Impact of UG Training on Understanding the Severity of Antimicrobial Resistance

Anushka Deogaonkar1*, Jayshree Dawane2

Received: 14 June 2023; Accepted: 03 July 2023

ABSTRACT

Background: Antibiotic resistance is increasing at an alarming rate. Many reasons are there which need urgent attention toward this problem. Efforts in all directions are required to address this serious issue. The irrational prescribing habits of physicians lead to increasing morbidity, mortality, and treatment costs. One of the key components of the system is the prescriber and their practices. In the present study, efforts were made to know the understanding of the medical students about the severity of the problem and to find out the focus area that needs to be modified.

Materials and methods: A cross-sectional, questionnaire-based survey was conducted among the second-year medical students of a teaching hospital after the ethical approval study was explained to the student and written consent was taken. The questionnaire was given before and after exposure to formal lectures on antimicrobial agents. The collected data was analyzed.

Results: It was clear that inappropriate use of antimicrobials causes antimicrobial resistance (AMR) (87.3%) and can harm patients (82%). Interactive patient-oriented problem-solving modules on the internet (35%) and small group problem-based learning are preferred by (32%) students. Preparedness about antimicrobial use was seen only in 50% of the students in a few essential aspects. Learning during the medical course only does the purpose of sensitization, for the thorough knowledge repeated exposure is essential.

Conclusion: Most of the students were partially aware of the AMR. The only concern was their casual attitude regarding antibiotic use. Further educational interventions are necessary to improve their understanding and perceptions of antibiotic resistance, as well as their attitude toward antibiotic use.


INTRODUCTION

Antimicrobial resistance (AMR) poses a catastrophic threat to the entire world today. The increase in the incidence of the problem can be due to irrational use, liberal prescribing, lack of knowledge, self-medication, and poorly drawn-out clinical guidelines. The factors leading to AMR are well identified, like over and indiscriminate usage of antibiotics, easy availability of substandard antimicrobials, prescribing them on demand, and irrational use of newer and higher antibiotics, which are reserved drugs for severely infected patients. New antimicrobial development is a herculean task in terms of manpower and economic burden. This evolving public health issue is driven by both the irrational use of antimicrobials for human health and the inadequate measures to control the spread of infections.

Rational antibiotic prescribing can prevent the emergence of resistance. Focus is needed on the development of novel antibiotics or modifications of the existing antibiotics and restricting the usage of available antimicrobials. AMR can be sufficiently delayed, or its onset can be manipulated. In 2016, the National Treatment Guidelines for Antimicrobial Use in Infectious Diseases were introduced. However, introducing rules alone is not sufficient to bring about the desired outcomes in the use of antimicrobial agents. For sustainable and effective adherence to best practices, prescribers need to be encouraged to internalize the principles that emphasize optimized antibiotic prescribing. Successful management of antibiotic therapy requires robust national and local information on the usage of antibiotics to enable a better understanding of the evolving relationship between antibiotic consumption, the emergence of resistance, and the prevalence of healthcare-associated infections.

Antimicrobial stewardship is an effort to educate antimicrobial prescribers and consumers on their appropriate and rational usage. The principles include accurately identifying patients who need antibiotic therapy, using local epidemiology to guide the selection of empiric therapy, avoiding agents with overlapping activity, adjusting antibiotics when culture results become available, monitoring for toxicity, and optimizing the dose, route, and duration of therapy. According to the World Health Organization, education of healthcare workers and medical students on rational antimicrobial prescribing or “antimicrobial stewardship” is an integral part of all AMR containment activities. Healthcare organizations need to work toward sustainable systems that promote shared knowledge and provide prescribers with a choice architecture that prompts and facilitates antibiotic prescribing.

Therefore, it is of utmost importance to assess understanding of the depth of knowledge about the antimicrobials and severity of resistance, awareness, and implications in the budding prescribers. The first step in this direction is to prepare our future prescribers to deal with the problem. The present study was undertaken to assess the knowledge and perception of undergraduate (UG) medical students about AMR so that the appropriate remedies can be implemented in the medical curriculum to handle the problem of AMR.

OBJECTIVES

• Assessment of the understanding of UG students about AMR.
• To identify the gaps in knowledge to implement appropriate remedies for incorporating the culture of rational antimicrobial use.

MATERIALS AND METHODS

This is a cross-sectional, unicentric, observational, descriptive study conducted in the Bharati Vidyapeeth (Deemed to be University) Medical College, Pune. Convenient samples, that is, the medical students of second year MBBS from Bharati Vidyapeeth (Deemed to be University) Medical College, Pune, were included in the study. Participation was voluntary, and responses were kept anonymous.

© The Author(s). 2023 Open Access. This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (https://creativecommons.org/licenses/by-nc/4.0/). Please refer to the link for more details.
Approval from the Institutional Ethics Committee was obtained before starting the study.

Necessary information like how it will be conducted, why we will be doing it, etc., regarding this study was given to the participants. Students were allowed to ask questions/queries regarding the study. We answered all the questions and cleared their doubts of the students.

Written consent was taken after giving complete information about the study to the participants.

No attempts were made to alter course material or teaching methods before or during the study.

The questionnaire was used pre and postexposure to antimicrobial teaching to obtain information about the knowledge and perception of UG students about AMR. Information included age, sex, attitudes, and perceptions about antimicrobials, awareness of the problem of antimicrobial-resistant diseases, sources of antimicrobial education, and self-confidence in antimicrobial prescribing. Students reported their perceptions about the quality of their education regarding the appropriate use of antimicrobials and their preparedness to prescribe antimicrobials upon graduation.

**Statistical Analysis**

Data generated from the questionnaire was analyzed using Statistical Package for the Social Sciences software and presented as mean and standard deviation. Categorical variables are presented as percentages (%). Nonparametric tests were used to assess differences between groups and correlations between variables.

**Observations and Results**

**Perceptions about Antimicrobials**

In the curriculum of MBBS, students are exposed in the second year to learn about antimicrobial agents and their use for different clinical conditions. This step is the foundation of gaining concrete knowledge of antimicrobials with rational use. In this study, we assessed the knowledge and understanding of use, adverse effects, resistance, and antimicrobial stewardship.

Most of them (84.6%) were of the opinion that antimicrobials are overused nationally. They have the understanding that better use of antimicrobials will reduce problems with antimicrobial-resistant organisms (85.2%). Only 4.6% in the posttest feel that the appropriate use of antimicrobials is not very useful in reducing AMR. It looks like there is still confusion about what exactly is the appropriateness of antimicrobial use. However, it was sure that a strong knowledge of antimicrobials is important in their medical career (89.3%), and more educational stress on the appropriate use of antimicrobials (82.6%) is required.

New antimicrobials will be developed in the future that will keep up with the problem of resistance (17.9%). A maximum of them are of the opinion that prescribing broad-spectrum antimicrobials when equally effective narrow-spectrum antimicrobials are available increases the problem of AMR (82.6%). Around 85.3% think that poor infection control practices by healthcare professionals cause the spread of AMR. Inappropriate use of antimicrobials causes AMR (87.3%) and can harm patients (82%).

Interactive patient-oriented problem-solving modules on the internet were the most (35%) preferred method to learn about antimicrobial prescribing and resistance. Problem-solving sessions (33%) attended by small groups of medical students by faculty was the next most common method. Grand rounds lectures (8%), lecture series for medical students (9%), interactive patient-oriented problem-solving modules on CD-ROM (7%), and roleplaying sessions (8%) dealing with patients demanding antimicrobial therapy are less preferred. There was minimal difference between the pre and posttest responses (Fig. 1).

**Participants Rating the Sources to Learn about Antimicrobial Use and Resistance**

Participants were given multiple choices for this question. The most common sources to obtain information about antimicrobial agents were textbooks (62%), peers (58%), Wikipedia (42%), smartphones (35.3%), medical journals (39.3%), infectious diseases specialists, noninfectious diseases physicians, hospital pharmacists, and pharmaceutical representatives are the less frequently used sources (Table 1).

Around 21.3% attended lectures on rational use, 21.3% learned the right duration of treatment for specific infections, 14.7% understood when to start antibiotics, and 6.6% got knowledge about the correct dosing from formal lectures (Table 2).

When we compared the education received for appropriate use of the antimicrobials, the maximum number (77.3%) of students expressed that they had minimal or no education about it in the pretest.

![Fig. 1: Preferred method to learn about antimicrobial prescribing](image)

### Table 1: Sources preferred to learn about antimicrobial use and resistance

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Items</th>
<th>Participants Rating</th>
<th>Items Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Infectious diseases specialists</td>
<td>2.6%</td>
<td>4 (2.6%)</td>
</tr>
<tr>
<td>2</td>
<td>Noninfectious diseases physicians</td>
<td>1.3%</td>
<td>2 (1.3%)</td>
</tr>
<tr>
<td>3</td>
<td>Hospital pharmacists</td>
<td>8.6%</td>
<td>13 (8.6%)</td>
</tr>
<tr>
<td>4</td>
<td>Pharmaceutical representatives</td>
<td>6.6%</td>
<td>3 (6.6%)</td>
</tr>
<tr>
<td>5</td>
<td>Medical journals</td>
<td>39.3%</td>
<td>59 (39.3%)</td>
</tr>
<tr>
<td>6</td>
<td>iPhone or smartphone apps</td>
<td>35.3%</td>
<td>53 (35.3%)</td>
</tr>
<tr>
<td>7</td>
<td>Wikipedia</td>
<td>42%</td>
<td>63 (42%)</td>
</tr>
<tr>
<td>8</td>
<td>Textbooks or study guides</td>
<td>62%</td>
<td>93 (62%)</td>
</tr>
<tr>
<td>9</td>
<td>Peers (other students)</td>
<td>58%</td>
<td>87 (58%)</td>
</tr>
</tbody>
</table>
Antimicrobial Resistance

Most of them would like to get the learning about the appropriate use of antimicrobials in the second and fourth, that is, the final year of MBBS. They feel that learning in the second year and revision in the fourth year will help them to perfect their understanding and practical knowledge of it (Fig. 3).

Students were given four clinical conditions for the comment on diagnosis and use of medicines. A significantly high number of students were able to diagnose it correctly and advised treatment after the lecture series on chemotherapy (Fig. 4).

In the pretest, most of them were unaware of the term antimicrobial stewardship, but in the posttest, 60% of the students responded positively (Fig. 5).

**DISCUSSION**

The discovery of antibiotics was a boon to human life. Antibiotics have been used successfully to treat various infections for many decades. The problem of antibiotic resistance started to step in with irrational use, self-medication and easy availability. AMR is a massive, persistent threat at present. There are many contributing factors to AMR which need to be addressed immediately. Lack of provider knowledge, particularly with regard to prescribers who are insufficiently qualified, supervised or supported, prescriber habit, and poor availability of independent medicines information such as clinical guidelines and drug bulletins.

Poor knowledge and lack of training about antibiotic resistance during UG medical studies may lead to a change in behaviour among future doctors. The present study is a small effort to know the shortcomings in knowledge delivery and create awareness of the problem for future prescribers. Second-year medical students participated in this study, and they were evaluated based on a pre and posttraining designed test questionnaire considering them as future prescribers. Knowledge about the current practices, rational use of antibiotics, and adverse effects arising due to the use of antibiotic agents were assessed.

Students were sure about the fact that antimicrobials are overused; better use will help to deal with the problem of resistance. In-depth knowledge is important, and acquiring it during the UG course will be of great value. Problem-solving sessions in small groups and interactive modules on the internet will provide a chance to interact and create more impact. They think that journals and textbooks are the authentic sources of information about AMR, but this alone is not sufficient. After attending the formal lectures on antimicrobials, there was definitely an increase in awareness about the problem, but repeated exposure to the topic is required by using different methods to incorporate it into the practice. Till now, they were unaware of the resistance, but lectures were definitely useful to them in improving their understanding of the severity of the problem. They are sure that they will be able to use it rationally at graduation. In the study, the perception of antimicrobials

---

**Table 2**: Formal lectures that address the following topics during medical curriculum

<table>
<thead>
<tr>
<th>Attended any formal lecture(s) that address the following topics</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rational use of antibiotics in general</td>
<td>21.3%</td>
</tr>
<tr>
<td>When to start antibiotics?</td>
<td>14.7%</td>
</tr>
<tr>
<td>How to select the correct dosing?</td>
<td>6.6%</td>
</tr>
<tr>
<td>How to select the right duration of treatment for specific infections?</td>
<td>21.3%</td>
</tr>
</tbody>
</table>

**Table 3**: Use of medical education for preparedness upon graduation

| To know when to start antimicrobial therapy | 41.3% |
| How to select the best antimicrobial for a specific infection? | 50.6% |
| To describe the correct spectrum of antimicrobial therapy for different antimicrobials | 25.9% |
| Understand the basic mechanisms of AMR | 43.3% |
| How to streamline or de-escalate antimicrobial therapy? | 14.0% |
| How to find reliable sources of information to treat infections? | 13.9% |
| How to transition from IV to oral antibiotics (IV to PO switch)? | 24.0% |
| How to handle a patient who demands antimicrobial therapy that is not indicated? | 26.6% |

---

**Fig. 2**: Education regarding the appropriate use of antimicrobials so far

**Fig. 3**: Preferred academic year for learning the appropriate use of antimicrobials

However, after the exposure to the lectures, half of the students (78.6%) mentioned that they now have very useful knowledge about the appropriate use of antimicrobials (Fig. 2).

At this level of exposure (50.6%), students were confident about the selection of antibiotics for specific infections and (43.3%) knew the basic mechanism of AMR. A total of 41.3% were sure about when to start antimicrobial therapy (Table 3). Knowledge of the correct spectrum of antimicrobial therapy for different antimicrobials (25.9%), the transition from intravenous (IV) to oral antibiotics (25.9%), and (26.6%) handling a patient who demands antimicrobial therapy that is not indicated. Overall, 50% of the students said that on completion of the course, they are prepared to deal with the various aspects of antimicrobial use. Some remedial measures are required to increase the preparedness of all students (Table 3).
increased considerably in a positive light after the posttraining analysis compared to the pretraining. Results obtained in the study by Higuita-Gutiérrez et al. showed a discrepancy where limited knowledge was reflected in the selection of antibiotic treatment for respiratory, urinary tract, and skin and soft tissue infections after completion of the curriculum. However, in the study conducted by Khan et al., most of the students were aware of AMR and its consequences, the only concern being their casual attitude regarding antibiotic use. In the posttraining analysis, most of them preferred the second and fourth years of the UG course for learning the appropriate use of antimicrobials.

When to start, for specific conditions, knowing the spectrum of activity, and when to de-escalate are the important points to be remembered in antimicrobial therapy. Antimicrobial de-escalation has been largely ignored as an important operational component and should earn its rightful place alongside guidelines and clinical pathways. These are the highly considered aspects in preventing AMR. Similarly, completing the prescribed course of antibiotics is equally important. It has been observed that many times, the patients abruptly stop the antibiotic once symptoms disappear.

Information to find out the source of infection needs to be obtained for prescribing the correct antibiotic, depending on the organisms. Once started to transfer the patient from parenteral (IV) to oral formulation is equally important.

Patient demand for antimicrobials is commonly seen in the population with the belief of prompt relief from the disease; this has been shown to increase unnecessary prescriptions and the problem of AMR. Knowledge of handling these patients who demand antimicrobial agents where not needed and proper training to communicate with them has been imparted thoroughly in the students. Chandy suggested in his editorial that effective communication and insight about the problem would help to develop relevant strategies to contain AMR.

In the study, opinions about educational interventions in the current curriculum favored interactive patient-oriented problem-solving modules on the internet, while the least favored were grand rounds of lecture and roleplaying sessions. The study conducted by Ross et al. showed that only one intervention from the World Health Organization good prescribing guide proved useful. Another study by Davenport et al. features an outcome-based approach for teaching and introduces a key strategy in facilitating prudent prescribing, where the early introduction of the relevant knowledge concepts and skills into the UG medical curriculum. In the present study in posttraining analysis, a large number of students feel that to create a long-term impact of the rational use; it should be taken twice in the course in the second and in the final year of MBBS. Another research carried out by Sikkens et al. showed an alternative wherein E-learning during a limited period of time can significantly improve medical students’ performance of an antimicrobial therapeutic consultation in a situation simulating clinical practice 6 months later.

They were given four clinical conditions for the correct diagnosis and the drug of choice. Posttest, there was a significant increase in the number of students with correct answers. A study conducted by Okedok-Alex et al. suggested that there was good knowledge of antibiotic use and resistance; however, practice levels were poor. Our results appeal to various interventions to improve the clinical knowledge and rational application base of UGs.

Antimicrobial stewardship needs high-level executive commitment. Infection control and antimicrobial stewardship teams need to be introduced during the course and allowed to interact with the students. Antimicrobial stewardship must be seen as part of patient care and not a management-led cost-saving exercise. No structured provision about it currently exists in India. The study also determined awareness regarding antimicrobial stewardship, with only almost 37% deeming it fully familiar and 33% familiar but unaware of the meaning. An article published by Hsu showed that approximately 150 students who participated in this module have been highly engaged in identifying antibiotic stewardship interventions in their early practice and creating potential solutions. Incorporation of antimicrobial stewardship is a must in the graduating course time to improve the practices toward the rational use of antimicrobials.

CONCLUSION

The perception of rational antimicrobial use was seen to be definitely improved after the training. Although the curriculum equipped the students with a theory base, a lack of clinical navigation and knowledge was observed. It was deemed necessary and important to include learning of antimicrobial use for all years of UG medical training. Moreover, educational interventional studies should continue to be carried out to understand what curriculum works best for equipping UG students for rational antimicrobial usage in clinical practice. There is also a need to enrich existing courses and training about antibiotic use in the curriculum of the medical course with more emphasis on antimicrobial stewardship.

ETHICAL CLEARANCE

The study was conducted after approval from the Institutional Ethics Committee.

SOURCE OF SUPPORT

ICMR-STS approved.

REFERENCES

16. Ross S, Loke YK. Do educational interventions improve prescribing by medical students and junior


