Effectiveness of a training program on the knowledge and awareness of antimicrobial resistance and stewardship among dental house-surgeons

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ABSTRACT

INTRODUCTION Resistance to antimicrobials poses a global threat. Dentists are frequent prescribers of antibiotics, and irrational prescribing can contribute to the burden. Educational interventions are most effective during the early years of training. This study aimed to assess improvement in knowledge, attitude and practice of antimicrobial resistance among dental interns following an educational intervention.

METHODS A quasi-experimental study (before and after study) was conducted in a dental teaching institution in Kerala, India. The module was adapted from Antimicrobial Stewardship: A competency-based approach, A Massive Open Online Course (MOOC) by the World Health Organization. A post-test was conducted three months after baseline evaluation using previously validated questionnaires consisting of four domains (knowledge, attitude, practice, and clinical scenarios).

RESULTS A total of 43 dental interns participated in the study. The mean pre-test and post-test scores for the knowledge domain were 7.11 ± 1.00 and 7.39 ± 1.39 (p=0.262). Mean attitude scores showed a statistically significant increase from 6.23 ± 0.78 to 7.04 ± 0.92 (p<0.001). In the practice domain, there was a marginal decrease in the mean scores from 6.18 ± 1.13 to 5.95 ± 1.55 (p=0.390). Response to questions in the mock clinical scenarios showed an improvement in scores from 1.23 ± 1.08 to 1.74 ± 1.51 after the intervention, but the difference was not statistically significant (p=0.102).

CONCLUSIONS Implementing an educational module showed an improved attitude towards antimicrobial resistance. No significant changes were observed with knowledge scores, while practice-related questions showed a marginal decline.

Clinical trial registration The study protocol was registered with the Clinical Trial Registry of India.
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INTRODUCTION

Antimicrobial resistance (AMR) is a major cause of death and a global health issue[1]. More than 1.27 million people died in 2019 as a direct result of antibiotic-resistant bacterial illnesses, with millions more potentially dying, according to the study on the global burden of antimicrobial resistance in more than 200 countries and territories[1]. It is predicted that by 2050, AMR could cause 10 million deaths yearly, with the Asian continent carrying the highest mortality burden[2]. Recognizing the complexity of the issue and the urgent need for a multi-sectorial approach to combat it, the World Health Organization (WHO) declared AMR as one of the top 10 public health threats faced by humans[3].

AMR develops when microbes change over time and grow resistant to medicines, complicating the illness. Although AMR is a natural phenomenon, it is hastened by the 'misuse and overuse' of antibiotics. Widespread antibiotic resistance led to increased demand for newer and better antibiotics

globally, as nearly all currently used antibiotics are based on discoveries made more than 35 years ago. Though 32 antibiotics were in the clinical development pipeline in 2019, only six of these were deemed to be innovative[4].

Dentists prescribe about 10% of the total antibiotic drugs consumed globally[5], and 80% of these antibiotic prescriptions are unnecessary[6,7]. The outpatient antibiotic prescription rate in dentistry in India is between 56%–88%[8], while the maximum rate approved by WHO is 30%[9]. In a survey by Garg et al.[10] on dentists in India, 92.4% over-prescribed antibiotics and 38.2% prescribed antibiotics for root canal treatment, similar to studies done in the United States[11] and Spain[12,13]. Several factors influence the over-prescription of antibiotics in dentistry such as patient demand, refusal of dental treatment, and time limitations, to name a few[14]. Oral infections are widespread, and dentists commonly resort to antibiotics to control infection or as a prophylactic measure. There is a tendency among dental health professionals (especially young graduates) to prescribe higher antibiotics even for mild infections to achieve rapid relief in symptoms that could contribute to antimicrobial resistance. This makes dentists an ideal target group for implementing interventions for optimizing antibiotic use, which could preserve the current antibiotics' effectiveness for as long as possible. Antimicrobial stewardship is one such intervention.

Antimicrobial stewardship is a commonly used multimodal methodology to combat the rise of AMR by appropriate selection of drug regimen, dosage, duration, and administration route, thereby reducing systemic toxicity and developing drug-resistant microbial strains[15]. In dentistry, antimicrobial stewardship recommends several amendments, including the need for accurate diagnosis, a standardized drug protocol for patients needing emergency treatment for acute infections, initially using narrow-spectrum antibiotics, reserving broad-spectrum antibiotics for more complex infections, and not prescribing antibiotics for viral infections[16]. Educating dentists early in their careers would help in preventing AMR as evidence by improvement in prescribing practices after educational interventions among dental students[17]. Ideally, an introduction to the concept of AMR should begin during the training years of dentistry. In Indian settings, house surgency (internship) is an ideal time to improve clinical and patient management skills, and students are in a semi-independent practice. This pilot study was designed to assess if such an educational intervention would improve the knowledge, attitude, and practice of antimicrobial resistance and stewardship among dental interns.

METHODS

Study design and population

A quasi-experimental study (before and after study) was conducted among dental interns (house surgeons) at Amrita School of Dentistry (a dental teaching institution and hospital), Kerala, India during 2021. In India, house-surgency or internship is a mandatory 1-year training period after the completion of a four-year Bachelor of Dental Surgery (BDS) course. During this period, the house-surgeons are in a state of semi-independent practice and a period to hone their clinical skills in dentistry. All dental interns (n=47) were invited to participate in the study. The students who were unwilling to participate in the survey or were absent on the day of data collection and intervention, were excluded from the study.

Study intervention

The study intervention was an educational module on AMR customized for dental students. The module was adapted from Antimicrobial Stewardship: A competency-based approach, A Massive Open Online Course (MOOC) by WHO[18]. The course included the five basic units [Introduction, Principles of Antimicrobial Prescribing, Pharmacology of Antimicrobials for Clinicians (Selected Topics), Antimicrobial resistance for clinicians, Antibiotic allergies], which is designed to improve the foundational clinical knowledge necessary to use antimicrobials wisely and a customized sixth unit on how dentists can incorporate this knowledge in their daily work using common clinical dental scenarios. The course was delivered by an expert in antimicrobial resistance over two sessions. Each session lasted about 90 minutes. The sessions were delivered with the aid of Microsoft PowerPoint presentations, clinical scenario discussions and interactive engagements.

Data collection tool

Before the intervention, a baseline assessment (pre-test) was conducted using a validated Knowledge, Attitude and Practice (KAP) questionnaire (Supplementary file) adapted from a previous study[19] and clinical scenarios adapted from another previous study[20]. The clinical scenarios consisted of five situations that dentists could encounter in their routine practice and had to decide whether to prescribe antibiotics for the given condition. These were included to understand if training would help dental interns to apply knowledge and attitude gained during a situation that mimicked a real-life scenario. Follow-up (post-test) was done using the same KAP questionnaire and clinical scenarios three months after the intervention.

Data analysis

IBM SPSS Version 20 for Windows was used to code, tabulate, and analyze the data that had been obtained. Each correct response for the knowledge, attitude, and practice domain was coded 1, while every false response was coded 0. Thus, for the knowledge, attitude, and practice domains, the maximum possible scores were 9, 7, and 8, respectively. Pre-test and post-test scores in each of the three domains were described using descriptive statistics, which were expressed as the mean, standard deviation, and frequency

Table 1. Comparison of mean scores of knowledge attitude and practice pre- and post-intervention among dental house-surgeons (N=43)

Domain	Time point	Mean ± SD	p§
Knowledge	Pre-test	7.11 ± 1.00	0.262
	Post-test	7.39 ± 1.39	
Attitude	Pre-test	6.23 ± 0.78	<0.001*
	Post-test	7.04 ± 0.92	
Practice	Pre-test	6.18 ± 1.13	0.390
	Post-test	5.95 ± 1.55	
Clinical scenarios	Pre-test	1.23 ± 1.08	0.102
	Post-test	1.74 ± 1.51	

*Significant at p<0.001. § Paired t-test used.

for continuous data, and percentages for categorical data (correct answers). A paired t-test was used to compare pre- and post-test scores (continuous data), and a chi-squared test was used to see how each question's response changed before and after the intervention. Statistical significance was defined as p<0.05.

RESULTS

A total of 43 out of 47 dental interns participated in the study (response rate: 91.6%). Among the participants, three were males. The study participants belonged to the age group 23–27 years. All the participants who answered the pre-test completed the post-test also.

The mean pre-test and post-test scores for the knowledge domain were 7.11 ± 1.00 and 7.39 ± 1.39, respectively. There was no statistically significant difference in the scores post-intervention (p=0.262). Mean attitude scores showed a statistically significant increase (p<0.001) from 6.23 ± 0.78 pre-intervention to 7.04 ± 0.92 post-intervention. There was a marginal decrease in the mean scores after the intervention in the practice domain, but the difference was not statistically significant (p=0.390). Response to questions in the mock clinical scenarios showed an improvement in scores from 1.23 ± 1.08 to 1.74 ± 1.51 after intervention, but the difference was not statistically significant (p=0.102) (Table 1).

An analysis of pre- and post-test scores for each question in the knowledge, attitude and practice domains was done by comparing the percentage of correct responses. It was observed that there was a slight decrease in scores post-intervention for knowledge questions such as: 'Is there a presence of any bacteria in human bodies which are useful?', 'Can antibiotics be used to cure infections caused by bacteria?', 'Is it ok to stop antibiotics without completing the dose if you feel well?' and 'Can frequent use of antibiotics decrease the occurrence of infection?'. In contrast, scores were increased for questions such as: 'Can antibiotics be used to cure viral infections?' and 'Should dental infections always be treated with antibiotics?'; but the differences were not statistically significant. The knowledge of the question: 'Can antibiotics speed up the recovery process of cold and cough?' increased from 23.3% to 27.9% post-intervention and was statistically significant (p=0.017) (Table 2).

An increase in scores was noted for attitude questions such as whether there is misuse of antibiotics, is antibiotic resistance a problem, does overuse result in resistance, and does resistance affect your/your family's health. The difference was not statistically significant for all questions except for a question on whether antibiotic resistance is a problem in India (Table 3).

For practice-based questions, only questions such as 'Is

Table 2. Comparison of responses to individual knowledge questions pre- and post-intervention among dental house-surgeons (N=43)

Questions	Correct response (%)		p§
	Pre-test	Post-test	
K1. Are there any bacteria in human bodies which can be helpful for us?	100	97.7	-
K2. Can antibiotics be used to cure infections caused by bacteria?	100	97.7	-
K3. Can antibiotics be used to cure infections caused by viruses?	65.1	76.7	0.719
K4. Is it okay to stop taking antibiotics without finishing the complete dose if you are feeling well?	97.7	86	1.000
K5. Should dental infection always be treated with antibiotics?	39.5	79.1	1.000
K6. Can antibiotics cause any side effects?	95.3	95.3	1.000
K7. Have you heard the term 'Antibiotic Resistance'?	97.7	93	1.000
K8. Can antibiotics speed up the recovery process of cold and cough?	23.3	27.9	0.017*
K9. Do you think frequent use of antibiotics can decrease the occurrence of infection?	93	86	0.370

*Significant at p<0.05. § Chi-squared test used.

Table 3. Comparison of responses to individual attitude questions pre- and post-intervention among dental house-surgeons (N=43)

Questions	Correct response (%)		p§
	Pre-test	Post-test	
A1. Do you think there exists misuse of antibiotics?	95.3	100	-
A2. Is antibiotic resistance a problem in India?	90.7	97.7	0.046*
A3. Does overuse of antibiotics result in antibiotic resistance?	97.7	100	-
A4. Does antibiotic resistance affect you or your family's health?	58.1	86	0.648
A5. Would you prefer a prescription containing antibiotics for dental infection?	4.7	67.4	0.590
A6. Do you think that taking less antibiotics than prescribed is more beneficial?	88.4	79.1	0.265
A7. Is it necessary to know the 'Rational use of antibiotics'?	97.7	95.3	0.823
A8. Would you visit the dentist for follow-up after taking antibiotics?	90.7	79.1	0.834

*Significant at p<0.05. § Chi-squared test used.

Table 4. Comparison of responses to individual practice questions pre- and post-intervention among dental house-surgeons (N=43)

Questions	Correct response (%)		p§
	Pre-test	Post-test	
P1. Do you consult a doctor before starting an antibiotic?	97.7	95.3	0.823
P2. Can we buy antibiotic from medicine shops/pharmacies directly?	60.5	65.1	0.484
P3. Can we use antibiotics after the suggestions from friends/neighbor?	95.3	83.7	0.523
P4. Do you follow the advertisement (leaflets/internet etc.) while purchasing antibiotics?	83.7	86	0.978
P5. If one of your family members is sick, do you share the antibiotics together?	86	86	0.140
P6. If you have cold and cough and the doctor does not prescribe antibiotics, would you follow the suggestion?	100	88.4	-
P7. Do you stop taking antibiotics without completing the full course?	95.3	90.7	0.042*

*Significant at p<0.05. § Chi-squared test used.

it advisable to buy antibiotics from pharmacies directly' and 'Do you follow advertisements while purchasing antibiotics' showed an improvement in the correct responses. In contrast, all the other questions showed a marginal decrease in post-intervention scores. The differences in mean scores, however, were not statistically significant (p>0.05).

DISCUSSION

This study demonstrates the effect of an educational module on knowledge, attitude and practice regarding antibiotic resistance among dental interns in a teaching hospital in India. The study observed that an educational module improved the attitudes regarding AMR but did not significantly improve knowledge and practice. Antibiotic resistance is already recognized as a serious public health issue, and dentists contribute to it by frequently prescribing inappropriate and unwanted antibiotics[21]. Several studies in India reported that knowledge regarding antibiotic resistance was inadequate among dental students[22-24] and proposed educational interventions and continued awareness sessions to improve the same.

In our study, three months after the intervention, the participants' total knowledge score did not significantly improve. This was similar to the study conducted in Saudi Arabia that assessed the effectiveness of an online course on the knowledge and perception of antimicrobial resistance among dental students. While there was a significant improvement immediately after the intervention, further follow-up after two months did not contribute significantly to advancement in knowledge and perception[25]. Although the change in knowledge score was not significant, it was interesting to see that 79.1% of the participants responded correctly to the question 'Should dental infection always be treated with antibiotics?' compared to 39.5% before the intervention. This could be due to the extra emphasis given during the educational module on differentiating inflammation from infection and the discussion of clinical scenarios. Since most oral diseases are inflammatory

conditions associated with pain rather than actual infection[26], the improvement of student knowledge in this aspect looks valid even though statistically significant differences were not noted. Similarly, more students responded correctly to the questions related to the use of antibiotics against viral illness, and this result was statistically significant. This result was comparatively higher than those reported by a study conducted in the United Arab Emirates among medical and non-medical students[27]. In the present study, 93% of students were aware of the term 'antibiotic resistance', which was similar to the results described in the survey conducted among final-year medical graduates in UAE[27] as well as in Lebanon[28]. While this study failed to demonstrate improved knowledge scores after intervention, targeted education through online or face-to-face programs have shown to be an effective strategy in tackling AMR[17]. Several reasons could be attributed to why some studies showed an increased knowledge after intervention. The duration of the training was much longer, and students were asked to record their prescriptions. Being under observation could have contributed to better prescribing practices and fewer errors. This points to the need for an audit and monitoring of prescriptions, which is not a regular practice.

There was a significant improvement in the total attitude score of the participants three months after the intervention. All participants thought that antibiotic misuse existed, resulting in antibiotic resistance. This was much higher than the results that Lomi et al.[29] reported in a study conducted in India[29] and was comparable to the results described by Shah et al.[19] in a survey conducted in Nepal among university students. Around 97% of respondents in the present study were aware of the concept of antibiotic resistance compared to 72% in a study conducted in Saudi Arabia[30]. A survey conducted in the US also reported that about 22.1% of students were 'not at all familiar' with the term antibiotic stewardship. About 71% said they could benefit from more education regarding the antibiotic course[31]. In our study, an improvement in attitude was noted for the question on the effect on AMR on personal and family's health and the percentage of correct responses was much higher than those reported in another study conducted in India[29]. There was a substantial increase in the correct answers to the question on preference of antibiotics for dental infection (A5) from 4.7% before intervention to 67.4% after the intervention. This could be because the students are now aware that removal of foci of infection is the primary treatment in dental infections, and antibiotics are just adjuvants – one of the focus points of discussion in the delivered educational module. All the participants identified antibiotic resistance as a national problem compared to 47.8% in Nepal[19], 83% in China[32], and 93% in the US[33].

The total practice score showed a marginal decrease three months post-intervention, though it was not statistically significant. This indicates that knowledge does not always translate into practice. Clinical scenarios were used as an extension to practice questions. Improvement in scores was observed, but the results were not statistically significant. Overall mean scores were low, further strengthening the observation that practice did not improve as hypothesized. Though there was a slight increase in knowledge levels, it is questionable whether this increase translated into improving the practice domain. This issue was also raised by other studies conducted in India[34-36]. Translating the skills gained through theory sessions and interactions into practice takes time and requires periodic reinforcements and lifelong learning. The period of three months is too short for improving the practice. Considering the fact that our population were interns with limited clinical experience outside of the dental institute, it would take more time and reinforcements to bring about a significant improvement in practice domain. Keeping this in mind, we utilized clinical scenarios as an extension to practice questions for which we observed a positive change.

In the dental education program in India, students are introduced to antibiotics in their second year of study. The students do not independently treat patients at this stage. In their clinical training, students prescribe antibiotics under the strict supervision of the instructor. It is during their internship that they are in a state of semi-independent practice and start prescribing medications. But many times, the continuum between theoretical knowledge gained in their second year of study and clinical practice in the further years is lacking. This warrants the inclusion of different educational interventions like sensitization workshops and continuing dental education programs on antibiotic resistance to continuously reinforce the knowledge and attitude of students and practitioners on antibiotic resistance and to bring about a change in their practice.

While accepting that there was no significant improvement in knowledge and practice scores in this study, the need for targeted educational interventions cannot be neglected. Discussions regarding AMR in dentistry have not gained as much attention compared to medicine. Offering courses and knowledge dissemination sessions could be one approach to start such dialogues. Training students on antimicrobial resistance in a state of semi-independent practice like house-surgency is expected to translate into better prescribing practices during their independent practice. This calls for the need for reinforcement or refresher courses and audit of practices to ensure optimal antimicrobial usage.

Limitations

The strength of the study lies in delivering an educational intervention developed based on a MOOC and adapted to students of dentistry. Antimicrobial resistance is taught inclusively with certain topics in pharmacology. However, given the prominence AMR has gained recently and the gravity of its threat, it is important that future dentists and health professionals are provided with exclusive sessions.

Our study had a few limitations. As it was an exploratory study, it was conducted among dental interns in a single institute with a limited sample size, the results might not be generalizable. Additionally, we did not have a control group in this study. Hence, the changes in scores cannot be attributed to our intervention alone. Prior knowledge on antimicrobial resistance through other sources could also be a factor. Quasi-experimental studies are also affected by changes occurring due to natural variance and factors unrelated to intervention affecting the outcome. We believe such factors (casual attitudes, knowledge from other sources) may have influenced the post-test which did not show a significant improvement in knowledge and attitude scores.

CONCLUSIONS

The purpose of this study was to determine how dental interns' knowledge, attitude, and practice of antimicrobial resistance would change as a result of a short and preliminary educational module. Knowledge scores showed only marginal improvement while there was a positive impact on attitude, but it did not translate into practice. Recognition that antimicrobial resistance is a major problem, highlights the need to implement newer strategies and approaches to sensitize dental students on antimicrobial resistance and stewardship.

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The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none was reported.

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ETHICAL APPROVAL AND INFORMED CONSENT
Ethical approval was obtained from the Institutional Ethics committee of ... (Approval number: ECXXX-XXXX-2021-355; Date: ...). Participants provided informed consent.

DATA AVAILABILITY
Data sharing is not applicable to this article as no new data were created.

AUTHORS' CONTRIBUTIONS
RV: conception of idea, analysis of data. RV, AS, AP and DB: design of work. RV and DB: interpretation of data, revision of work. AS and AP: acquisition of data and drafting of work. All authors read and approved the final version of the manuscript.

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