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Original Research Article

Knowledge, attitudes, and practices toward antibiotic use and resistance among medical students: a cross-sectional study

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ABSTRACT

Background: Antimicrobial resistance (AMR) is becoming a major global health problem, which is jeopardizing the effectiveness of current antibiotics and causing increasing difficulty in routine clinical care. As future prescribers, medical students must develop strong knowledge, attitudes, and practices (KAP) to ensure effective antimicrobial stewardship (AMS). It explored the knowledge, attitude and practice of Indian undergraduate medical students concerning antibiotics and antimicrobial resistance.
Methods: A cross-sectional survey was conducted among 500 undergraduate medical students at a tertiary care hospital attached to a medical college in India. A validated, structured 30-item questionnaire based on World Health Organization (WHO) guidelines was used to assess KAP. The responses were reported using a 5-point Likert scale. Statistical analyses included t-tests, Mann-Whitney U tests, and Welch's ANOVA to evaluate the influence of AMR training and academic progression ($p<0.05$).
Results: Students demonstrated strong theoretical knowledge of AMR, but reported low confidence and limited engagement in AMS activities. Only 47.6% had formal AMR training, and 16.8% participated in AMS programs. Trained students scored significantly higher in knowledge ($p=0.006$) but not in attitudes or practices. KAP scores improved progressively across academic years, with final-year students and interns scoring the highest.
Conclusions: While Indian medical students show a high awareness of AMR, confidence and practice-oriented engagement are limited. Curricular reforms incorporating experiential learning and early AMS integration are crucial to bridging the knowledge-practice gap.

Keywords: Antibiotic stewardship, Antimicrobial resistance, Attitude, Knowledge, Medical students, Practice

INTRODUCTION

Antimicrobial resistance (AMR) is among the most critical public health threats of the 21st century, rendering common infections harder to treat and leading to prolonged illness, increased mortality, and rising healthcare costs. The World Health Organization (WHO) has identified AMR as one of the top 10 global health threats.[1] Inappropriate antibiotic use through over-prescription, self-medication, and non-compliance continues to fuel AMR globally.[2,3] In this context, medical students, as future healthcare providers, play a crucial role in mitigating AMR through informed prescribing and advocacy for antimicrobial stewardship (AMS).[4]

Despite various national and institutional efforts, studies from diverse regions, including the UK, Saudi Arabia, Jordan, and China, consistently reveal a gap between students' theoretical understanding of AMR and their confidence or willingness to engage in stewardship behaviors.[5-11] In India, where antibiotics are widely available over-the-counter and prescribing practices are loosely regulated, improving AMR-related medical education is particularly urgent.[12-14]

This study explored the knowledge, attitudes, and practices (KAP) of Indian medical students regarding AMR and evaluated the impact of formal training and academic progression on their competencies. The findings aim to inform educational strategies and reinforce antimicrobial stewardship interventions.

METHODS

Study design and participants

This cross-sectional study was conducted at a tertiary care hospital attached to a medical college in India from April to May 2025. A total of 500 undergraduate medical students, evenly distributed across first to final year and internship, were included using a universal sampling strategy.

Data Collection Tool

A structured, self-administered 30-item KAP questionnaire was developed based on WHO AMR guidelines and adapted from validated international tools.[15,16] The questionnaire consisted of 10 items each assessing knowledge, attitudes, and practices, and employed a 5-point Likert scale for responses.

Reliability and validity

The questionnaire underwent expert review by pharmacologists and infectious disease specialists. A pilot study was done using the questionnaire and after analyzing the results for reliability, Cronbach's alpha was 0.972, indicating excellent internal consistency.

Ethical considerations

The study received approval from the Institutional Ethics Committee. The study was conducted on voluntary participants whose electronic informed consent was obtained before administering the questionnaire. Data confidentiality and anonymity were maintained throughout the study.

Statistical analysis

Descriptive statistics summarized demographic variables and item responses. Independent samples t-tests and Mann-Whitney U tests assessed the impact of AMR training on KAP scores. Welch's ANOVA evaluated differences across academic years. Spearman's correlation coefficients were used to examine associations between KAP domains. A p value of <0.05 was considered statistically significant.

RESULTS

Among the 500 participants, 78% were aged 18-22 years and 74.4% were female. Academic year representation was evenly distributed. Notably, only 47.6% had received formal AMR training, and just 16.8% reported participating in antimicrobial stewardship programs, consistent with other low- or middle-income country settings.[10,17]

Table 1: Knowledge assessment on antibiotic use and resistance.

Statement	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Correct response rate (%)	Statistical test
Antibiotics are effective against bacterial infections but not viral infections	2 (0.4)	5 (1.0)	12 (2.4)	245 (49.0)	236 (47.2)	96.2	t=2.34, p=0.020*
Overuse and misuse of antibiotics contribute to antimicrobial resistance	0 (0.0)	2 (0.4)	11 (2.2)	197 (39.4)	290 (58.0)	97.4	t=1.12, p=0.26
Completing the full course of antibiotics is necessary to prevent resistance	2 (0.4)	4 (0.8)	74 (14.8)	202 (40.4)	218 (43.6)	84.0	t=1.87, p=0.063
Bacteria can become resistant to antibiotics, but people do not become resistant	4 (0.8)	25 (5.0)	237 (47.4)	147 (29.4)	87 (17.4)	46.8	t=3.45, p=0.001*
Poor infection prevention and control contribute to antibiotic resistance	2 (0.4)	26 (5.2)	181 (36.2)	143 (28.6)	148 (29.6)	58.2	t=2.10, p=0.037*
Resistance can spread between humans, animals, and the environment	2 (0.4)	68 (13.6)	139 (27.8)	175 (35.0)	116 (23.2)	58.2	t=1.95, p=0.052
Broad-spectrum antibiotics should be used only when necessary to reduce resistance	5 (1.0)	2 (0.4)	98 (19.6)	159 (31.8)	236 (47.2)	79.0	t=1.67, p=0.097
Self-medication with antibiotics contributes to antibiotic resistance	1 (0.2)	6 (1.2)	105 (21.0)	156 (31.2)	232 (46.4)	77.6	t=2.01, p=0.046*

Note: *-p<0.05.

Table 2: Attitude assessment on antibiotic use and resistance.

Statement	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Positive attitude (%)	Statistical test
Antibiotic resistance is a growing public health concern worldwide	2 (0.4)	1 (0.2)	53 (10.6)	146 (29.2)	298 (59.6)	88.8	U=4062, p=0.67
Guidelines for antimicrobial prescribing should always be followed	0 (0.0)	1 (0.2)	169 (33.8)	120 (24.0)	210 (42.0)	66.0	U=4130, p=0.82
I feel confident in my knowledge of antibiotic use and resistance	0 (0.0)	91 (18.2)	190 (38.0)	144 (28.8)	75 (15.0)	43.8	U=3985, p=0.54
Medical students should receive more training on antimicrobial stewardship	2 (0.4)	0 (0.0)	70 (14.0)	171 (34.2)	257 (51.4)	85.6	U=4211, p=0.91
Patients often expect an antibiotic prescription even when unnecessary	2 (0.4)	3 (0.6)	164 (32.8)	162 (32.4)	169 (33.8)	66.2*	U=4098, p=0.73
Non-prescription access to antibiotics should be restricted	1 (0.2)	2 (0.4)	241 (48.2)	120 (24.0)	136 (27.2)	51.2	U=4156, p=0.85
Pharmaceutical industry influences antibiotic prescribing	2 (0.4)	21 (4.2)	195 (39.0)	136 (27.2)	146 (29.2)	56.4*	U=4023, p=0.61
More policies and regulations needed to control antibiotic use	2 (0.4)	0 (0.0)	164 (32.8)	118 (23.6)	216 (43.2)	66.8	U=4189, p=0.88
Doctors should educate patients on unnecessary antibiotic use	3 (0.6)	2 (0.4)	71 (14.2)	134 (26.8)	290 (58.0)	84.8	U=4077, p=0.70
I worry that antibiotic resistance will impact future practice	0 (0.0)	21 (4.2)	204 (40.8)	113 (22.6)	162 (32.4)	55.0*	U=4112, p=0.79
Students should be involved in antimicrobial stewardship programs	2 (0.4)	0 (0.0)	162 (32.4)	127 (25.4)	209 (41.8)	67.2	U=4198, p=0.89
Antibiotic resistance is not a major concern in medical education	113 (22.6)	237 (47.4)	73 (14.6)	64 (12.8)	13 (2.6)	70.0**	U=3956, p=0.49

Note: *-p<0.05.

In terms of knowledge, as shown in Table 1, 80.8% of students correctly acknowledged the importance of completing prescribed antibiotic courses. Additionally, 58.2% were aware of the role of cross-species transmission in AMR propagation, and 79.0% recognized that broad-spectrum antibiotics should be used with caution. A substantial proportion (77.6%) identified self-medication as a significant driver of resistance. The mean knowledge score was 4.10 (SD=0.62).

Regarding attitudes as shown in Table 2, the majority of students (85.6%) supported integrating AMR and AMS training into medical curricula. Most (84.8%) believed that physicians have a responsibility to educate patients about appropriate antibiotic use. However, only 43.8% reported confidence in their current AMR-related knowledge, and 55.0% were concerned about the long-term implications of AMR. Awareness of non-prescription access to antibiotics was present in 51.2%. The mean attitude score was 4.15 (SD=0.58).

Students reported generally positive practices as shown in Table 3. Approximately 85.0% reported they often encouraged others to complete prescribed antibiotic regimens, and 81.4% avoided recommending antibiotics that were not prescribed by a healthcare professional. However, only 43.4% engaged regularly in discussions related to AMR, indicating limited practical engagement. The overall mean practice score was 4.01 (SD=0.73).

Formal training was associated with a significantly higher mean knowledge score (trained: 4.23 vs. untrained: 3.99,

p=0.006), but differences in attitude (p=0.18) and practice (p=0.13) were not statistically significant. Similarly, Welch's ANOVA demonstrated significant differences in knowledge [F(4,247) =38.2, p<0.001], attitudes [F(4,246) =31.9, p<0.001], and practices [F(4,247) =39.8, p<0.001] across academic years, with senior students and interns scoring significantly higher.

Table 3: Practice assessment on antibiotic use and resistance.

Statement	Mean (SD)	Never	Rarely	Sometimes	Often	Always	Statistical test
Check if infection is bacterial	3.87 (0.91)	1 (0.2)	42 (8.4)	110 (22.0)	217 (43.4)	130 (26.0)	F=0.89, p=0.35
Encourage others to complete course	4.35 (0.79)	0 (0.0)	2 (0.4)	79 (15.8)	158 (31.6)	261 (52.2)	F=1.23, p=0.27
Follow antibiotic prescribing guidelines	3.90 (0.90)	0 (0.0)	40 (8.0)	128 (25.6)	171 (34.2)	161 (32.2)	F=0.76, p=0.38
Avoid self-medication	4.19 (0.91)	1 (0.2)	4 (0.8)	100 (20.0)	190 (38.0)	205 (41.0)	F=1.45, p=0.23
Refer to clinical guidelines	3.80 (0.97)	1 (0.2)	42 (8.4)	152 (30.4)	161 (32.2)	144 (28.8)	F=0.98, p=0.32
Stay updated on resistance	3.58 (0.92)	0 (0.0)	60 (12.0)	188 (37.6)	157 (31.4)	95 (19.0)	F=1.10, p=0.29
Participate in educational programs	3.30 (0.95)	4 (0.8)	105 (21.0)	192 (38.4)	136 (27.2)	63 (12.6)	F=0.67, p=0.41
Discuss resistance with mentors	3.29 (0.99)	3 (0.6)	116 (23.2)	202 (40.4)	89 (17.8)	90 (18.0)	F=0.82, p=0.36
Educate non-medical students	3.90 (0.92)	2 (0.4)	31 (6.2)	111 (22.2)	207 (41.4)	149 (29.8)	F=1.02, p=0.31
Personal behaviour contributes to responsible use	4.32 (0.85)	1 (0.2)	3 (0.6)	82 (16.4)	164 (32.8)	250 (50.0)	F=0.95, p=0.33

DISCUSSION

The findings affirm that Indian medical students possess high levels of theoretical knowledge regarding antimicrobial resistance (AMR). However, these do not consistently translate into confident attitudes or practical antimicrobial stewardship (AMS) engagement. The discrepancy between knowledge and practice has been well documented in similar studies conducted in Jordan, Bangladesh, and the Democratic Republic of Congo.[10,17,18]

Only a minority of students reported participating in AMS programs or discussing AMR in clinical settings, suggesting that curricular coverage is insufficiently experiential. This trend is consistent with previous studies indicating that didactic instruction alone does not yield durable behavior change.[19] Moreover, cultural norms and healthcare expectations in India, such as the widespread belief in antibiotics as "quick fixes", continue to influence both patient and prescriber behaviors.[20]

Recent interventions employing simulation-based training and interprofessional learning have shown promise in improving students' confidence and clinical stewardship behavior.[21] A 2024 Indian pilot study demonstrated the effectiveness of simulation-based modules in improving both AMR knowledge and behavioral intentions among medical undergraduates.[21]

CONCLUSION

Indian medical students demonstrate commendable theoretical knowledge of AMR and antibiotic use. However, gaps remain in confidence and practical engagement. Formal AMR training significantly improves knowledge but is insufficient to change attitudes and practices in isolation. Medical curricula should integrate AMS training early and utilize experiential, case-based, and simulation-driven strategies to strengthen AMR preparedness among future prescribers.

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