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Research Brief

Antimicrobial stewardship in medical education in Germany: a brief survey and a students' and educator's call for change

Oana M. Scholz[1], Nina Krüger[1], Erik Betzold[1], Jonas Bader[1], Nico Thul[1] and Cihan Papan MD[1,2]

[1]Center for Infectious Diseases, Institute of Medical Microbiology and Hygiene, Saarland University, Homburg, Germany and [2]University Hospital Bonn, Institute for Hygiene and Public Health, Bonn, Germany

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Introduction

Antimicrobial resistance (AMR) is an ever-increasing threat to human health on a global scale.[1] As of 2022, AMR has been reported to be the leading cause of death in humans worldwide related to infectious diseases.[2] Misuse of antibiotics is a major mechanism driving the growth of AMR.[3] Antimicrobial stewardship (AMS) describes an approach aiming to promote responsible use of antimicrobial drugs, pursuing to improve patient care and reducing the burden of AMR.[4,5] The effectiveness of AMS has been shown previously.[6] It is however necessary that AMS interventions are implemented on a larger scale.[7,8] Unfortunately, there is a severe shortage of specialists with a pertinent training.

Not only clinical microbiologists and infectious diseases specialists need to be trained, but every doctor treating patients with infectious diseases—in a multidisciplinary, one-health approach, this also entails other professions working with antibiotics, for example, veterinarians and pharmacists.[9,10] Consequently, AMS should be taught every medical student.

At Saarland University, Germany, students gain a rough understanding of antibiotics, but deeper insights and intuitive skills, especially pertaining to AMS, are missing. In addition, the many different specialties working with antimicrobial substances and their topic-specific approaches can be confusing for medical students while often missing basic AMS principles. In the updated German National Competency-Based Catalogue of Educational Objectives in Medicine however, it is stated that students should be able to "explain the rational use of antibiotics to avoid the development of resistances and consider the corresponding principles in their own practice" (for details on medical education in Germany, see appendix, page 3).[11]

Corresponding author: Cihan Papan; Email: cihan.papan@ukbonn.de
OMS and NK contributed equally.

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The aim of this article is to present how AMS is taught during medical education in Germany, by comparing the results of a survey of students from other German universities with our own experiences.

Methods

We performed a concise survey, for which we drew a sample of ten medical students across six German universities. To collect the data, we created a questionnaire consisting of 15 open, ranking (5-point Likert scale) as well as multiple choice questions (see appendix, pages 6–10). We interviewed undergraduate students in the clinical part of their studies. The interviews were conducted between the 1st September 2022 and the 31st December 2022. All participants were informed about the voluntary and anonymous nature of the survey. The project was exempt from institutional review board approval.

Results

The results of the scoping survey varied widely (Figure 1a). No student indicated a "very well" ability to define AMS. Fifty percent stated a low frequency of being taught about AMS in context of antimicrobials usage (Figure 1b). Between the different statements of the University of Frankfurt, the answers diverged from one to four which could be caused by COVID-19. Overall, 20% of students reported not having any training in AMS at all. The most frequent (80%) method of teaching mentioned was lecture. In 8/10 cases, an additional course with practical contents like evaluating an antibiogram was included. Of note, 30% of the students invested their free time learning about the subject matter. In less than half (30%) of the universities, AMS was taught in more than one field, for example, internal medicine, pharmacology, or surgery.

The subjective confidence in navigating AMR and in using antimicrobials was universally low (Figure 1c, d). All participating students expressed the wish for more teaching on AMS (Figure 1e). In the interview the students additionally were asked, which materials or methods they would have wished for. The most

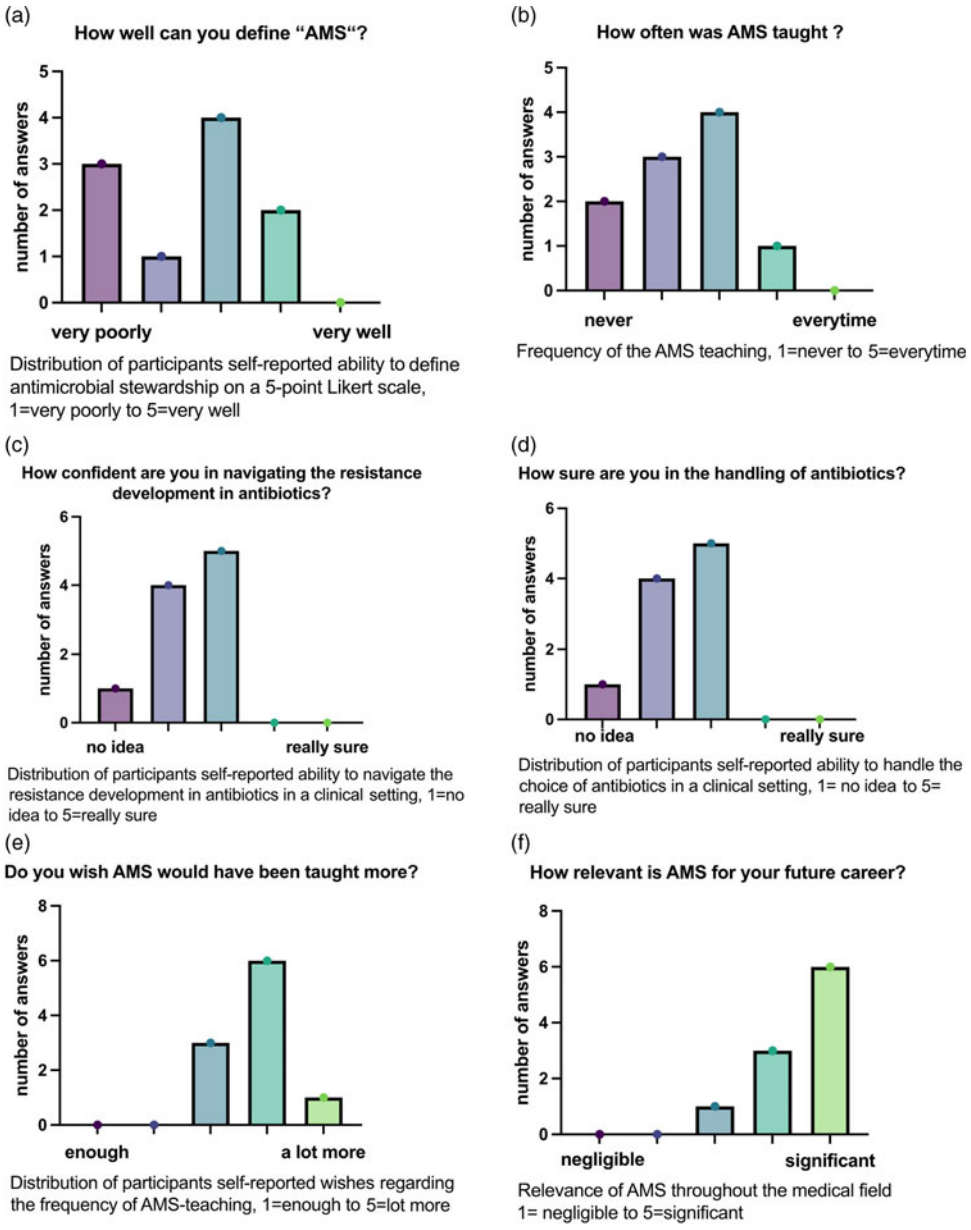

Figure 1. Responses of medical students to a scoping survey on AMS during medical undergraduate education in Germany, (a)–(f).

frequent answer (90%) was practical teaching, for example, bedside teaching and case-based elements with problem-based learning. Other answers were reference books, apps, study materials, and information about the consequences of AMRs. Lastly, we asked the students which field they intended to specialize in and whether they thought AMS to be relevant for that. All students acknowledged the relevance of AMS for future doctors irrespective of the intended specialty (Figure 1f).

Discussion

The results of our scoping survey demonstrate that medical students are often unsure how to use antimicrobials correctly. Our findings indicate that there is a blatant need for more AMS content during medical undergraduate education in Germany.

The results presented herein are in accordance with previous results from the USA.[12] The vast majority of the interviewed students of our study wished for more education on appropriate use of antimicrobials. Similar results were shown on a European scale.[13,14]

Limitations of our study are the small sample size and the focus on Germany. However, we believe that due to our point of view as students in the last years of medical school surveying fellow students across different universities, we were able to open up new perspectives on the matter. This project, along with the aforementioned studies, highlights the ongoing lack of undergraduate education on AMS. This is highly critical especially in the context of rising resistances and death numbers.[15] We see this development, the rising AMRs in combination with the missing changes in AMS education, as highly problematic.

The goal of teaching AMS in medical school should be to generate physicians who have the appropriate mindset and knowledge about antibiotics, and who know and follow AMS-principles-led management of patients with infectious diseases.

We present here a framework to facilitate the implementation of AMS in medical curricula, the WWH (what, why, how)

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framework. The framework also entails the use of diagnostics,[16,17] the importance of communication with patients,[18] and the employment of novel, artificial intelligence-based approaches (see appendix, page 4).[19,20]

Along the lines of this framework, the following teaching formats could be leveraged to maximize the learning experience of students: The core problem and why antibiotics are different would best be presented in a lecture or a flipped classroom format. Study materials should be included. The best ways to treat patients/AMS should be presented through case-based learning with development of a step-by-step plan, as we have experienced during the elective course "Stewards for future" at the Saarland University.[19] Teaching at the patient's bedside in small groups is another helpful way to consolidate knowledge. In addition, easy-to-use and quickly accessible materials, such as a pocket-sized handbook or a smartphone application containing the most relevant diseases and therapies including the dosages and length of the therapy, should be provided. Mental frameworks to facilitate the use of antibiotics could be included as well (see appendix, page 5).[21,22]

The aforementioned lack of AMS contents in medical undergraduate curricula makes it necessary to implement electives like "Stewards for future" in undergraduate medical education.[23] As of now, in Germany, AMS contents are largely taught in postgraduate courses, which, albeit subsidized, are expensive and cumbersome to integrate into physicians' time schedules. The German national action plan on antimicrobials entails the education of physicians as AMS experts to tackle the threat of AMR, especially given the dearth of infectious diseases specialists, clinical microbiologists, and infection prevention and control specialists.[24] In contrast to the immersive, case-based approach that is used during the elective course "Stewards for future," the bulk of these postgraduate courses consists of lectures, partly presented in a blended-learning style. From our experience, it seems reasonable to demand an early curricular implementation of AMS principles, including training of communication skills, aspects pertaining to interdisciplinary and interprofessional patient care, and the necessary attitude to acknowledge the scope of the AMR threat. We believe that these goals can best be achieved by interdisciplinary bedside rounds and with simulated patients.

On account of our results, we recommend further action on a larger scale. AMS education implementation strategies need to be developed and quickly and globally brought to life. For this to be achieved, changes on many different levels will be necessary, on the teacher side (e.g., new lectures) as well as on the side of the policy makers. The growing threat of AMR and related deaths can only be tackled by a large mass of doctors who have the appropriate mindset and knowledge about antibiotics.

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Competing interests. The authors declare that they have no conflict of interest.

References

1. WHO. Antimicrobial resistance, 2021. https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance. Accessed March 24, 2023.
2. Antimicrobial Resistance Collaborators. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. *Lancet*. 2022;399:629–655. doi: 10.1016/S0140-6736(21)02724-0
3. Papan C, Willersinn M, Weiß C, Karremann M, Schroten H, Tenenbaum T. Antibiotic utilization in hospitalized children under 2 years of age with influenza or respiratory syncytial virus infection – a comparative, retrospective analysis. *BMC Infect Dis* 2020;20:606. doi: 10.1186/s12879-020-05336-5
4. Dyar OJ, Huttner B, Schouten J, Pulcini C, ESGAP (ESCMID Study Group for Antimicrobial stewardshiP). What is antimicrobial stewardship? *Clin Microbiol Infect* 2017;23:793–798. doi: 10.1016/j.cmi.2017.08.026
5. Pickens CI, Wunderink RG. Principles and practice of Antibiotic Stewardship in the ICU. *Chest* 2019;156:163–171. doi: 10.1016/j.chest.2019.01.013
6. Baur D, Gladstone BP, Burkert F, *et al.* Effect of antibiotic stewardship on the incidence of infection and colonisation with antibiotic-resistant bacteria and Clostridium difficile infection: a systematic review and meta-analysis. *Lancet Infect Dis* 2017;17:990–1001. doi: 10.1016/S1473-3099(17)30325-0
7. Pierce J, Apisarnthanarak A, Schellack N, *et al.* Global antimicrobial stewardship with a focus on low- and middle-income countries. *Int J Infect Dis* 2020;96:621–629. doi: 10.1016/j.ijid.2020.05.126
8. Marcelin JR, Chung P, Van Schooneveld TC. Antimicrobial stewardship in the outpatient setting: a review and proposed framework. *Infect Control Hosp Epidemiol* 2020;41:833–840. doi: 10.1017/ice.2020.94
9. McEwen SA, Collignon PJ. Antimicrobial resistance: a one health perspective. *Microbiol Spectr* 2018;6. doi: 10.1128/microbiolspec.ARBA-0009-2017
10. Zay Ya K, Win PTN, Bielicki J, Lambiris M, Fink G. Association between antimicrobial Stewardship programs and antibiotic use globally: a systematic review and meta-analysis. *JAMA Netw Open* 2023;6:e2253806. doi: 10.1001/jamanetworkopen.2022.53806
11. Nationaler Kompetenzbasierter Lernzielkatalog Medizin. https://medizinische-fakultaeten.de/themen/studium/nklm-nklz/. Accessed March 24, 2023.
12. Abbo LM, Pottinger PS, Pereyra M, *et al.* Medical students' perceptions and knowledge about antimicrobial stewardship: how are we educating our future prescribers? *Clin Infect Dis* 2013;57:631–638. doi: 10.1093/cid/cit370
13. Dyar OJ, Pulcini C, Howard P, Nathwani D, ESGAP (ESCMID Study Group for Antibiotic Policies). European medical students: a first multicentre study of knowledge, attitudes and perceptions of antibiotic prescribing and antibiotic resistance. *J Antimicrob Chemother* 2014;69:842–846. doi: 10.1093/jac/dkt440
14. Dyar OJ, Nathwani D, Monnet DL, *et al.* Do medical students feel prepared to prescribe antibiotics responsibly? Results from a cross-sectional survey in 29 European countries. *J Antimicrob Chemother* 2018;73:2236–2242. doi: 10.1093/jac/dky150
15. Manesh A, Varghese GM, CENDRIC Investigators and Collaborators. Rising antimicrobial resistance: an evolving epidemic in a pandemic. *Lancet Microbe* 2021;2:e419–e420. doi: 10.1016/S2666-5247(21)00173-00.00.0000:00:007
16. Papan C, Argentiero A, Porwoll M, *et al.* A host signature based on TRAIL, IP-10, and CRP for reducing antibiotic overuse in children by differentiating bacterial from viral infections: a prospective, multicentre cohort study. *Clin Microbiol Infect* 2022;28:723–730. doi: 10.1016/j.cmi.2021.10.019
17. Fröhlich F, Gronwald B, Bay J, *et al.* Expression of TRAIL, IP-10, and CRP in children with suspected COVID-19 and real-life impact of a computational signature on clinical decision-making: a prospective cohort study. *Infection* 2023:1–8. doi: 10.1007/s15010-023-01993-1
18. Stivers T. Managing patient pressure to prescribe antibiotics in the clinic. *Paediatr Drugs* 2021;23:437–443. doi: 10.1007/s40272-021-00466-y
19. Marra AR, Nori P, Langford BJ, Kobayashi T, Bearman G. Brave new world: Leveraging artificial intelligence for advancing healthcare epidemiology, infection prevention, and antimicrobial stewardship. *Infect Control Hosp Epidemiol* 2023:1–4. doi: 10.1017/ice.2023.122
20. Abd-Alrazaq A, AlSaad R, Alhuwail D, *et al.* Large language models in medical education: opportunities, challenges, and future directions. *JMIR Med Educ* 2023;9:e48291. doi: 10.2196/48291

21. Abdoler EA, O'Brien BC, Schwartz BS. Following the script: an exploratory study of the therapeutic reasoning underlying physicians' choice of antimicrobial therapy. *Acad Med* 2020;95:1238–1247. doi: 10.1097/ACM.0000000000003498
22. Wang R, Degnan KO, Luther VP, *et al.* Development of a multifaceted antimicrobial stewardship curriculum for undergraduate medical education: the Antibiotic Stewardship, Safety, Utilization, Resistance, and Evaluation (ASSURE) elective. *Open Forum Infect Dis* 2021;8:ofab231. doi: 10.1093/ofid/ofab231
23. Veranstaltungsplan: Stewards for future - Training von Studierenden zur Bekämpfung von Antibiotikaresistenzen. https://www.uniklinikum-saarland.de/fileadmin/UKS/Lehre/Dekanat/VP_SS2023/Klinik/Wahlpflichtfaecher/wf_SS2023_stewards_for_future.pdf. Accessed May 5, 2023.
24. Die Bundesregierung. DART 2030 Deutsche Antibiotika-Resistenzstrategie. https://www.bundesgesundheitsministerium.de/fileadmin/Dateien/3_Downloads/A/Antibiotika-Resistenz-Strategie/DART_2030_bf.pdf. Accessed July 8, 2023.

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