

# Knowledge attitude and practice regarding antimicrobial resistance and stewardship among medical students

Anand Bhimaray Janagond<sup>1</sup>, Kranti Gouripur<sup>2</sup>, R. Manjula<sup>3</sup>,  
Shivakumar S. Solabannavar<sup>1</sup> and Varalakshmi Manchana<sup>4\*</sup>

<sup>1</sup>Department of Microbiology, S. Nijalingappa Medical College & H.S.K. Hospital & Research Centre, Navanagar, Bagalkot-587102, Karnataka, India, <sup>2</sup>Department of ENT, SSPM Medical College and Lifetime Hospital, At Post: Padve, Kasal, Tal: Kudal, Dist: Sindhudurga- 416534, Maharashtra, India, <sup>3</sup>Department of Community Medicine, S. Nijalingappa Medical College & H.S.K. Hospital & Research Centre, Navanagar, Bagalkot-587102, Karnataka, India and <sup>4</sup>School of Medical Sciences, University of Hyderabad, Prof. CR Rao Road, Gachibowli, Hyderabad-500046, Telangana, India

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**Abstract:** *Background:* Antimicrobial Resistance (AMR) is one of the top ten global public health threats faced by humanity that requires urgent multisectoral actions. Medical students play a vital role as the future prescribers and stewards of antimicrobials. Their knowledge, attitude and practice (KAP) regarding AMR and Antimicrobial stewardship (AMS) are crucial for ensuring rational and responsible use of antimicrobials in clinical settings. *Aim:* This study aimed to assess the KAP of medical students regarding AMR and AMS in a tertiary care hospital in North Karnataka, India. *Methodology:* A cross sectional study design was adopted and Google-form-based questionnaire was administered to MBBS (N=230) students who had passed Microbiology and Pharmacology. The data was analyzed by appropriate descriptive and inferential statistics. *Results:* Among 230 students, 99% knew that AMR is a global healthcare issue, and that irrational use of antimicrobials contributes to the development of AMR, and have the right concept of AMS. The knowledge regarding prevalence of common resistant phenotypes in India, and antibiotics that are likely to be effective against common resistant phenotypes is varying among the students. Students think that it is important to update about AMR and to adhere to right dose-frequency-duration of antibiotic. Though the students believe that they received adequate training, considering their poor knowledge in some of the topics/ concepts assessed in this questionnaire, they definitely need more focused training to develop better knowledge and practices regarding AMR and AMS. *Conclusion:* The learning objectives and expected competencies regarding AMR and AMS for medical students need to be clearly delineated and conveyed. They may be made certifiable competencies to ensure effective learning.

**Keywords:** Antimicrobial resistance, Antimicrobial Stewardship, Questionnaire, Medical Students, Knowledge Attitude Practice.

## Introduction

Antimicrobial resistance (AMR) is a major global health challenge that affects human, animal and environmental health. According to the World Health Organization (WHO), AMR is one of the top 10 public health problems faced by humanity and it requires urgent multisectoral action to achieve the Sustainable Development Goals (SDG) [1-2]. Antimicrobial stewardship (AMS) is a program that requires coordinated efforts to promote the appropriate use of antimicrobials, improves patient outcomes, reduce resistance to

antimicrobials among various pathogenic organisms, and decreases the spread of infections caused by multidrug-resistant organisms [2-3]. AMS aims to optimize the selection, dose, route, duration and timing of antimicrobial therapy, while minimizing the adverse effects on patients and the environment [3-5].

Medical students are the future prescribers and stewards of antimicrobials. Their knowledge, attitude and practice (KAP) regarding AMR and AMS are crucial for

ensuring rational and responsible use of antimicrobials in clinical settings. Moreover, medical students can play an important role in educating patients and the public about AMR and AMS, and influencing their behaviour and expectations [6]. However, several studies have reported that medical students have inadequate knowledge, poor attitude and inappropriate practice regarding AMR and AMS [5].

Objective of this study was to assess the KAP of medical students of MBBS Phase III part I, Phase III part II and House surgeons, who have completed their training in Microbiology and Pharmacology, regarding AMR and AMS in a tertiary care hospital in North Karnataka, India.

### Material and Methods

The present cross-sectional study was conducted after obtaining approval from the Institutional ethics committee and informed consent from the participants was obtained after explaining the study purpose and tentative time taken for participation. Medical students who had passed Microbiology and Pharmacology examinations from the institutions located in North Karnataka.

Sample size estimation was done using Openepi software version 2.3.1. Taking the publication by Mohan B. Sannathimmappa et al [7] as a reference, at 95% confidence level and 20% relative precision, the sample size was estimated as 175.

A questionnaire was designed on the themes of Knowledge, Attitude and Practices pertaining to AMR and AMS and data was collected through Google-form format. Ten questions each for

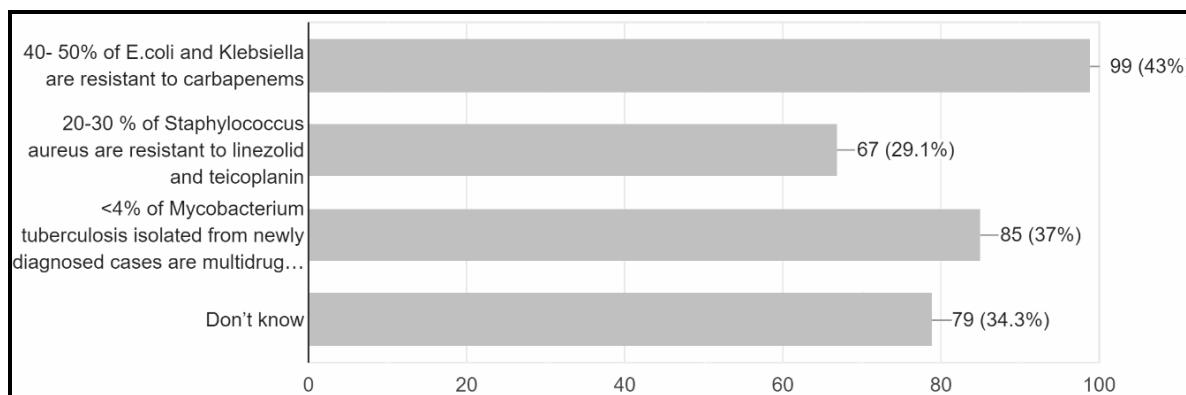
assessing Knowledge, Attitude and Practices with weightage of 60% on AMR and 40% on AMS were included. Questions had multiple correct options and all the questions had “don’t know” as an option to prevent guessing. Likert scale was used to collect responses for the questions assessing Attitude and Practice. The questionnaire was validated by two Microbiologists, an ENT Surgeon and a Professor of Community Medicine involved in teaching medical students. Responses were collected by sharing the questionnaire in WhatsApp groups of the MBBS students daily for a week. The collected data was coded, grouped, percentages were calculated and analysed.

### Results

A total of 230 MBBS students consented and submitted the google form. Participants included 130 MBBS Phase III/I (67%), 39 Phase III/II (17%), 13 recently joined Interns (5%) and 25 interns about to complete (11%) internship.

*Assessment of Knowledge regarding AMR and AMS:* Students responded that AMR is a problem present among bacteria (95%), viruses (38%), parasites (26%) and fungi (36%) respectively. Students identified major causes for AMR as irrational use of antimicrobials (84%), spontaneous increase in resistance among pathogens (75%), lack of discovery of newer antibiotics (34%) and less investment in research for antibiotic development (23%). The participants’ understanding of AMR situation in India is depicted in Figure 1.

**Fig-1:** Responses to “Fact(s) that represent(s) the current AMR situation in India (Choose all options that you feel are correct)”



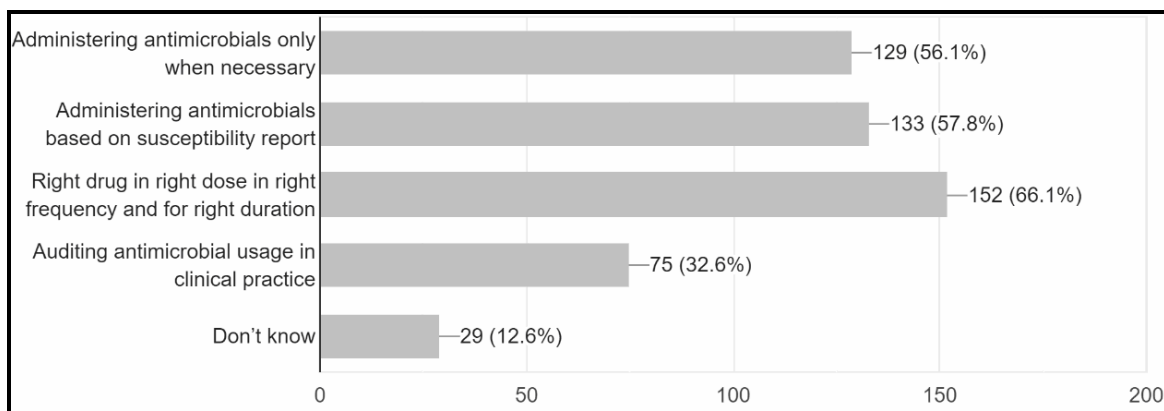
The students identified reasons for the infections by *Candida auris* becoming a global challenge as high AMR among the strains (49%), invasiveness (46%), high transmissibility (24%), factors common to all fungi in general (24%) and do not know (18%).

For the question, “the organism(s) identified as Critical Indian Priority pathogen(s) for which innovative new treatment options are urgently needed is(are)” students correctly identified carbapenem resistant *Klebsiella pneumoniae* (39%), colistin resistant *E.coli* (20%) and colistin

resistant *Acinetobacter baumannii* (13%), and incorrectly identified as Methicillin Resistant Coagulase Negative *Staphylococcus Spp* (54%); while 27% students answered as do not know [8].

The students identified ICMR (69%), National Center for Disease Control (NCDC) (47%), WHO (44%), National Institute for Occupational Safety and Health (NIOSH) (14%) as the organizations working to address the AMR issue in India. Students could identify various activities of AMS (Figure 2).

**Fig-2:** Responses to “Antimicrobial stewardship activity(ies) include (Choose all options that you feel are correct)”



Students mentioned antibiotics likely to be effective against MRSA correctly as Vancomycin (73%), Clindamycin (29%), and incorrectly as Piperacillin-Tazobactam (28%), Ceftriaxone (24%) and Imipenem (16%). Students mentioned antibiotics likely to be effective against carbapenem resistant *Escherichia coli* correctly as Levofloxacin (22%), Colistin (20%), and incorrectly as Amoxicillin-Clavulanic acid (40%), Cefoperazone-Sulbactam (30%), Ertapenem (11%), and 25% were not sure of the answer. Students mentioned antibiotics likely to be effective to treat an abscess caused by *Pseudomonas aeruginosa* incorrectly as Ceftriaxone (45%), Cotrimoxazole (27%),

Amoxicillin-Clavulanic acid (26%), and correctly as Ciprofloxacin (35%), Ceftazidime (31%), Amikacin (19%), and 19% were not sure of the answer [9].

Students mentioned that AMR issue can be addressed by focusing on optimum use of antimicrobials in healthcare settings (72%) and among lay public (65%), reducing use of antimicrobials in veterinary/fisheries (22%) and agriculture (20%) fields, while 7% were not sure. Assessment of attitude and practices of the students regarding AMR and AMS are summarized in tables 1 and 2 respectively.

<b>Table-1: Assessment of Attitude regarding AMR and AMS</b>						
<b>AMR /AMS</b>	<b>Question</b>	<b>Strongly Agree (%)</b>	<b>Agree (%)</b>	<b>Neutral (%)</b>	<b>Strongly Disagree (%)</b>	<b>Disagree (%)</b>
AMR	I feel, AMR will affect me/my family's health in the near future	37	48	11	2	1
AMR	I feel, enough efforts are being made by the Govt/ health institutions/ health organizations to address the AMR issue in India	10	31	32	23	3
AMR	I had enough opportunities to learn about AMR in MBBS curriculums far	13	55	18	11	3
AMR	Infection Prevention & Control practices (handhygiene, biomedical waste management, surveillance of health care associated infections, etc) will effectively reduce AMR if done Diligently	32	52	12	3	2
AMR	Being a student I can still contribute in controlling AMR problem	35	55	9	0	1
AMS	Irrespective of the clinical specialty, it is important to be updated about AMR and antimicrobial stewardship	47	44	6	1	1
AMS	Optimum utilization of diagnostic Microbiology services helps in addressing AMR issue	36	55	6	3	0
AMS	It is vital to adhere to correct dose, frequency and duration of antimicrobial, inspite of clinical improvement before the completion of Antimicrobial course	46	41	10	2	2
AMS	Enough awareness is being created about Antimicrobial resistance and Stewardship outside the medical curriculum (print media, social media, electronic media, academic events and programs, etc)	10	28	23	30	8

<b>Table-2: Assessment of Practices regarding AMR and AMS</b>						
<b>AMR/ AMS</b>	<b>Question</b>	<b>Strongly Agree (%)</b>	<b>Agree (%)</b>	<b>Neutral (%)</b>	<b>Strongly Disagree (%)</b>	<b>Disagree (%)</b>
AMR	I have tried (putting reasonably good efforts) to learn about Antimicrobial Resistance and/ or Stewardship in the MBBS curriculum so far	11	63	17	8	1
AMR	I have tried (putting reasonably good efforts) to learn about Antimicrobial Resistance and/ or Stewardship outside the MBBS curriculum from the sources such as internet/ books/ seniors/friends	10	45	25	17	3
AMR	I purchase antibiotics without prescription over the counter in pharmacy	7	39	7	35	12

AMR/AMS	Question	Strongly Agree (%)	Agree (%)	Neutral (%)	Strongly Disagree (%)	Disagree (%)
AMR	During my clinical postings, while going through the patient records in the hospital I analyse whether the antimicrobial prescribed is appropriate for the condition of the patient, and if the dose and duration recommended is appropriate	13	57	20	8	2
AMR	I have read guidelines/ documents related to antibiotic resistance or antibiotic prescription published by ICMR/WHO/Others	11	36	27	25	2
AMR	I have tried to find out about the AMR rate / antibiotic policy in our hospital	8	29	31	29	3
AMS	I usually take antibiotics for sore throat, cold and single episode of diarrhea	10	36	12	31	11
AMS	I always adhere to the complete duration and frequency of antibiotic once started	30	50	9	10	1
AMS	I adhere to the correct method of hand hygiene practices during all the moments requiring hand hygiene during clinical postings/ patient encounters	30	59	8	4	0
AMS	I have tried to convince family members/ patients/ public/ friends to adhere to rational use of antibiotics	24	61	10	4	0

An open-ended optional question “explain briefly how being a student you can still contribute in addressing AMR issue” was included at the end of the questionnaire. 151 (66%) students responded and the themes obtained after analysis of those responses are tabulated in table 3.

S. No.	Themes and sub-themes	No. of responses
1	Self-regulation	49
	By updating knowledge	24
	By avoiding irrational use	25
2	Creating awareness/ Influencing	93
2.1	In whom?	
	Family and friends	31
	Patients	14
	General public	45

S. No.	Themes and sub-themes	No. of responses
2.2	How to create awareness?	
	Social media	2
	News	2
2.3	Focus of creating awareness?	
	Completing course	14
	Avoid for trivial infections	7
	Hygiene	3
3	Advocacy	7
4	Research	5
5	Non-specific	17

### Discussion

India is one of the countries with high burden of infectious diseases and AMR. India also has a large population of medical students who are exposed to various challenges and opportunities in antimicrobial prescribing and stewardship. Improving the KAP of medical

students through effective curricula, training and interventions can enhance their competence and confidence in antimicrobial prescribing and stewardship, as well as their awareness and advocacy on AMR issues [7]. In the present study 230 MBBS students, of both genders participated. Majority of the participants were from MBBS Phase III/I (66.5%). This could be because they had passed Microbiology a month before the study and were more impressionable by the investigator who taught them until recent time.

All the participants except one agreed that AMR is a major global healthcare challenge. Most of the participants indicated that the AMR issue is present among bacteria (95%), while less than 40% mentioned that the AMR issue is present in viruses, fungi and parasites. AMR is a bigger challenge among bacterial infections, due to higher number of bacterial infections compared to the other organism groups. AMR is also a problem among viruses (e.g, HIV), fungi (e.g, *Candida Spp*) and parasites (e.g, *Plasmodium falciparum*). Since many students failed to recognize the AMR issue among non-bacterial pathogens, there is a need to create awareness in this regard.

*Knowledge about AMR and AMS:* The reasons for development of AMR were correctly identified as irrational use of antimicrobials (84%) and pathogenic organisms becoming more and more resistant (75%). Majority are unaware of the lack of funding and sparse research in developing newer antimicrobials [6-7]. Nearly one-third of the students accepted that they are not sure about the current prevalence of AMR in India. Less than half of the students could correctly recognize prevalence of Carbapenem Resistant Enterobacterales (43%) and Multidrug Resistant Tuberculosis (MDR-TB) in India. This emphasizes the need for educating MBBS students about the magnitude of AMR problem in India.

Students showed over all good understanding about the concept of AMS. Only 33% knew that antimicrobial usage audit is a component of AMS, and 13% students were not sure about the components of AMS [2]. The basic knowledge of the antibiotics that are likely to be effective against bacterial resistant phenotypes MRSA, CRE and *Pseudomonas aeruginosa* likely to be

encountered in routine clinical practice was inadequate. This can greatly affect their rational prescribing factors once they start their independent clinical practice.

Students chose optimum utilization of antimicrobials in healthcare settings and by lay public as the main areas to be focused to reduce AMR. Only around 20% students think that reducing antimicrobial usage in veterinary, agriculture, poultry and fisheries will be effective. Students need to be made aware that antimicrobial usage in non-human settings is several folds more than in human healthcare, and one health approach is vital in addressing AMR [7].

*Attitude towards AMR and AMS:* Majority agreed that the AMR issue is likely to affect them in future. In general students' attitude towards AMR and AMS are acceptable. It can be improved further by making them aware about the various measures being taken by Govt and non-Govt organizations to combat AMR and encourage AMS. Though they believe that they had enough opportunities to learn about AMR and AMS, they have inadequate knowledge about the topics. It emphasizes that their learning objectives and expected competencies regarding AMR and AMS have to be clearly delineated and conveyed; If possible, they should be made certifiable competencies (must know).

It is encouraging to know that the students believe that, even while being students, they can contribute by self-regulation (by updating their knowledge and avoiding irrational antimicrobial use) and by creating awareness among family, friends, patients and lay public (about importance of completing antimicrobial course and avoiding OTC consumption of antimicrobials). Students need to be motivated to inculcate such attitudes and they should be provided with support, encouragement for practicing these by the curriculum. The competency based medical education (CBME) curriculum of National Medical Commission (NMC) of India provides flexibility to each institution to incorporate such things in the curriculum. The medical teachers need to understand the importance of AMS and controlling AMR,

their ability to influence on the evolving minds of the medical students, and design and implement AMS components in the regular curriculum.

*Practices regarding AMR and AMS:* Students agreed about the following - They have tried to learn about AMR and AMS in their curriculum and also outside their MBBS curriculum, they routinely analyze the antibiotics prescribed to patients in their patient encounters during their training as a medical student, they adhere to complete course of antibiotics whenever they are advised, they have tried to convince others regarding the importance of following the right dose- frequency-duration of prescribed antibiotics.

Students had equivocal response to the following practices - Taking antibiotics for minor illnesses, purchased antibiotics without prescription, reading guidelines on AMR/AMS by ICMR/WHO/ Others, tried to find out about the AMR rate / antibiotic policy in the hospital posted in. Students claimed to have attempted to learn about AMR and AMS in their curriculum and outside and also are analyzing appropriateness of antibiotics in their patient encounters. They need encouragement in avoiding antibiotics for minor (mostly viral) infections and motivation to read and update AMR status and guidelines by bodies like WHO/ICMR. Ideally the practices should be assessed by observing the participants. Studies have found significant differences between attitudes and practices. As it is challenging to observe practices like adherence to antibiotic prescription, it is commonly assessed by asking questions.

Studies conducted in India and abroad have shown that the KAP regarding AMR and AMS are much variable among the medical students and most of the studies emphasize on the need for continuous efforts to improve it. Studies suggest that the medical curriculum should have components to achieve this [10-12]. A wide variety of educational interventions have been

attempted to develop and maintain adequate competency in prescribing antimicrobials, and WHO Guide to Good Prescribing is considered as a promising model for the design of targeted prescribing curricula and has been shown to be effective in a several types of settings [13].

The study has the following limitations: The number of participants in each MBBS phase were not equal, hence KAP among the students having different years of educational exposure could not be compared. This study was done in only one center, hence the results may not be generalized, though the results are expected to motivate necessary curricular changes within the institution. Ideally the practices should be assessed by observing the participants, as it is more resource intensive, it was assessed using the questionnaire.

### Conclusion

MBBS students even after passing Microbiology and Pharmacology generally lack knowledge regarding prevalence of common resistant phenotypes in India and antibiotics that are likely to be effective against common resistant phenotypes. Students believe that AMR and AMS are worth learning and had enough opportunities to learn in their curriculum, but lack adequate knowledge and practices. It is necessary to have defined competencies and learning objectives on AMR and AMS in MBBS curriculum. Making such competencies certifiable will ensure effective learning by the students.

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\*All correspondences to: Dr. Varalakshmi Manchana, Assistant Professor, School of Medical Sciences, University of Hyderabad, Prof. CR Rao Road, Gachibowli, Hyderabad-500046, Telangana, India. E-mail: lakshmi@uohyd.ac.in