Janaki Medical College Journal of Medical Sciences (2025); Vol.13 (2):1-6

JMCJMS

Editorial

The Ticking Time Bomb: Preparing Nepal's Medical Students for the Antimicrobial Resistance Crisis

Pathiyil Ravi Shankar*

Editor, JMCJMS

Author's Affiliations

*IMU Center for Education, IMU University, Kuala Lumpur, Malaysia

Correspondence to:
Prof. Dr. Pathiyil Ravi Shankar
IMU Center for Education, IMU University, Kuala Lumpur, Malaysia
Email: ravi.dr.shankar@gmail.com

Keywords: Antimicrobials, Developing countries, Drug Resistance, Humans, Medical Students, Nepal

Background

Low- and middle-income countries (LMICs) like Nepal face more severe antimicrobial resistance (AMR) burdens compared to developed higher-income countries (HICs). Drug-resistant infections significantly increase patient morbidity, mortality, duration of hospitalization, and healthcare expenses [1,2]. Resistant and multidrug-resistant bacterial strains are prevalent throughout Nepal [3, 4]. Differences between prescribed antibiotic use and over-the-counter availability and use of these medicines may have a significant contribution to increasing AMR rates [5]. Taking note of the serious nature of the problem, the World Health Organization (WHO) has published a global action plan on AMR [6].

Clinical Evidence and Healthcare Impact

Concerning levels of multidrug resistance among urinary tract pathogens, with particularly high resistance to amoxicillin, co-trimoxazole, fluoroquinolones, and third-generation cephalosporins was seen at the Kathmandu Model Hospital. This necessitated reassessment of standard urinary tract infection (UTI) treatment protocols [7]. Intensive care units (ICUs) globally report exceptionally high multidrug-resistant gram-negative infections. These show a strong correlation with healthcare-associated infections and increased mortality rates. Insufficient knowledge coupled with poor

practices was seen across human and veterinary healthcare sectors [8].

Systemic Challenges

Multiple healthcare system deficiencies in Nepal exacerbate the problem of inappropriate antimicrobial usage. These deficiencies include inadequate diagnostic capabilities affecting prescribing decisions and rational use of antimicrobials, widespread over-the-counter antimicrobial access, insufficient infection prevention measures at health institutions, and economic pressures promoting inappropriate prescribing behaviours.

Patient adherence is low, and is influenced by knowledge gaps, forgetfulness, communication barriers between healthcare providers and patients, personal beliefs, purchasing convenience, and trust in treatment efficacy [9]. Patients may purchase small doses of antibiotics and may stop treatment after their symptoms subside. Studies in Rupandehi district identified inappropriate antibiotic use resulting from demand-supply interactions occurring within weak regulatory frameworks, consumer knowledge deficits, financial constraints, limited antibiotic options, and pharmaceutical company incentives [10].

The COVID-19 pandemic worsened antimicrobial misuse, with hospitalized patients receiving antibiotics at higher rates [11]. Healthcare professionals recognize the importance of AMR and support strict guideline implementation, acknowledging that inappropriate antibiotic use harms patients and worsens resistance [12].

Future physicians play a crucial role in combating antimicrobial resistance (AMR) and promoting rational antimicrobial (AM) use. However, research reveals substantial knowledge deficits among medical and other healthcare students globally. Chinese medical students demonstrated significant gaps in AMR understanding and deemed teaching of the topic inadequate [13]. While students generally acknowledge AMR as a problem, they often lacked fundamental knowledge about resistance mechanisms and stewardship principles. This underscores the urgent need for comprehensive antimicrobial stewardship (AMS) training at the global level [14].

Nepalese Context

Studies from Nepal and other nations reveal mixed educational outcomes among medical students regarding AMR. At Kathmandu University medical students possessed better knowledge, attitudes, and practices (KAP) regarding antibiotic use compared to non-medical students, though significant gaps were noted between first year and final-year students in both the groups. Recommendations to improve KAP included implementing lectures, workshops, seminars, and media campaigns to enhance awareness and promote behavioural change [15].

Studies among Nepalese medical students showed generally positive results, with most demonstrating adequate knowledge and attitudes toward AM and AMR. Researchers emphasized the need for continued sensitization using diverse educational methods [16]. Final-year students and interns in Lalitpur showed good knowledge and attitudes, with interns demonstrating better rational prescribing practices compared to final-year students [17].

Current Educational Challenges

Antimicrobial education in the medical curriculum needs strengthening. Antimicrobials and basic antimicrobial concepts are introduced during the preclinical years, while clinical applications may be addressed during clinical rotations. Practical training in rational medicine use often receives insufficient attention. Drug and Therapeutics Committees (DTCs) and Infection Control Committees (ICC) which should promote rational prescribing, frequently lack visibility and documentation of their activities in medical institutions.

Antimicrobial Stewardship Implementation

Antimicrobial stewardship is "the optimal selection, dosing, and duration of antimicrobial treatment resulting in the best clinical outcome with minimal side effects to the patients and minimal impact on subsequent resistance" [18]. Grande International Hospital (GIH) became Nepal's pioneering healthcare institution to establish and maintain a comprehensive multidisciplinary antimicrobial stewardship program (ASP) combined with infection control measures [19].

Implementation challenges for ASP included physician resistance, inadequate antibiotic prescribing knowledge, insufficient staff for ASP activities, diagnostic testing limitations, and problems with antibiotic availability. A successful program incorporates multiple components including an ASP committee, prescribing guides with choice and dosage recommendations, inpatient formulary restrictions, educational outreach for healthcare professionals, and regular program reviews.

International Best Practices

The United Kingdom (UK) developed and implemented comprehensive AMR and stewardship competencies for undergraduate medical education, organized into six key domains: infection prevention and control, antimicrobials and AMR, antimicrobial prescribing and stewardship, vaccine uptake, person-centred care, and interprofessional collaborative practice [20]. These are assessed during the Prescribing Skills Assessment. German medical students favoured teaching formats that prioritized clinical applications, peer and clinician interactions, and receiving continuous formative feedback from instructors [21].

Economic and Social Impact

AMR significantly increases healthcare costs and worsens patient outcomes. In the United States, patients with resistant organism infections incur additional costs ranging from $6,000-$30,000 compared to those with susceptible infections [22]. Studies globally show increase in mortality in over 48% of cases. Healthcare system costs reaching up to $1 billion annually and economic burdens ranging from $21,832 patient case to over $3 trillion in GDP losses have been noted [23].

Vulnerability plays a dual role in AMR—both as a consequence of and a contributing factor. Social determinants including socioeconomic status, housing conditions, overcrowding, and education levels influence AMR exposure, and spread [24][25]. A Nepalese hospital study found that hospital-acquired infections with AMR resulted in additional medical expenses of $381.15, medicine costs of $202.37, out-of-pocket expenses of $370.56, and extended hospitalizations by 9 days per patient [26]. (1 USD = 141.3 NPR as of 29 October 2025).

Educational Recommendations and Innovations

Pedagogical Approaches

Effective AMR education should follow a spiral curriculum model and should be revisited throughout all study years, incorporating case-based learning using local resistance patterns. However, resistance pattern data availability remains a significant challenge. During the period from 2004 to 2007 AD, the Drug Information Centre (DIC) at the Manipal Teaching Hospital in Pokhara used to publish local resistance patterns in a quarterly Drug Information Bulletin. Interprofessional education involving medicine, dentistry, pharmacy, nursing, and laboratory science students has proven highly effective in reducing AMR [27].

Recommended teaching methods include simulation-based learning, clinical case discussions, blended and team-based approaches, web-based modules, educational outreach, seminars, patient-centred education, and audit and feedback interventions [28].

Core Competencies for Medical Graduates

Essential competencies include:

- **Knowledge**: Resistance mechanisms, local epidemiology, antimicrobial pharmacology
- **Skills**: Specimen collection, culture report interpretation, appropriate antimicrobial selection
- **Attitudes**: Stewardship mindset, patient safety focus, commitment to continuous learning

Assessment Strategies

Evaluation methods should emphasize competency-based assessments rather than knowledge-only examinations. Portfolio-based evaluation of stewardship activities, and Objective Structured Clinical Examinations (OSCE) incorporating AMR scenarios can be used. Community-based learning integrated with medical school community medicine postings can enable students to contribute to local AMR surveillance knowledge. In Nepal, community diagnosis and visits are common in the undergraduate medical curriculum.

Implementation Framework

Institutional Integration

An institution in Chennai, India provided students access to online educational materials comprising 20 expert-delivered lectures covering microbiology basics, AMR fundamentals, stewardship principles, infection management, antimicrobial pharmacokinetics and pharmacodynamics, and vaccination [29]. Online resources on AMR are available and can be used to support student learning under faculty guidance.

System Requirements

National action plans for AMR should incorporate educational components, utilizing WHO resources adapted to local contexts. Nepal's action plan to combat AMR should be stressed.

Conclusion and Future Directions

Kerala, India's successful model to address AMR and promote rational antibiotic use demonstrates the potential of public-private partnerships and multilevel implementation approaches, including state-wide clinical guidelines, medical curriculum revision, and comprehensive training programs for all

practitioners [30]. Nepal and other developing nations must develop customized models addressing local AMR challenges while ensuring population health protection.

Medical educators must collaborate to address this pressing challenge, equipped with appropriate knowledge, skills, and attitudes. The integration of comprehensive AMR education into medical curricula is a critical step toward combating resistance and promoting rational antimicrobial use in clinical practice.

REFERENCES

1. Prestinaci F, Pezzotti P, Pantosti A. Antimicrobial resistance: a global multifaceted phenomenon. Pathog Glob Health 2015;109(7):309-18.
2. Gebeyehu E, Bantie L, Azage M. Inappropriate use of antibiotics and its associated factors among urban and rural communities of Bahir Dar City Administration, Northwest Ethiopia. PloS one 2015;10(9):e0138179.
3. Rijal KR, Shrestha N, Pahari N, et al. Methicillin resistant Staphylococcus aureus in patients visiting western regional hospital, Pokhara. Journal of Institute of Medicine Nepal 2008;30(1):21-5.
4. Kayastha K, Dhungel B, Karki S, et al. Extended-spectrum β-lactamase-producing Escherichia coli and Klebsiella species in pediatric patients visiting International Friendship Children's Hospital, Kathmandu, Nepal. Infect Dis: Research and Treatment 2020;13:1178633720909798.
5. Pokharel S, Adhikari B. Antimicrobial resistance and over the counter use of drugs in Nepal. J Glob Health 2020;10(1):010360.
6. World Health Organization Eastern Mediterranean Region. Global Action Plan on Antimicrobial Resistance. Available from: https://www.emro.who.int/health-topics/drug-resistance/global-action-plan.html Accessed 26 Sept 2025.
7. Baral P, Neupane S, Marasini BP, Ghimire KR, Lekhak B, Shrestha B. High prevalence of multidrug resistance in bacterial uropathogens from Kathmandu, Nepal. BMC Res Notes 2012;5(1):38.
8. Parajuli A, Mitchell J, King N, et al. Drivers of antimicrobial resistance within the communities of Nepal from One Health perspective: a scoping review. Front Public Health 2024;12:1384779.
9. Udas S, Chand OB, Shrestha B, et al.. The facilitators of and barriers to antimicrobial use and misuse in Lalitpur, Nepal: a qualitative study. BMC Public Health 2024;24(1):1219.
10. Nepal A, Hendrie D, Selvey LA, Robinson S. Factors influencing the inappropriate use of antibiotics in the Rupandehi district of Nepal. Int J Health Plann Manage 2021;36(1):42-59.
11. Thapa B, Pathak SB, Jha N, Sijapati MJ, Shankar PR. Antibiotics use in hospitalised COVID-19 patients in a tertiary care centre: a descriptive cross-sectional study. JNMA J Nepal Med Assoc 2022 760(251):625.
12. Jha N, Mudvari A, Hayat K, Shankar PR. Perceptions regarding antimicrobial resistance and stewardship programs among healthcare professionals. J Nepal Health Res Counc 2023;20(3):689-696.
13. Zhao A, Xiao S, Kandelaki K, et al. Knowledge, perception, and educational status of antimicrobial resistance among Chinese medical students. Microb Drug Resist 2019;25(10):1458-64.
14. Efthymiou P, Gkentzi D, Dimitriou G. Knowledge, attitudes and perceptions of medical students on antimicrobial stewardship. Antibiotics 2020;9(11):821.
15. Shah P, Shrestha R, Mao Z, et al. Knowledge, attitude, and practice associated with antibiotic use among university students: a survey in Nepal. I Int J Environ Res Public Health 2019;16(20):3996.
16. Panthi S, Pathak P, Sitaula J. Knowledge, attitude and practice on antibiotic use and its resistance among medical students in a tertiary care hospital. Journal of Chitwan Medical College 2020;10(4):16-9.
17. Jha N, Shrestha S, Shankar PR, Bhandary S. Knowledge, attitude and practice about antibiotic use, self-medication and antibiotic resistance among final year medical students and interns at a medical college in Lalitpur, Nepal. Journal of Chitwan Medical College 2020;10(3):69-73.
18. Gerding DN. The search for good antimicrobial stewardship. Jt Comm J Qual Improv 2001;27(8):403-4.

19. Khanal S, Acharya U, Trotter AB, et al. Challenges and opportunities in the implementation of an antimicrobial stewardship program in Nepal. Antimicrob Steward Healthc Epidemiol 2023;3(1):e58.
20. McMaster D, Courtenay M, Santucci C, et al. Consensus-based antimicrobial resistance and stewardship competencies for UK undergraduate medical students. JAC Antimicrob Resist 2020;2(4):dlaa096.
21. Wiese-Posselt M, Lâm TT, Schröder C, et al. Appropriate antibiotic use and antimicrobial resistance: knowledge, attitudes and behaviour of medical students and their needs and preferences for learning. Antimicrob Resist Infect Control 2023;12(1):48.
22. Cosgrove SE. The relationship between antimicrobial resistance and patient outcomes: mortality, length of hospital stay, and health care costs. Clin Infect Dis 2006;42(Supplement_2):S82-9.
23. Naylor NR, Atun R, Zhu N, et al. Estimating the burden of antimicrobial resistance: a systematic literature review. Antimicrob Resist Infect Control 2018;7(1):58.
24. Broom A, Peterie M, Kenny K, et al. Vulnerability and antimicrobial resistance. Crit Public Health 2023;33(3):308-17.
25. Shutt AE, Ashiru-Oredope D, Price J, et al. The intersection of the social determinants of health and antimicrobial resistance in human populations: a systematic review. BMJ Glob Health 2025;10(5).
26. Liu X, Shrestha R, Koju P, et al. The direct medical economic burden of healthcare-associated infections and antimicrobial resistance: A preliminary study in a teaching hospital of Nepal. J Glob Antimicrob Resist 2022;29:299-303.
27. Alzard S, Exintaris B, Sarkar M, et al. A global investigation into antimicrobial knowledge in medicine, pharmacy, nursing, dentistry and veterinary undergraduate students: A scoping review to inform future planetary health multidisciplinary education. BMC Med Educ 2024;24(1):1227.
28. Haque M, Rahman S, Majumder MA. Classroom to Clinic to Community: Elevating Antimicrobial Stewardship Training in Medical Curricula. Advances in Human Biology 2025:10-4103.
29. Tirupakuzhi Vijayaraghavan BK, Ranganathan L, Venkataraman R, et al. Improving antimicrobial resistance awareness among medical students in India: the sensitization of medical students on antimicrobial resistance (SOS-AMR) study. J Med Educ Curric Dev 2024;11:23821205241239842.
30. Singh S, Charani E, Devi S, et al. A road-map for addressing antimicrobial resistance in low- and middle-income countries: lessons learnt from the public private participation and co-designed antimicrobial stewardship programme in the State of Kerala, India. Antimicrob Resist Infect Control 2021;10(1):32.