia
Gastrointestinal tract infections, Hepatobiliary infections and Skin and soft-tissue infections	a. Explain the role of various serological markers in Hepatitis B and its postexposure prophylaxis b. Case-based question on Parasites causing anaemia and write the pathogenesis and laboratory diagnosis of Malaria c. Enlist various skin lesions and micro-organisms causing it
Central Nervous System (CNS) infections Zoonotic infections, and Sexually Transmitted Disease (STD)	a. What are oppurtunistic infections? Oppurtunistic infections involving CNS infections b. A case of dog bite on the arm, then write the pathogenesis of rabies and course of action c. A case of STD with a rash on the palm, write its provisional diagnosis, enlist the STD pathogens and note on congenital syphilis
Hospital acquired infections Emerging infections and AETCOM (Attitude, Ethics and Communication).	a. Case-based question on patient with sore throat, fever, fatigue, headache, loss of taste and smell. Write the provisional diagnosis and add a note on sample collection and laboratory diagnosis of COVID-19 b. Standard precautions for infection prevention and control c. Communication regarding Human Immunodeficiency Virus (HIV) testing with the person and maintaining confidentiality

[Table/Fig-1]: Questionnaire for both batches of MBBS with traditional and new CBME curriculum.
(Authors included both case-based and non case-based questions for comparison in the old and new batches and evaluated the results of both. For a comprehensive assessment of various elements, not all questions were made case-based.)

STATISTICAL ANALYSIS

Statistical analysis was conducted using International Business Machine (IBM) Statistical Package for Social Sciences (SPSS) version 25.0 software. A comparison of both groups was performed, and Chi-square values and p-values were calculated. The p-values <0.05 were considered significant.

RESULTS

A theory test of selected topics in microbiology and viva voce was conducted for both traditional and new curriculum MBBS students. Results were analysed and noted in the form of tables.

A case-based long question is asked, then the new batch with the new CBME curriculum were able to do the provisional diagnosis better in comparison to the traditional batch (81% vs 54%, p-value 0.0005, significant) which is clearly depicted in [Table/Fig-2]. However, the correct aetiology, pathogenesis, and laboratory diagnosis were written better in the Traditional batch compared to the new one (54% vs 32%). For non-case-based questions, 55 (67%) students from the traditional batch attempted well compared to the new batch (p-value=0.00033). When authors compared the AETCOM skills, authors found that in the new batch, as they have compulsory AETCOM modules from the first MBBS and were trained using various methods like role play, they all had a thorough understanding regarding proper communication and ethics (99%, p-value <0.00001, significant). In terms of confidentiality, 80% of traditional and 90% of new students were aware. Regarding working in a team, 50% of students with a traditional curriculum were aware as they learned these concepts while studying HIV reporting and teamwork; they had learned about the role of the Hospital Infection Control Committee (HICC) in the prevention of nosocomial infections.

In viva voce, the performance of the traditional batch was around 67%, while in the new batch it was around 40% [Table/Fig-2] (p-value- 0.00156, significant) as they showed a lot of confusion regarding the names and types of microorganisms, how they cause infection, and serological methods for diagnosis. They mixed up

S. No.	Theory questions	Batch with traditional curriculum (n=82)	Batch with new curriculum (n=74)	Chi-square test	p-value
1	Case-based long questions				
	a. Provisional diagnosis	44 (54%)	60 (81%)	11.957	0.00054
	b. Correct aetiology	44 (54%)	24 (32%)	6.0921	0.012
	c. Pathogenesis	44 (54%)	24 (32%)	6.0921	0.012
	d. Correct laboratory diagnosis	44 (54%)	24 (32%)	6.0921	0.012
2	Non-case based long questions	55 (67%)	25 (34%)	17.253	0.00033
3	AETCOM- soft skill (evaluated using one compulsory question in theory paper- 4 marks)				
	Role of communication and ethics	41 (50%)	73 (99%)	44.3505	<0.00001
	Maintaining confidentially	66 (80%)	67 (90%)	2.3786	0.123
	Working as a healthcare team	41 (50%)	73 (99%)	45.3505	<0.00001
4	Viva	55 (67%)	30 (40%)	9.9981	0.00156

[Table/Fig-2]: Comparison of theory knowledge and concepts between traditional batch and new batch.
*p-value <0.05 is considered significant

bacteria and viruses and were confused about the reference books. They readily named advanced methods of diagnosis like multiplex Polymerase Chain Reaction (PCR) without understanding their role.

The feedback taken from various faculties of the Microbiology Department from seven medical colleges in India is shown in [Table/Fig-3,4]. The feedback questionnaire was designed considering the changes in the new CBME guidelines, such as introducing new teaching/learning methods, particularly case-based teaching, a system-wise approach, and time allotment. Additionally, teachers' initial apprehensions, challenges, and concerns regarding the pattern and the need for Curriculum Implementation Support Program (CISP) training (as training was batch-wise, only 64% were trained by CISP) were addressed. The questionnaire was prepared by MD and PhD teachers with extensive teaching experience and validated by the Coordinator of the Medical Education Unit. Overall, the response was diverse as half of the faculties were happy about the curriculum change but still skeptical about the implementation part and felt that the new CBME curriculum is not motivating the students to learn subject-specific (Microbiology) due to the lack of clear-cut guidelines and uniformity in teaching across different institutions. While 64% of faculties appreciated some revisions in the new CBME curriculum, like alignment and integrated teaching. They felt that this approach would provide a comprehensive overview of a single concept and appreciated the concepts of Small Group Discussion (SGD) and Self-directed Learning (SDL). Many of them also believed that learning system-wise would shift the focus of the subject towards clinical medicine rather than the essentials of microbiology.

DISCUSSION

After the induction and implementation of the new CBME curriculum in Microbiology in Phase 2, the test results in the two batches showed a statistically significant difference. The traditional curriculum batch students demonstrated more clarity in identifying the correct aetiology, understanding pathogenesis, and laboratory diagnosis (p-value=0.012, significant), while the new curriculum students had a better comprehension of AETCOM (Communication, Confidentiality, and Teamwork) and clinical diagnosis (p-value <0.00001, Significant). In viva voce, the traditional batch had better clarity regarding the names of microorganisms, their pathogenesis, and diagnosis (p-value=0.00156, Significant), while the new curriculum students showed a lot of confusion regarding the names of microorganisms. Similar studies have been conducted by many authors [6,7]. In 2020, Kotur N et al., studied the impact of the

S. No.	Questions asked to the faculties	Response by faculties
1	First reaction for CBME	
	a. Happy and necessary b. Happy but skeptical-2 c. Not happy	21 (42%) 25 (50%) 4 (8%)
2	Apprehensions and concerns about new CBME	
	a. Basic Concept of system is lost and focus is only on clinical disease b. Faculty scarcity c. Lack of student motivation, guidelines for classes and uniformity d. Challenging to implement e. Lack of student comprehension	21 (42%) 04 (8%) 05 (14%) 27 (56%) 14 (29%)
3	Revisions done in CBME appreciated	Appreciated by
	a. Skill training and less lectures b. Integrated teaching and alignment c. SGL/SDL* d. Clinical aspects enhanced e. Case-based learning f. Foundation course and AETCOM* g. Formative assessment	14 (29%) 32 (64%) 28 (56%) 28 (56%) 05 (14%) 11 (21%) 05 (14 %)
4	#Any preparation before implementation of CBME- Adequate/Inadequate/ Needs more time	
	a. Training b. Planning and implementation	05 (14%) found that it was adequate, while 43 (86%) wanted more training sessions 46 (93%) faculties found it difficult and needs more time
5	CISP training done and does it solve all queries?	
	a. Yes	32 (64%)
	b. No	18 (36%)

[Table/Fig-3]: Feedback and reflections-1 from the microbiology faculties from seven Medical Colleges of India (N=50).
#Question 4- In the CBME the change in curriculum was a major shift for microbiology from old methods, system-based content, and lots of expectations from the teachers to teach the same. Teachers own assessment regarding his/her preparedness to satisfactorily conduct the CBME is expected here. Whether training and planning is adequate or not was a major concern for all.
SGL: Small group learning; *SDL: Self-directed learning; *AETCOM: Attitude, ethics and communication; *CISP: Curriculum implementation support program

S. No.	Questions assessed	Response by the faculties
1	**Areas of improvement**	
	a. Training to faculties in SGL, SDL*	14 (29%)
	b. Preparation of content	32 (64%)
	c. Time constraint	14 (29 %)
	d. Preparation of teaching schedule	28 (56%)
2	**Reduction of content will affect learning?**	
	a. Help learning	11 (22%)
	b. Concepts will not be clear	22 (44 %)
	c. Not sure	17 (34%)
3	**Learning microbiology system wise will affect learning?**	
	a. Better, useful	25 (50%)
	b. Gaps of understanding will be created	21 (42%)
	c. Not sure	04 (8%)
4	**Number of teachers is sufficient?**	
	a. Yes	21 (42%)
	b. No	29 (58%)
5	**Are you satisfied will assessment format?**	
	a. Yes	21 (42%)
	b. No	29 (58%)

[Table/Fig-4]: Feedback and reflections 2 from the microbiology faculties from seven Medical Colleges of India (N=50).
SGL: Small group learning; *SDL: Self-directed learning

new curriculum on students' performance and the differential time utilisation of the teaching faculty in the subject of Physiology [6]. They compared the internal marks of the students and used a semi-structured questionnaire for the teaching faculty. The results of the present study were not consistent with this study as they found that the new curriculum students performed better, and the difference in marks was statistically significant [6]. However, the time utilised for planning and administrative activities by teachers was high and took a toll on the teachers. They suggest that measures to promote research and faculty strength in the existing medical colleges should be prioritised [6].

Another analogous study was conducted in the Pharmacology subject by Sharp K et al., where he compared the academic performances of traditional versus new CBME MBBS curriculum students. The outcomes of the present study were in accordance with his results where the traditional curriculum batch performed better than the new curriculum batch in writing the pathogenesis and correct diagnosis [7]. On the contrary, a study done by Thind A et al., compared traditional teaching with new CBME students in Phase 1 physiology subject and concluded that new curriculum students scored significantly higher than the traditional students in the pre and post-test questionnaire [8].

While there are some studies, like the one done by Begum N et al., in the subject of Pharmacology, who found marginal differences in the performance of students. In the feedback taken by students, 46.8% of students liked the new teaching methods, and 55% did not like the new teaching methods [9].

While assessing the feedback of medical teachers, authors found that 86% of the teachers desired more training sessions. A 93% of faculties found it difficult and felt the need for more time many felt that the faculties are deficient in number to implement SGD and SDL. Similar findings were cited by Kotur N et al., that although the newer MBBS curriculum is found to be promising for medical students, it is taking a huge toll on the teaching faculty [6]. They suggest promoting research and faculty strength in existing medical colleges [6]. The authors emphasised the need for a faculty development program, communication skills, and attitude [6].

Sharma R et al., also highlight that the new educational roles of teachers as a facilitator, planner, manager, and performance assessor are significant, and a mere three days of CISP cannot provide this competency and address the deficient staff [10].

Many studies mention that the time allocation for teaching microbiology during the preclinical curriculum has been considerably reduced due to the new approach. Medical students also overwhelmingly reported that there is a shortage of time to effectively learn the course material [11]. When authors executed the course, authors found that during their tenure, students had various institutional functions, sports activities, vacations, and absenteeism for the practice of events and a few days before all examinations, which took a toll on curriculum time, reducing the period to a mere eight and a half months.

A comprehensive approach to incorporating microbiology into the clinical scheme without losing the basic clarity of the core subject is needed. New innovative methods of using virtual patients are suggested. The medical education scenario is changing as students embrace the accessibility and interactivity of e-learning. Virtual patients are e-learning resources that may be used to advance microbiology education [12]. Mapping microbiology content in a clinical presentation curriculum is suggested by Pettit RK and Kuo Y-P [13]. They have reported that clinically important microbes, their pathogenesis, symptoms, and diagnosis of corresponding infectious diseases should be integrated into clinical schemes within a clinical presentation curriculum.

While review and change are needed in the UG medical curriculum, there are points that need attention and further research. Knowledge of basic principles of microbiology and important features of micro-organisms like their morphology, virulence factors, antibiotic resistance (in bacteria) provide an understanding of the full spectrum of their pathogenicity and form the basis of learning the infectious syndromes they cause. Only an overview of microorganisms does not suffice, as students showed confusion when asked about the aetiological agents of syndromes. Students confused bacteria with viruses and fungi. Almost all microorganisms cause pathology in various organ systems and are not restricted to one system. The clinical syndromes belong to a system. This dichotomy causes confusion for students. Therefore, it is important to successfully incorporate microbiology into modules in the preclinical curriculum to maintain an equilibrium between fundamental sciences and clinical information.

Recent studies have revealed that medical students forget roughly 25-35% of basic science knowledge after one year, more than 50% by the next year, and 80-85% after 25 years [14-16]. Thus, there is a lack of clinical relevance and inadequate connection between the practical application of basic sciences to clinical conditions and the teaching methods used [14]. If authors were to develop a vision regarding these infections, their epidemiology, presentations, and the approach to laboratory diagnosis in UG students, it would be worthwhile to consider mapping microbiology content with clinical context effectively in the course.

Limitation(s)

The mode of teaching, one being offline and the other being online, transitioned from traditional to the new curriculum during the COVID-19 pandemic. It was crucial to note the initial impact, gather teacher feedback, and compare the students of both curricula during that period. The results and conclusions in the present study were drawn from a single centre. The findings of the study should not be generalised to other Medical Colleges in the country. Therefore, authors suggest conducting multicentric studies, which can provide a better outcome of changes in the curriculum.

CONCLUSION(S)

After implementing the new CBME curriculum for UG students and analysing the feedback of teachers and the performance of students, it was felt that a review of the curriculum is required for a satisfactory outcome in microbiology so that microbiology content is incorporated with clinical relevance. From their answers in the theory and viva, it was clear that the understanding of the basics of microbiology was lacking in the new batch. Students used terminology and even wrote about advanced techniques in diagnosis without understanding. Students voiced their concern about the reduced time allotment. From the teachers' responses, it was clear that many are not trained in CISP. They need more time to prepare and arrange content in an effective way. A larger multicentre study can further substantiate our observations. There is a need to review this curriculum to make it more effective. Reconsideration of time allotment, the number of faculty, faculty development, training, and developing relevant content are the need of the hour. This will form a firm basis for understanding infectious diseases in the future.

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