Teaching methods need continuous innovation to encourage undergraduate medical students to enhance their competency level and skills. Every undergraduate medical student should be able to discuss the Revised National Tuberculosis Control Program (RNTCP) and Direct Observed Treatment Short (DOTS) course recommended by the World Health Organization (WHO). The DOTS strategy was launched in 1992, with the objective of detecting at least 70% of new sputum-positive tuberculosis (TB) patients and curing at least 85% of such patients. The aim of this study was to improve the competency level of Undergraduate (UG) Bachelor of Medicine and Bachelor of Surgery (MBBS) students by teaching them the objectives of the RNTCP at a program implementation site in the medical college. The RNTCP could be considered and conducted as Program-Based Teaching and Learning (PBTL) for the UG medical students. The following skills were to be implemented in the RNTCP PBTL: Sputum Collection, Ziehl-Neelsen staining and Grading, Mantoux test, and TB Culture and Molecular test (Gene Xpert). Phase II undergraduate MBBS students (N = 104) participated in the PBTL. This study was conducted in the RNTCP laboratory of a tertiary-care teaching medical college hospital. This descriptive study included advanced skill-based teaching such as Directly Observed Practical Skill, Demonstration-Observation-Assistance-Performance, Video Demonstrations, Role Play, and Group interaction as teaching tools. Pre-/post-test, Objective Structured Practical Examination, and frequently asked questions were used as assessment tools. The pre- and post-test marks were compared, and other assessments were also analyzed using SPSS. At the end of the teaching program, the feedback forms were collected from students and analyzed. The mean score obtained for 104 MBBS students in the pre-test, post-test, and other assessment tools were 213.3 and 487.5, respectively (p < 0.001). We conclude that skill-based teaching and learning tools to teach public health program like RNTCP provide valuable essential skills for undergraduate medical students. This Program Based Teaching and Learning could be successfully extended to all medical colleges.

INTRODUCTION

Successful medical teaching requires teachers to emphasize the learners’ needs and understand variations in learning styles and approaches (1). In the field of medical education, several innovations in teaching methods have come up, a few of which are accepted globally, such as integrated teaching, problem-based learning, self-directed learning, early patient contact education for capability, and community orientation (2, 3). As tuberculosis (TB) caused by Mycobacterium tuberculosis is a dreadful infectious disease, teaching and training as per the Revised National Tuberculosis Control Program (RNTCP) in all medical colleges has been made mandatory by the Medical Council of India (4). A study conducted to evaluate physician compliance with the World Health Organization (WHO) TB treatment guidelines reveals the poor awareness of WHO guidelines and low compliance among physicians (5). One of the reasons for the increase in the prevalence of TB was found to be that doctors are not aware of the guidelines for diagnosis and management of TB, which results in the emergence of drug-resistant TB.
in developing and underdeveloped countries. Every Indian medical graduate should obtain the knowledge and the skill to diagnose and manage TB patients in the field (6).

A study conducted in Nigeria, one of the countries with the largest numbers of TB cases, reveals gross inadequacies in TB knowledge and management practices among Nigerian medical interns (7). Nigeria, as a heavily TB-burdened state, has an urgent need to revamp and reform the undergraduate medical education curriculum, with a focal emphasis on TB (7) and other infectious and tropical diseases for undergraduate Bachelor of Medicine and Bachelor of Surgery (MBBS) students (8). A recent study has found that the quality of TB care is suboptimal and variable in urban India’s private health sector (9). Addressing this is critical for India’s plan to end TB by 2025 (10). Another study, conducted by means of a questionnaire in a metropolitan city in India to assess the knowledge of TB diagnosis, national guidelines, and treatment among undergraduate students, found that the level of knowledge was not consistently adequate (11).

Program-based teaching helps medical students identify the disease at the earliest stage to prevent its spread. The revised RNTCP-DOTS, a national health program in India, was launched in 1992. This program involves learning multiple diagnostic competent skills, which could be taught in a program-based teaching model. Most of the Indian undergraduate medical curriculum for Phase II students includes teaching and assessing TB by demonstrating acid-fast Bacilli (AFB) by Ziehl-Neelsen (ZN) staining technique in a given slide with a sputum smear. Instructors also explain the Mantoux test procedure and the morphology of Mycobacterium tuberculosis in culture bottles in the practical classes. However, the competency gained by the students in simple practical classes will provide inadequate knowledge and skill to participate in the RNTCP-DOTS program for the diagnosis and management of TB in the future (12).

Teaching undergraduate MBBS students about sputum microscopy, the major component of RNTCP-DOTS, using a program-based model rather than in a microbiology practical hall would allow them to directly observe the protocol of RNTCP-DOTS in the program site. The students would therefore attain their competency level more efficiently and be able to serve the community. Students would develop the required attitude and communication skills necessary to communicate with suspected TB patients for sputum collection and be able to explain how to cough up sputum for testing, as well as the ability to perform ZN staining and Mantoux test, read cultures in a BSL2 hood, and observe molecular tests in an RNTCP laboratory at a program site.

**PROCEDURE**

Ethical approval for this study was received from the Institutional Ethical Committee. All the Phase II undergraduate MBBS students of a private medical college teaching hospital were informed about the study and their consent was obtained. Program-Based Teaching and Learning (PBTL) was conducted in the RNTCP laboratory, where routine diagnostic protocols are followed step by step, from sputum collection to Gene Xpert, a molecular diagnostic test.

Various teaching tools such as Directly Observed Practical Skill (DOPS), Demonstration by virtual laboratory, Observation by students, Assistance by teacher, and Performance by students (DOAP), Video Demonstrations, Role Play, and Group interactions were adapted to achieve the goals of teaching the components of RNTCP-DOTS programs in the hospital laboratory. The various skill-based assessment tools, such as pre-test and post-test, Objective Structured Practical Examination (OSPE), and Frequently Asked Questions (FAQ), were also implemented.

The teaching materials were prepared based on CDC and RNTCP guidelines (https://www.cdc.gov/tb/publications/guidelines/testing.htm, https://tbcindia.gov.in/index1). They were given to the students one week prior to the implementation of the program. Around 30 multiple-choice questions (MCQ) and FAQ were prepared for the pre- and post-test (the questions are provided in Appendix 1).

The study was conducted for two days, eight hours per day. The 104 students were divided into four groups in a lecture hall and the pre-test was conducted. The teaching session started with a four-minute video demonstration (https://www.youtube.com/watch?v=Tgx6eHPMo-s) on TB awareness and the universal safety guidelines to follow while working with TB-infected specimens. A video demonstration on sample collection by the London school of Hygiene and tropical Medicine (https://www.youtube.com/watch?v=iEKuxxUBP0Y) was also screened. Ziehl-Neelsen staining and grading as per RNTCP guidelines was demonstrated with the support of Ilearn Labs (www.ilearnlabs.com) software, a game-based instruction of Ziehl-Neelsen staining where the user must choose the appropriate stain for each step of the technique. The students found the concept of play and practice used in the software an interesting and easy method for learning the technique.

We utilized the DOAP method to teach each step of the Mantoux test as a simulated patient–doctor role play. We used flow charts and explained TB culture using MacCartney culture bottles with M. tuberculosis growth in Lowenstein-Jensen medium. The DOPS method was used to teach Gene Xpert to detect M. tuberculosis at the molecular level. The students were asked to answer the FAQ during the program.

Finally, the post-test was conducted after completion of the skill-based components of RNTCP-DOTS, with the addition of the OSPE for sputum collection, sputum microscopy, and AFB grading of specific slides. The stations were created with a checklist to encourage critical thinking.

The marks obtained on the post-test and pre-test were compared and analyzed using the Statistical Package for Social Sciences. The mean scores obtained by the 104 MBBS students in the pre-test and post-test were 213.3 and 487.5, respectively (P < 0.001).
At the end of the teaching, we used a Likert scale to obtain student feedback of this program. The students were asked to give their feedback about the teaching materials, skill-based teaching method, demonstrations, critical thinking, group discussions, and other aspects of the course. Statistical analysis showed that about 70% of the 104 students liked all the sessions and graded them as excellent.

CONCLUSION

An undergraduate medical student should possess the requisite knowledge of TB diagnosis and management and the associated skills. These skills and knowledge are essential for the student to function effectively as a physician while participating in TB disease control programs. The program-based teaching on TB control gives a better platform for the students to observe the various steps of the control in the program site directly. This is an excellent opportunity for students to be exposed to experimental learning.

The multiple competencies of RNTCP-DOTS adopted in the PBTL will definitely motivate the students. It will facilitate better teacher–student and teacher–teacher interactions. “Unite to end TB,” the ultimate goal of the WHO, can be achieved by the medical sector, which plays an important role in TB control.

SUPPLEMENTAL MATERIALS

Appendix 1: CDC and RNTCP guidelines for diagnosis of tuberculosis and treatment
Appendix 2: Frequently asked questions
Appendix 3: Pre- and post-test questions
Appendix 4: OSPE
Appendix 5: Results of comparative data analysis of pre- and post-test DOPS
Appendix 6: Student feedback on PBTL
Appendix 7: IEC certificate

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