

Antimicrobial resistance and stewardship education

Supporting the pharmaceutical workforce in AMR and AMS

2023



FIP Development Goals



International
Pharmaceutical
Federation

Colophon

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Foreword

It is with great pleasure and purpose that we launch the “FIP antimicrobial resistance and stewardship education: supporting the pharmaceutical workforce in AMR and AMS” report. At a time when global health imperatives are more pressing than ever, and the challenges posed by antimicrobial resistance (AMR) are increasingly evident, this report stands as a testament to FIP’s commitment to advancing pharmaceutical education and practice.

AMR is a critical global health concern, demanding immediate and collaborative action. The role of the pharmaceutical workforce in addressing this challenge cannot be overstated. As the worldwide pharmacy community continues to evolve, it is essential that pharmacists and pharmaceutical professionals are equipped with the knowledge and skills required to contribute meaningfully to AMR mitigation and stewardship efforts.

This report aligns the urgent need to combat AMR with FIP’s overarching Development Goals. By providing insights, recommendations and strategies for the effective education of pharmaceutical professionals in the realm of AMR, we aspire to drive positive change on a global scale. The collaboration between FIP and its member organisations, along with various stakeholders, has been instrumental in shaping this report’s content and direction.

We extend our gratitude to all those who have contributed their expertise, time and unwavering commitment to the creation of this report. It is through such collective efforts that we can take meaningful steps toward a future where AMR is more effectively managed, and the pharmaceutical workforce plays a pivotal role in achieving this outcome.

As leaders in the pharmacy profession, we are dedicated to fostering a culture of continuous learning, innovation and adaptability. This report is in line with our shared vision of a world where the pharmaceutical workforce is at the forefront of tackling global health challenges.



Prof. Cátia Caneiras
Co-chair, FIP AMR Commission



Manjiri Gharat
Co-chair, FIP AMR Commission

Executive summary

I am pleased to present this executive summary of our comprehensive report, “Antimicrobial resistance and stewardship education: supporting the pharmaceutical workforce in AMR and AMS”. As the CEO of the International Pharmaceutical Federation (FIP), I need to acknowledge the critical importance of addressing antimicrobial resistance (AMR) and the pivotal role that pharmaceutical education plays in this global challenge.

Our report comprises four insightful chapters at the centre of AMR and antimicrobial stewardship (AMS) education:

Chapter 1 highlights the gravity of AMR as a pressing global health concern and the consequent challenges it poses to healthcare systems worldwide. AMS programmes are essential in optimising drug use. The report highlights the five strategic objectives set by the World Health Organization (WHO) to guide the fight against AMR. FIP’s collaboration with WHO is instrumental in advocating the vital role of pharmacists in combating AMR and aims to reduce its global impact while improving patient outcomes.

Chapter 2 explores the education of AMR and AMS in pharmaceutical programmes in-depth, with focus on the perspectives of pharmacy educators, practitioners and students. The chapter describes the importance of integrating key topics into the curriculum and utilising diverse teaching methods. Continuous professional development is highlighted as a necessity in this ever-evolving field. Effective communication within healthcare teams and ongoing education for healthcare professionals, particularly pharmacists, are emphasised to ensure the proper use of antibiotics.

Chapter 3 presents the findings from our FIP AMR pharmaceutical education survey, revealing insights from educators, practitioners and students across various WHO regions. The survey showcases the strengths and areas for improvement in existing curricula. It outlines the need for curriculum improvements and comprehensive learning experiences. Furthermore, the report includes case studies from diverse nations, such as Costa Rica, Croatia, Lebanon, Tanzania, Ireland, Norway, Nigeria, the UAE and the European Union. These case studies exemplify various approaches to addressing AMR, highlighting the importance of interdisciplinary collaboration, tailored educational initiatives and practical experience in combating AMR effectively.

Chapter 4, the final chapter, draws together the key insights from the preceding chapters. We reaffirm the critical role of education and training in the fight against AMR and emphasise the need for continued collaboration and innovation. The chapter offers a forward-looking perspective, outlining recommendations and strategies to address the challenges posed by AMR and strengthen pharmaceutical workforce development.

In conclusion, education and training are fundamental pillars in the fight against AMR. The report stresses the necessity for ongoing curriculum improvements, interdisciplinary collaboration and practical experience to equip the pharmaceutical workforce with the knowledge, skills and attitudes needed to mitigate the threat of AMR. Public awareness and engagement, regulatory measures and international collaboration are also vital components of a comprehensive strategy for addressing AMR globally.

In my role as CEO of FIP, I strongly urge all stakeholders to take heed of the insights and recommendations outlined in this report. We are fully committed to supporting pharmaceutical workforce development and actively contributing to the global mission of combating AMR. Together, let us seize the opportunity to make a tangible and transformative difference in addressing this crucial healthcare challenge aligned with the FIP Development Goals.



A handwritten signature in black ink, appearing to read 'C Duggan'.

Dr Catherine Duggan

CEO, International Pharmaceutical Federation (FIP)

1 Antimicrobial resistance and stewardship

1.1 Introduction and overview of antimicrobial resistance and stewardship

Antimicrobial resistance (AMR), which is a significant threat to public and environmental health, occurs when microbes become resistant to antimicrobials to which they were initially susceptible.¹ Situations are increasingly arising where bacteria that are resistant to most, or even all, available antibacterial drugs are causing serious infections that were readily treatable until recently.² According to the World Health Organization (WHO), AMR is among the top 10 threats to global health as it threatens human and animal health and welfare, the environment, food and nutrition security and safety, economic development and equity within societies.³

AMR poses significant risks to patient safety, healthcare quality and costs. Each year, hundreds of thousands to several million people worldwide die from infectious diseases caused by resistant microbes.⁴ Rational use of antibiotics improves patient safety and reduces the burden of AMR, whereas irrational use leads to detrimental health outcomes. Proper use of essential antimicrobials after childhood immunisation is a cost-effective aspect of modern health care. However, inappropriate antibiotic use contributes to the development of AMR, including many adverse drug reactions (ADRs), which are avoidable, often resulting from health practitioner errors or inadequate training.⁵

As a pressing global health concern, and to achieve the health-related Sustainable Development Goal (SDGs) targets, there must be a halt to the spread of AMR. The complex and multifactorial contributory factors must be addressed in all countries. In response to this global health challenge, antimicrobial stewardship (AMS) programmes, which are coordinated sets of interventions and strategies aimed at optimising antimicrobial use, improving patient outcomes and preserving the effectiveness of existing antimicrobial agents, have emerged as essential strategies to combat AMR and ensure the responsible use of antimicrobial agents.⁶ Nowadays, it is widely accepted that AMS is the crucial strategy to fight AMR.⁷ AMS interventions are associated with decreases in mortality.

The WHO, in its Global action plan on antimicrobial resistance outlines five strategic objectives to address AMR, including:⁸

1. Improving awareness and understanding of AMR;
2. Strengthening knowledge through surveillance and research;
3. Reducing the incidence of infection through effective sanitation and hygiene measures;
4. Optimising the use of antimicrobial agents; and
5. Ensuring sustainable investment in countering AMR.

In the WHO Global Action Plan, there is an emphasis on the importance of multi-sectoral collaboration, global surveillance and the development of new antimicrobial agents. Additionally, education and training initiatives play a pivotal role in AMS. Antimicrobial resistance, health care professionals including pharmacists, need to be equipped with knowledge about appropriate antimicrobial prescribing practices, including dosage, duration and drug selection. They should understand the principles of AMS and recognise the importance of individual and collective responsibility in combating AMR. The WHO "Health workers' education and training on antimicrobial resistance: Curricula guide" provides comprehensive guidance that addresses a global gap in AMR education and builds further on the AMR competency framework to lay out learning objectives and outcomes as they pertain to the main health worker groups involved in the stewardship of antimicrobials.¹

1.2 FIP's activities in antimicrobial resistance and stewardship

Given the importance of the global health threat, AMR has been a priority for FIP over the past decade. FIP has been leading AMR work reflecting it under FIP programmes, projects and Development Goals (DGs)⁹ including DG16 (Communicable diseases), DG17 (Antimicrobial stewardship) and DG19 (Patient safety), which are key to developing and considering pharmacists' vital role in AMR.¹⁰

In particular, FIP DG17 stands for: (i) strategies and systems in place to develop a pharmaceutical workforce prepared to deliver quality services for AMS; (ii) infrastructures and frameworks in place to deliver services for AMS; and (iii)

promoting research and development of new antimicrobials, new antimicrobial combinations and new techniques, and evaluating the impact of AMS programmes.¹¹

Since 2013–14, FIP has mapped pharmacists' crucial contribution to reducing AMR and consequently issued a report (2015) and a statement of policy (2017).^{12,13} At the same time, FIP contributed to the WHO's consultations to develop the "Global action plan on antimicrobial resistance" that was subsequently adopted by the 68th World Health Assembly in 2015. Since then, FIP has been collaborating with the WHO on the implementation of this plan to reduce the global burden of AMR.

Furthermore, as a priority in the action plan, FIP collaborated with WHO on providing educational materials on AMR. In 2018, FIP was one of the reviewers of the first Interprofessional Competency Framework on AMR Control that was published by the WHO. This competency framework is intended to serve as a reference for academic institutions, educators, accreditation bodies, regulatory agencies and other users. It helps them to ensure that pre-service education and in-service training equip health care professionals with the requisite competencies to address AMR.¹⁴

Consequently, in 2019, FIP contributed to the WHO "Health workers' education and training on antimicrobial resistance: Curricula guide". The aim of the curricula guide is to provide educators at pre-service and in-service levels with comprehensive guidance on what and how they may develop or include learning content in their local AMR curricula or syllabi.³ The guide covers advice for prescribers of antimicrobials, nurses, midwives, pharmacists, laboratory scientists, public health officers and health services managers. It facilitates equipping them with the practical competencies to manage antimicrobials according to their roles or allowed scope of practice.¹

In 2020, the FIP Bureau set up the FIP Commission on AMR to provide oversight, delivery and regional examples for global advancement. The Commission has achieved multiple deliverables, such as the AMR/AMS Resources Repository for pharmacists, a series of awareness events, a successful session at [FIP Congress in Seville](#), and the latest ones, in 2022, were a [series of events](#) dedicated to the World Antimicrobial Awareness Week (WAAW) in collaboration with the Commonwealth Pharmacists Association. In addition, FIP held two regional workshops to promote the awareness of AMR, strengthening AMS and supporting evidence-based interventions. The [workshop 1](#) and [workshop 2](#) focused on regional educational and development needs in AMR and AMS. During the workshops, the [FIP Commitment on Antimicrobial Resistance and Antimicrobial Stewardship by 2030](#) was launched. The commitment includes various actions for education, practice, scientific research and workforce development across nations and regions.

In parallel, as part of the multinational needs assessment programme, FIP conducted an education training needs assessment project to understand needs-based education priorities for the pharmacy workforce across 21 countries (including 26 member organisations) in 2021. Organisations were asked to map their ongoing policies and projects towards the FIP DGs. Out of 21 organisations that responded to the projects mapping question, eight highlighted that FIP DG17 (Antimicrobial stewardship) mapped to their ongoing policies and projects. Their ongoing policies and projects included: (i) availability of national guidelines related to AMS; (ii) involvement of pharmacists in the national committee for AMS; and (iii) ongoing campaign and awareness of the proper use of antibiotics highlighted by some organisations. They also described some needs and gaps in the nations, for example: (i) poor implementation of the regulation on dispensing antibiotics without prescription and prescribing practice; (ii) competency-based education requires further development (including early career and advanced and specialist training), as the scope of practice is not always defined, which highlights opportunities to provide early years foundation training focusing on AMS; and (iii) advanced and specialist training is a clear need (gap) worldwide, which provides opportunities to develop specialised training, such as in AMS or clinical leadership.

Following this project, in 2022, FIP also conducted another multinational needs assessment programme about what community pharmacy teams need in order to support good hygiene. It focused on surveying community pharmacists in five countries: India, Indonesia, Saudi Arabia, South Africa and Thailand. The project discussed the community pharmacy team's knowledge about hygiene's impact on AMR. From a total of 60 participants, a strong hygiene awareness within the community pharmacy team was prioritised, with a majority recognising the importance of good hygiene practices in preventing the spread of germs. While half of the respondents consider disinfection as crucial for disease prevention, a minority from India, Indonesia and Thailand expressed reservations about its significance. Concerns regarding the potential impact of excessive disinfectant use on AMR were shared by two-thirds of participants. Additionally, over half of participants believed that a lack of microbe exposure weakens the immune system. In terms of hygiene approaches to reduce AMR, the majority favoured public education on hand hygiene and disinfection as effective strategies, particularly in India, Indonesia, South Africa and Thailand. Food hygiene education was also deemed important by over half of respondents, notably in India, while advice on travel health and sexual hygiene was less commonly selected,

chosen by only a quarter of participants. These findings underscore the varied perspectives and preferences within the community pharmacy team concerning hygiene practices and their role in combating AMR.¹⁵

In 2022, the FIP Survey for Education on AMR was built on the work of the WHO curricula guide. In line with the guide, the survey includes five domains on foundations that build knowledge and awareness of AMR, appropriate use of antimicrobial agents, infection prevention and control, diagnostic stewardship, and surveillance, as well as ethics, leadership, communication and governance. It was implemented to help academics, pharmacists and pharmaceutical scientists in practice and pharmacy students to understand current educational status and needs.

In 2023, FIP restructured the membership of the Commission to bring it closer to the regional individual members and member organisations. The Commission also acts like the policy committee and has prepared an update of the FIP policy statement on "[Mitigating antimicrobial resistance through antimicrobial stewardship](#)".

FIP furthermore represents pharmacists in the global health arena, where FIP advocates that pharmacists play a key role to tackle AMR and can support AMS teams, leading to improvement in patients' clinical outcomes, a reduction in the emergence of AMR and savings in health care costs. For example, FIP shared our position on AMR with WHO as part of the consultation of "Human medicine prescribers, dispensers, and other healthcare workers on the over-the-counter sales of antibiotics" in 2023. FIP also annually represents the voices of pharmacists at the World Health Assembly, most recently at the 76th WHA on 21–30 May 2023, where FIP presented an individual statement about pharmacists' crucial role in AMR and AMS, and highlighted FIP's recent collaborative work with WHO.

The above shows FIP's ongoing advocacy and activities driving action on the international level. The rich variety of resources, educational materials, digital events, research publications, reports and repositories can be used globally to support the enhancement of the pharmacist's role in AMR and AMS. Coupled with our advocacy work, FIP makes sure pharmacists are key health care professionals to combat AMR with their essential contributions to AMR reduction.

2 Antimicrobial resistance and stewardship in pharmaceutical education

Chapter 2 investigates the understanding of AMR and the aligned aspect of AMS education. We will explore these topics from three distinct viewpoints: those of pharmacy educators, pharmacy practitioners and pharmacy students. By examining the insights and experiences of these key stakeholders, we aim to provide a well-rounded and insightful perspective on AMR and the educational efforts surrounding it within the field of pharmacy.

2.1 Introduction to antimicrobial resistance and stewardship education

The WHO has emphasised the importance of AMR and AMS education. The first objective of the Global Action Plan on AMR is to improve awareness and understanding of AMR through effective communication, education and training. To address AMR, all clinicians and health-care workers must become stewards of antimicrobials by prescribing them appropriately and educating their patients and colleagues on the proper use of this increasingly scarce medical resource. WHO Europe has developed an online course on AMS for a competency-based approach. It is free and accessible in several languages, and there are currently more than 40,000 people enrolled in the course. Moreover, World Antibiotic Awareness Week, which takes place annually in November, aims to increase awareness of global AMR and to encourage best practices among the public, healthcare professionals and policymakers.⁸ FIP contributes regularly to the commemoration of this week.

Literature reports, various informative actions and innovative gamification initiatives have been developed to educate and raise awareness about AMR and the correct use of antibiotics among the general population, especially among young people. For example, the e-Bug programme, operated by the UK Health Security Agency, is a health education programme that aims to promote positive behavioural change among children and young people to support infection prevention and control efforts, and to respond to the global threat of AMR.¹⁶ e-Bug provides free resources for educators, community leaders, parents and caregivers to educate children and young people and ensure they are able to play their role in preventing infection outbreaks and using antimicrobials appropriately. Moreover, researchers from Spain created playful, educational activities to render the problem of bacterial resistance and the action of antibiotics more understandable among young people. The dissemination media used were creative and innovative, and were selected according to the trends in digital communication and the use of scientific and health content provided by “tips” with useful advice, infographics, YouTube videos, Twitter threads, online challenges on Kahoot, stories on Instagram, use of QR codes and others.¹⁷

Despite such initiatives mainly directed towards the public, data regarding the status of education on AMR/AMS to professionals remain limited. A recent review identified a range of learning activities on antibiotic resistance as part of the One-Health approach. Such applications can be introduced to a wide audience to help arrest the current crisis for the next generation, using a number of teaching opportunities: board and role-play games, round tables, musicals, e-learning and experiments that can be coupled with more curricula and formal education to inform a diverse group of audiences.¹⁷ In some African countries, an antimicrobial prescribing app was launched and delivered to support antimicrobial prescribing and improve AMS practice. A study examined healthcare students’ understanding and attitudes towards AMR and AMS while using this app. Despite the fact that 70% of the respondents indicated that they had been taught about prudent use of antibiotics, and diagnosis of infections and their management using antibiotics in their universities, notable gaps of knowledge were elucidated. Over half of the respondents had no prior information on the term “AMS” and reported a lack of resources for accessing up-to-date information on drugs; for instance, only 36% had had an opportunity to access an app as a learning resource even when 70% of the respondents thought that a mobile app would support an increase in their knowledge. Those results reveal the need for an improved framework of AMR and AMS education among healthcare students.¹⁸

Recently, researchers from the US described a classroom-based project that engages students in systematic surveillance or environmental AMR. The short classroom research modules lowered common barriers for institutional participation in course-based research and brought real-world microbiology into the classroom by educating students about the pressing AMR concern while empowering them to be partners in solution creation.¹⁹ In light of the above findings, it remains imperative that policymakers, higher education health institutions, and stakeholders create a clear portfolio based on such evidence like obtained from these and similar studies, in which proper AMR/AMS education is implemented in preparation for future healthcare workforce.

In conclusion, the global threat of AMR requires comprehensive education and awareness initiatives. The WHO has emphasised the importance of AMR/AMS education, aiming to improve awareness and understanding through effective communication, education and training. Online courses, such as the one developed by WHO/Europe, have enrolled tens of thousands of participants, while initiatives like the e-Bug programme and innovative gamification efforts target young people to promote positive behavioural change. Despite these public-focused initiatives, there is a need to improve the education on AMR/AMS among health care professionals, as limited data indicate gaps in knowledge and resources. The integration of learning activities on antibiotic resistance into diverse teaching opportunities, such as board games, e-learning, and experiments, can inform a wide range of audiences. Additionally, the use of antimicrobial prescribing apps and classroom-based projects engaging students in AMR surveillance contributes to raising awareness and empowering future AMR policymakers. Higher education institutions and stakeholders must prioritise the implementation of proper AMR/AMS education to prepare the healthcare workforce for the challenges ahead. Through investment in comprehensive education, AMR can be combated, and we can safeguard the effectiveness of antimicrobial treatments for generations to come.

2.2 Educators' perspectives

Curriculum design and delivery

AMR has been recognised as a global health and developmental threat, and concerted efforts are under way by individuals, local, regional and international professional organisations and governments to tackle it in various ways.²⁰ To fight AMR effectively from the grassroots, it is imperative to embed knowledge of AMR and its consequences across training programmes, most especially in the pharmacy education curriculum, since pharmacists are the custodians of these drugs.²¹ Moreover, it also becomes necessary to include AMS programmes in such training.²⁰

AMS programmes generally include a wide range of interventions designed to promote the optimal and rational use of antimicrobial agents and can improve patient outcomes and minimise treatment harms and prevent AMR. Evidence suggests that when these programmes are used in conjunction with other AMR reduction strategies, such as the implementation of prescription-only dispensing of antimicrobial agents across all countries and regions, they have the potential to save lives, reduce healthcare costs and improve other clinical outcomes.^{22,23} Thus, well-trained and competent pharmacists are indispensable in the fight against AMR. This is because many AMR reduction modalities, including AMS programmes, must be carried out or spearheaded by pharmacists and others. In many countries, pharmacists have critical roles to play with respect to AMS that include developing and managing antimicrobial usage guidelines, reviewing individual patient regimens to optimise therapy, educating healthcare staff and members of the public on the appropriate use of antimicrobials, and monitoring and auditing outcomes.¹² Consequently, the WHO recognises AMR education as one of the effective strategies for its containment.^{23,24} To achieve this, pharmacy curricula must be designed for effective delivery of AMR and AMS programmes.²⁴ For example authors from South Africa listed proposed topics for implementation as part of the AMS curriculum for undergraduate pharmacy training.²⁵ However, the list is not exhaustive. Each of the proposed topics should specify learning objectives that focus on knowledge, skills, and attitudes toward AMS the students should acquire. Moreover, designing local content in the curriculum to reflect national and regional needs should be encouraged.

Table 1. Topics suggested for inclusion in an antimicrobial stewardship curriculum adopted with modifications²⁵

| Topic | Perceived importance |
|---|----------------------|
| Foundations that build awareness of AMR | High |
| Appropriate use of antimicrobial agents | High |
| Standard treatment guideline and its compliance | High |
| Dose optimisation | High |
| Patient individualisation of treatment | Low |
| Intravenous-to-oral switch | High |
| Streamlining spectrum of actions of antimicrobials | High |
| Duration of therapy | High |
| Surgical prophylaxis | Moderate |
| National and international policy on antimicrobial prescriptions and access | Moderate |
| Culture sensitivity tests before treatment commencement | High |
| Infection prevention and control | Moderate |
| Antimicrobial surveillance and pharmacovigilance | High |
| Diagnostic stewardship and surveillance | Moderate |
| Use of antimicrobials and emergence of resistance | High |
| Common infection syndromes: community and hospital acquired | High |
| Ethics, leadership, communication, and governance pertinent to AMS | Moderate |

Delivery methods may involve the following depending on the stage of the students, learning objectives and availability of technology:

- AMS ward rounds as integral part of experiential learning;²⁵
- Rotational posting of pharmacy students to antiretroviral and anti-tuberculosis dispensing and counselling units.
- Didactic and interactive lectures through active listening with experts in the field by clinical pharmacists with experience in the practice of AMS, and community pharmacy posting;
- Interactive small group tutorials using problem-solving exercises and case-based learning encouraging students to present, analyse and discuss critical issues on AMR and AMS;
- Simulation and role playing;
- Project-based learning through surveys, project reports, strategic papers and critical appraisal of literature; and
- Flipped classroom approach — prior to live instructional classes, students should be exposed to basic knowledge and come to lectures to apply what they have learned. They can then receive feedback and gain in-depth understanding of the topic from the instructor.

However, teaching AMS should incorporate multiple didactic and assessment techniques.^{1,25} To establish a strong foundation for the successful implementation of AMS initiatives, it is imperative to start educating individuals about the nature and significance of AMR from an early age and sustain this educational effort throughout their development.

Assessing learners

Students' assessment on AMR and AMS can be broadly divided into two parts:

- Formative assessments used to monitor student learning and provide ongoing feedback. They help students identify their weaknesses and target areas that need improvement.
- Summative assessments, which require a pass mark, as in an examination, project report or paper. Examinations which involve essay questions, short answer questions, multiple choice questions and extended matching questions are examples of written summative assessments. The observed structured clinical examination (OSCE) and the observed structured practical examination (OSPE) are also examples of summative assessments.

Other assessment methods may include competency assessment, case-based discussions, one-to-one meetings/guided reflections, simulation exercises, written assignments, root cause analysis reports and preparation of a report translating evidence to policy. However, it is desirable for summative assessments to be applied upon completion of an entire curriculum or module and tailored according to local syllabus or course requirements.¹

Requirements for educators' competencies

Members of academic communities who are responsible for AMR and AMS curricula development and delivery must be appropriately trained to be responsible for the overall teaching, management and supervision of students' trajectory of learning. Thus, it is pertinent that the competencies on AMR and AMS to be taught to students are acquired, understood, maintained and practised by the educators who will be discharging these curricula.

Other requirements should include affiliation to a faculty position that is tied to an accredited health education and training institution. These foundational requirements will enable the educator to guide the student to achieve agreed learning objectives. Consequently, educators must be responsible for bringing together all relevant evidence to form a summative judgement at the end of the training period.

Educators must be experienced in their respective roles, be competent and be familiar with the modules they will be facilitating. They should have the ability and commitment to meet with students regularly and reflect and receive feedback on their supervision and teaching. Educators should strengthen their competencies by undertaking regular performance evaluation and work towards meeting their own professional requirements. They should endeavour to ensure regular checks on these six areas:¹

- Undertake continuing professional development to keep abreast of paradigms in both teaching and practice;
- Act as positive role models by guiding students on their personal and professional development;
- Ensure safe and effective care through training to enable students to provide individuals and communities with quality care during training and post qualification;
- Establish and maintain healthy and conducive environments for learning;
- Enhance learning through assessment; and
- Support and monitor educational and career progression for pharmacy students.

Academic capacity

An important barrier to integration of AMR in education would be the lack of a critical mass of faculty members who are prepared to teach this competency. It is thus important to prepare faculty members to be able to provide students with the competencies needed on AMR and AMS for their upcoming roles. However, competing demands for productivity, teaching and evaluating students have left most faculty members with insufficient time for learning how to develop effective systems that improve their productivity in this regard.^{26,27}

Few programmes that are offered for faculty members include ways of preparing them to develop curricula or teach learners.^{27,28} There are some attempts, however, in some countries to prepare faculty members for the dual purpose of leading clinical transformation and engaging students to learn and practise AMS.²⁹ Therefore, preceptors should be trained in this activity and their involvement should be encouraged, and this may help to promote the implementation of AMS curricula.³⁰

Involving early-career professionals in team-based quality improvement projects for AMS can improve clinical care and build the capacity of the workforce in both quality improvement and AMS. It is also important to emphasise the importance of CPD. AMS education needs to be available for educators to access on an ongoing basis throughout their

careers to ensure that antimicrobial use is based on current evidence, and is safe and effective, and that patients are not harmed by unnecessary or inappropriate prescribing.

As for the premises and laboratories for training students on AMR and AMS, most countries share academic environments that limit patient availability, and this would contribute to the increasing drift in the use of simulation technology.³¹ Laboratory capacity is needed to teach students ways to identify an organism and its antimicrobial susceptibility. Thus, it is important to invest in infrastructure and resources for testing before treatment commencement.

Experiential learning

Experiential training is viewed as an essential requirement for the development of competent skills for pharmacists' practice. It is thus important to identify the type of experiential training programmes that will best prepare pharmacy students for their future role in AMR and AMS. For pharmacists to adequately fulfil necessary roles on AMR teams and become antimicrobial stewards, pharmacy schools must adequately prepare pharmacy students prior to entry into actual practice.^{32,33} Unfortunately, AMS is not comprehensively taught in pharmacy school curricula.³⁴ When pharmacy students in South Africa and the USA were asked about their readiness for the selection and use of antibiotics, they expressed differing viewpoints, but the majority believed that further instruction and training on antimicrobials and AMS was required.^{35,36}

It is important to address the interprofessional approach to stewardship for the success of AMS.³⁷ AMS certainly is a multidisciplinary responsibility and students should be exposed to stewardship through interprofessional activities so that they become more aware of the importance of proper antimicrobial use as future clinical pharmacists. It is always necessary to emphasise proper communication among multidisciplinary teams for impactful AMR interventions.³⁷

Therefore, to implement effective AMS programmes, a specialist team on AMR is needed. The AMS team must be multidisciplinary, consisting of clinical pharmacists, physicians, microbiologists, infection control representatives and epidemiologists. There should be effective collaboration across various health sectors with pharmacists' expertise at the centre.

2.3 Practitioners' perspectives

The WHO, with its partners such as FIP, developed the "Health workers' education and training on antimicrobial resistance: Curricula guide", which is aimed at supporting countries in their effort to address the first objective of the Global Action Plan with regard to AMR (to improve awareness and understanding of AMR). The guide targets healthcare professionals' education and training on AMR in line with the WHO AMR competency framework.¹⁴

The Infectious Diseases Society of America (IDSA) and the Society for Healthcare Epidemiology of America issued guidelines for developing institutional programmes to enhance AMS, an activity that includes appropriate selection, dosing, route and duration of antimicrobial therapy.³⁸ Effective AMS programmes can be financially self-supporting and improve patient care. The evidence-based recommendations for comprehensive stewardship programmes of the IDSA guidelines cover many elements that may be considered and prioritised as supplements to the core active AMS strategies based on local practice patterns and resources, such as education, guidelines and clinical pathways, and dose optimisation, among other elements.³⁸

The perspectives of pharmacists and other health care professionals (HCPs), such as their attitudes, knowledge and perceptions, are key for establishing an effective antimicrobial stewardship programme (ASP). The attitudes, knowledge and perceptions of HCPs must be adequate and in line with ASP best practices and standards, which might not always be the case among HCPs. HCPs working in hospitals should have adequate knowledge and awareness of AMR, its triggering factors, and strategies required to cope with AMR.³⁹ Furthermore, monitoring the status of ASP competence among pharmacists and other HCPs also plays a vital role in effective implementation of ASPs at hospitals and healthcare facilities.

In AMS programmes, the pharmacy practitioner's role is essential in the creation and management of antimicrobial guidelines, the evaluation of patient regimens to optimise therapy, the training of healthcare workers in the proper use of antimicrobials, and the monitoring and auditing of antimicrobial usage outcomes.⁴⁰ When compared with AMS plans that rely on ward pharmacists, AMS schemes with a dedicated infectious diseases pharmacist have been shown to be associated with improved adherence to advised antimicrobial treatment practices. The most extensively used forms of

training in infectious diseases are specialty residency and fellowship training.⁴¹ Globally, pharmacists, particularly those with professional training and experience in AMS, play a critical role in AMS healthcare teams.⁴²

In the context of pharmacy practitioners and AMR education, different studies conducted in various geographic regions and countries in the published literature have diverse findings on the perspectives and KAP (knowledge, attitudes and practice) status among HCPs in healthcare practice setting. A prospective multicentre cross-sectional study on the attitudes of key HCPs, including physicians, nurses and hospital pharmacists, towards AMR and hospital ASPs reported that the attitudes of most of the HCPs was observed to be positive with most of the physicians (247/410, 60.2%) perceiving AMR to be a serious problem in Pakistani hospitals.⁴³ In this study, the key strategies proposed by the HCPs for combatting AMR and improving AMS included prospective audit with feedback and regular educational sessions.

Another KAP study in Iran sought to identify knowledge gaps among healthcare workers related to ASPs. The study found that health care workers lacked knowledge in certain aspects of AMR. It concluded that additional practice and education are necessary to improve ASP and reduce resistant patterns.⁴⁴

In China, a study on perceptions and participation regarding ASPs among hospital pharmacists found that pharmacists perceived that AMS programmes are important, but that their involvement in related activities is limited in all provinces, and barriers to participating in AMS included workload (59.5%), ineffective communication between pharmacists and doctors (57.7%), and inadequate knowledge of AMS (47.0%) among the respondents. Another study in Thailand on attitudes related to antibiotics dispensing among community pharmacists reported, as a measure of their attitude, low intention to dispense antibiotics for upper respiratory infections (mean +/- SD; 2.35 +/- 1.85 on a 7-point scale) and, based on the findings, recommended educational programmes for positive behavioural change.⁴⁵

A similar study on perceptions and attitudes among HCPs at selected health facilities in Uganda reported that most HCPs had a high AMS attitude (58%, 340/582) and fair AMS practice (46%, 261/582) using a modified Bloom's categorisation in measuring the attitudes and practice scores.⁴⁶ Similarly, a study in Zambia on the KAP of community pharmacists on AMR and it was reported that the community pharmacists had good knowledge and positive attitudes but showed poor practices that required abrupt educational interventions.⁴⁷ According to the study, most of the pharmacists agreed that adequate training, workshops and other relevant activities on antibiotic resistance are needed. A qualitative study in Tanzania on determinants of antibiotic dispensing among dispensers and owners of accredited medicine outlets observed that the respondents had relevant knowledge, reported as correct explanation of treatment guidelines for ARI and diarrhoea, and understood that irrational antibiotics use could lead to AMR, but the translation of this into practice was still very low.⁴⁸ Similarly, in a KAP study on antibiotic dispensing and antibiotic resistance in Egypt, the respondent community pharmacists exhibited a good basic knowledge (51.2%) and a positive attitude (74%) towards over-prescription of antibiotics. Additionally, 90% of them expressed a hope that the ministry of health might publish guidelines for antibiotics dispensing in the country.⁴⁹

In summary, the literature shows that across different geographical regions, while many HCPs show good awareness and knowledge of AMR, their dispensing practices and adherence to stewardship guidelines can be inadequate and irrational. Also, key strategies for effective AMS involve regular educational sessions, prospective audit with feedback, and improved communication between pharmacists and other HCPs. Pharmacy professionals play a crucial role in combating AMR, and equipping them with proper education and training on AMS is essential to enhance their knowledge, attitudes and practices, ensuring appropriate antibiotic use and contributing to better patient outcomes and global efforts to combat AMR.

2.4 Students' perspectives

The International Pharmaceutical Students Federation (IPSF) has actively advocated AMR and highlighted the role of pharmacists. Some achievements include co-hosting the Global AMR Youth Summit, publishing the AMR advocacy toolkit, and participating in WHO AMR consultations. These efforts emphasise the importance of pharmacists in optimising antimicrobial therapy and preventing the further spread of resistance.

On 21 March 2023, the IPSF Pharmacy Education Committee joined forces with the University of Manchester (UK) to organise a highly informative and engaging webinar focused on the "One health approach to AMR". The webinar aimed to raise awareness about the critical issue of AMR and emphasise the significance of a collaborative effort involving pharmacy students. The event stressed the need to make AMR a concern for everyone, highlighting the potential consequences and the urgency of action. In line with this initiative, the IPSF also launched the AMR Article Competition, providing an opportunity for students to actively contribute to the discussion on AMR. Through this competition,

students were invited to share their perspectives, insights and solutions, enabling them to have their voices heard and fostering their engagement in addressing this global health challenge. The AMR Article Competition served as a platform for students to showcase their knowledge, creativity and dedication to combating AMR while advocating the appropriate use of antimicrobial agents. The IPSF applauded the participation of students and their commitment to driving positive change in the fields of pharmacy education and public health.

Pharmacy students acquire knowledge on AMR and AMS programmes. Numerous surveys have been conducted to investigate pharmacy students' knowledge, attitudes and perceptions regarding this topic. The investigations reveal that pharmacy students highly value the significance of AMS as a vital healthcare concern and seek to enhance their understanding of the subject. Studies also recommend a revision of the pharmacy curricula to incorporate more comprehensive education on antibiotic resistance and stewardship.³⁶

For instance, the urgent need for AMR and AMS education has been clearly demonstrated as a primary objective of a recent investigation conducted in Punjab, Pakistan, to acquire an in-depth comprehension of antibiotic utilisation, AMR and AMS initiatives among pharmacy students. According to the study's findings, pharmacy students demonstrated a commendable understanding of antibiotics and antibiotic resistance. However, their acquaintance with ASPs was found to be inadequate.⁵⁰

Other research conducted in Pakistan aimed to investigate the contribution of pharmacy students and teachers to antibiotic resistance and stewardship initiatives and revealed that pharmacy students demonstrated a favourable attitude towards ASPs and expressed their willingness to actively participate in such programmes. The study concluded that pharmacy students should be actively engaged in the development and implementation of AMS programmes.⁵¹ Similarly, a study conducted in Japan assessed the comprehension level of pharmacy undergraduates regarding the usage of antibiotics. The findings showed that pharmacy students had a satisfactory awareness of the appropriate utilisation of antibiotics, but their understanding of antibiotic resistance and stewardship was deficient.⁵²

Another research study conducted by IPSF students and recent graduates highlighted the imperative to establish an enhanced curriculum that will effectively equip upcoming pharmacists with the necessary knowledge and skills regarding AMS interventions. This is due to the fact that a majority of students have had to resort to external sources to supplement their education in this area.⁵³

Some pharmacy programmes have introduced specific courses or paths of distinction focused on AMS, while others have identified the need for more education on these topics. A clear example is highlighted by the School of Pharmacy at the University of Wisconsin. The school has launched a PharmD path of distinction that is aimed at advancing the concept of AMS. This programme is designed to provide student pharmacists with the necessary skills and knowledge to optimise the utilisation of antibiotics in order to mitigate the development of resistance.⁵⁴ Overall, there is a need for more education and training on AMR and AMS programmes in pharmacy curricula.

Perspectives on AMR and AMS educational strategies

The creation of antimicrobial usage policies, training on antimicrobial therapy and the creation of institutional antimicrobial use guidelines are seen to be the three most significant AMR interventions. Pharmacy students agreed that hospital and clinical pharmacists should be included in the AMS team and believed that a clinical pharmacist should oversee putting together and leading the core AMS team. The team should also include specialists in infectious diseases.³⁵

Being the most approachable professionals in the community, pharmacists can impactfully change the behaviour of doctors, nurses and customers if they receive proper education and training.⁵⁰ Education can start from the early years during undergraduate degrees and be followed by a CPD programme on AMR and AMS. Numerous studies have looked at pharmacy students' thoughts on AMR and AMS instructional methods. One study from Pakistan highlighted the important impact that effective education and training of pharmacy students and instructors has in considering antibiotic prescription behaviours and reducing AMR.⁵¹ Different research highlighted the significance of educating pharmacy students promptly on appropriate antibiotic usage and AMS.⁵¹ Another study evaluated fifth-year pharmacy students' perceptions of AMS in northern Nigeria.²⁰

Rather than undergraduates, the stewardship programme targets pharmacists with postgraduate degrees. There is room for improvement to develop undergraduate education and training focused on AMS. Pharmacists play a key role in changing community perceptions of the demand for antibiotics, increase awareness about AMR, and hence provide rational antimicrobial use. Therefore, undergraduate education and training on AMR and AMS initiatives must be implemented in all pharmacy schools through evidence-based curricula.

3 Findings from the antimicrobial resistance pharmaceutical education survey

3.1 Method

Previous sections of this report emphasise the crucial role pharmacists play in combating AMR and promoting AMS. However, there is limited evidence regarding the educational needs of the pharmaceutical workforce at a global level. Both HCPs and students express a desire to enhance their knowledge and competency through targeted and effective education and training on AMR.

Chapter 3 presents the results of a survey conducted to address the question: “What is the educational content for the pharmaceutical workforce on AMR?” Four objectives were set for the survey:

1. To investigate the educational components of AMR for the pharmacy workforce based on the “Health workers’ education and training on AMR: Curriculum guide”;
2. To evaluate the relevance of the AMR educational component for pharmacy practice from practitioners’ perspectives;
3. To assess pharmacy students’ perspectives on their AMR educational component; and
4. To collect examples of good practice on course descriptions, examples of assignments, and learning activities related to AMR education.

A quantitative cross-sectional survey was conducted using the QuestionPro platform. An online questionnaire was designed and piloted from July to September 2022, consisting of three sets of questions targeting pharmacy educators, practitioners and students, linked to the above objectives. The survey for pharmacy educators and practitioners was developed based on the five modules recommended in the WHO curriculum guide for pharmacists’ education, covering various aspects related to AMR of which the themes have been adapted as the themes for this survey. The questionnaire was distributed in August 2022 to the FIP network and collaborators, and reminders were sent in September 2022. The survey details can be found in Appendix A of this report.

A descriptive analysis was done on the data obtained using Microsoft Excel. For the purpose of this analysis, responses for “very high extent” and “high extent” were cumulated as “high extent” while “very low extent” and “low extent” were cumulated as “low extent” in order to give a concise presentation of the findings.

Overview of the participants

A total of 272 respondents across all categories from 81 countries participated in this project. Figure 1 shows the distribution of the participants across countries.

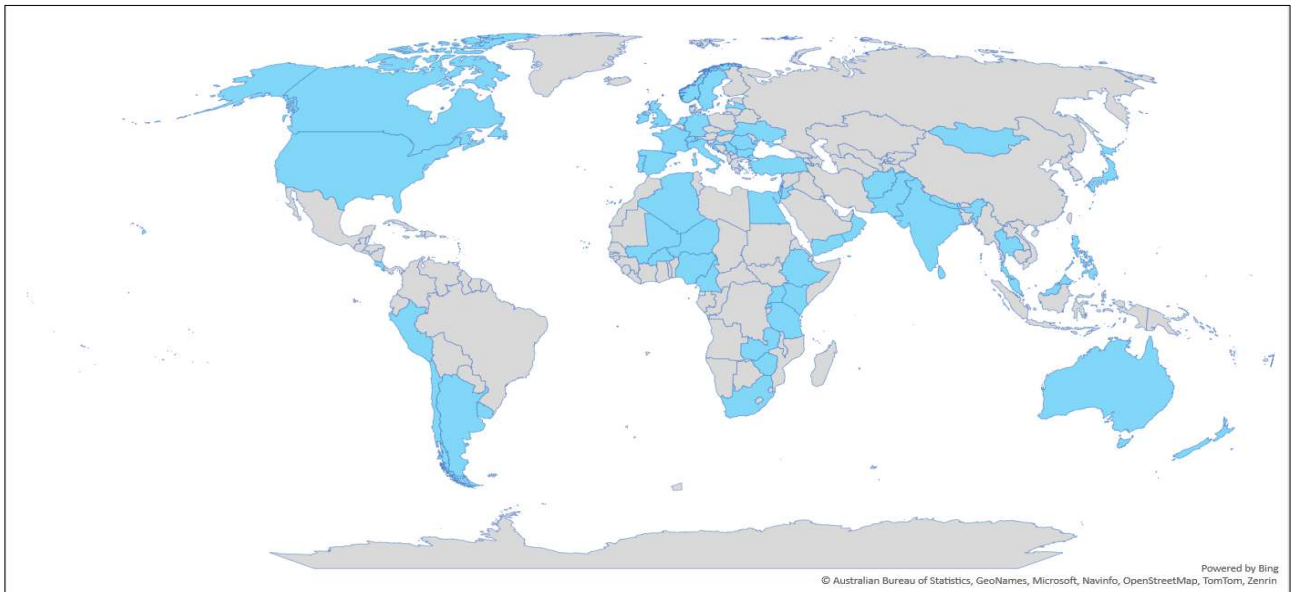


Figure 1. The distribution of the participants across countries (n=272).

Regarding regional distribution, Africa has the highest number of sampled respondents among educators (n=9, 20.9%), and practitioners (n= 42, 34%). Europe has the highest number of sampled respondents among students (n= 39, 37%). America has the lowest number of sampled respondents among students (n= 4, 4%) and the second lowest among practitioners (n=7, 6%). The Eastern Mediterranean region has the lowest number of sampled respondents among educators (n=1, 2.3%) and students (n=7, 7%) (Table 2).

Table 2. Respondents' distributions based on the target audience and WHO regions

| WHO Region | Educators | | Students | | Practitioners | |
|-----------------------|----------------------------|-------------------------|----------------------------|-------------------------|----------------------------|-------------------------|
| | Sampled respondents (n; %) | Country coverage (n; %) | Sampled respondents (n; %) | Country coverage (n; %) | Sampled respondents (n; %) | Country coverage (n; %) |
| Africa | 9 (20.9) | 7 (29.1) | 33 (32) | 13 (34.2) | 42 (34) | 6 (16.2) |
| America | 9 (20.9) | 3(12.5) | 4 (4) | 3 (7.9) | 7 (6) | 6 (16.2) |
| Eastern Mediterranean | 1 (2.3) | 1 (4.2) | 7 (7) | 4 (10.5) | 20 (16) | 6 (16.2) |
| Europe | 12 (27.9) | 7 (29.1) | 39 (37) | 12 (31.6) | 29 (24) | 35(28.7) |
| South-East Asia | 7 (16.3) | 4 (16.7) | 17 (16) | 4 (10.5) | 12 (10) | 3 (8.1) |
| Western Pacific | 5 (11.6) | 2 (8.4) | 6 (5) | 2 (5.3) | 13 (11) | 3 (8.1) |
| Total | 43 (100.0) | 24 (100.0) | 106 (100.0) | 38 (100.0) | 123 (100.0) | 37 (100.0) |

3.2 Educational components on AMR for the pharmacy workforce according to the “Health workers’ education and training on AMR: Curriculum guide”

Table 3 demonstrates the key messages from the findings of the pharmacy educators survey.

Table 3. Key messages on educational components of AMR for the pharmaceutical workforce

| Survey theme | Key messages from pharmacy educators |
|---|--|
| A. The knowledge, skills, and attitudes for AMR awareness | <ul style="list-style-type: none"> Pharmacy educators generally believe their curriculum effectively imparts knowledge on AMR control strategies, including the causes of infections, therapy selection and prevention processes. The curriculum also promotes attitudes emphasising patient-centred care, teamwork, pharmacovigilance and staying updated. However, areas such as the relevance of pharmacogenomics and record-keeping attitudes may require further emphasis. These findings can inform curriculum development to enhance students’ awareness, skills and attitudes in combating AMR effectively. |
| B. The knowledge, skills, and attitudes for appropriate use of antimicrobial agents | <ul style="list-style-type: none"> It is evident that while pharmacy educators perceive a generally high level of knowledge imparted about the appropriate use of antimicrobial agents, there are areas that require improvement, such as pre-authorisation and review of prescriptions. The curriculum effectively equips students with counselling skills but needs enhancement in skills for investigating adverse events and developing AMR management plans. Educators recognise the importance of communication and continuous improvement but should foster enthusiasm for quality improvement programmes. Emphasising prescription scrutiny and promoting AMS principles are crucial. These insights guide curriculum improvements to enhance students’ knowledge, skills and attitudes for combating AMR effectively. |
| C. The knowledge, skills, and attitudes for infection prevention and control | <ul style="list-style-type: none"> The curriculum is effective in imparting knowledge on educating patients about antimicrobial use and healthcare-associated infections. However, there is a need for improvement in understanding contamination risks during manufacturing and the importance of monitoring and surveillance systems. The curriculum equips students with skills related to vaccine knowledge, but there is a need to enhance skills in referring cases of antimicrobial contamination and monitoring good practices in the pharmacy. While hand hygiene practices are emphasised, attitudes related to self-declaration and abstaining from medication preparation when experiencing certain health conditions require further emphasis. |
| D. The knowledge, skills, and attitudes for diagnostic stewardship and surveillance | <ul style="list-style-type: none"> There is a need for curriculum improvement in several areas of diagnostic stewardship and surveillance, such as enhancing knowledge on topics like antimicrobial consumption data and molecular/genetic/genomic tests, strengthening skills related to data analysis and reporting, and fostering attitudes of teamwork, record-keeping and responsibility. By addressing these areas, pharmacy educators can equip students with a comprehensive understanding of diagnostic stewardship and surveillance, empowering them to actively engage in efforts to improve antimicrobial use and patient care. |
| E. The knowledge, skills, and attitudes for ethics, leadership, communication, and governance | <ul style="list-style-type: none"> There are areas of improvement in the pharmacy curriculum with regard to enhancing knowledge on reporting substandard products, leadership and governance, and effective communication. |

- There is a need to foster ethical decision-making and leadership to best equip pharmacy students for ethical practice, effective communication, and sound governance in the prevention and control of AMR.

Among the 43 pharmacy educators, more than three-quarters of them (78%) were working in the field of clinical pharmacy and pharmacy practice. More than half of them had a PhD degree (65%). More than a quarter of the educators were from Europe (28%) (Table 4).

Table 4. Characteristics of pharmacy educators' respondents (n=43)

| Variable | Frequency, n (%) |
|---|------------------|
| Years of involvement in pharmacy education | |
| Less than 5 years | 4 (10) |
| 5–10 years | 13 (30) |
| 10–15 years | 10 (23) |
| Greater than 15 years | 16 (37) |
| Area of practice (*Select all that applies question) | |
| Pharmaceutical microbiology | 2 (4) |
| Pharmacology and toxicology | 4 (10) |
| Pharmaceutics and pharmaceutical technology | 2 (4) |
| Clinical pharmacy and pharmacy practice | 33 (78) |
| Others | 2 (4) |
| Highest qualification | |
| PharmD | 8 (19) |
| MPharm | 1 (2) |
| MSc | 4 (9) |
| PhD | 28 (65) |
| Others | 2 (5) |
| Region | |
| Africa | 9 (21) |
| Americas | 9 (21) |
| Europe | 12 (28) |
| Eastern Mediterranean | 1 (2) |
| South-East Asia | 7 (16) |
| Western Pacific | 5 (12) |

A. Knowledge, skills, and attitudes for AMR awareness

A1. Knowledge of foundations that build knowledge and awareness of AMR

Figure 2 describes the extent to which pharmacy educators think their curriculum imparts knowledge on awareness of AMR control strategies.

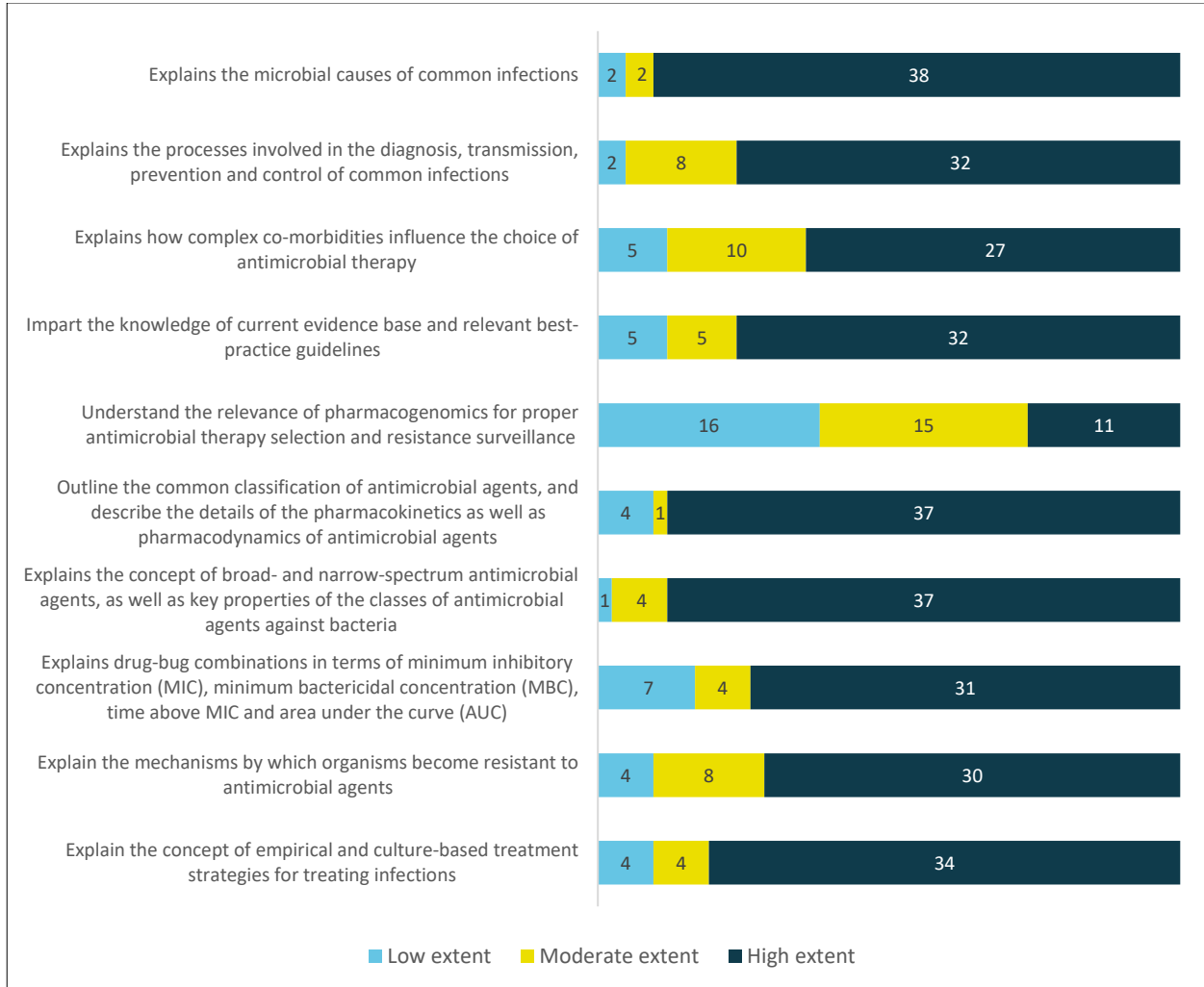


Figure 2. The extent to which pharmacy educators think their curriculum imparts knowledge on awareness of AMR control strategies (n=42).

The findings suggest that pharmacy educators perceive their curriculum to be effective in imparting knowledge on various aspects of AMR control strategies. The curriculum is seen as particularly strong in explaining the microbial causes of common infections (90%, n=38), the processes involved in infection diagnosis, transmission, prevention, and control of common infection (76%, n=32), the choice of antimicrobial therapy based on co-morbidities, and current evidence-based guidelines (76%, n=32), classification of antimicrobials, details of pharmacokinetics and pharmacodynamics (88%, n=37), concept of broad- and narrow-spectrum antibiotics (88%, n=37), and concept of empirical and culture-based treatment strategies (80%, n=34). However, there may be room for improvement in areas such as the relevance of pharmacogenomics (38%, n=16), which educators feel is addressed to a lower extent. These insights can help identify areas for further curriculum development to enhance student awareness and understanding of AMR control strategies.

A2. Skills for foundations that build knowledge and awareness of AMR

Figure 3 describes the extent to which pharmacy educators think their curriculum equips students with the skills to improve awareness of AMR. During the survey, respondents were posed with a preliminary query asking whether their curriculum equips students with the skills to improve awareness of AMR.

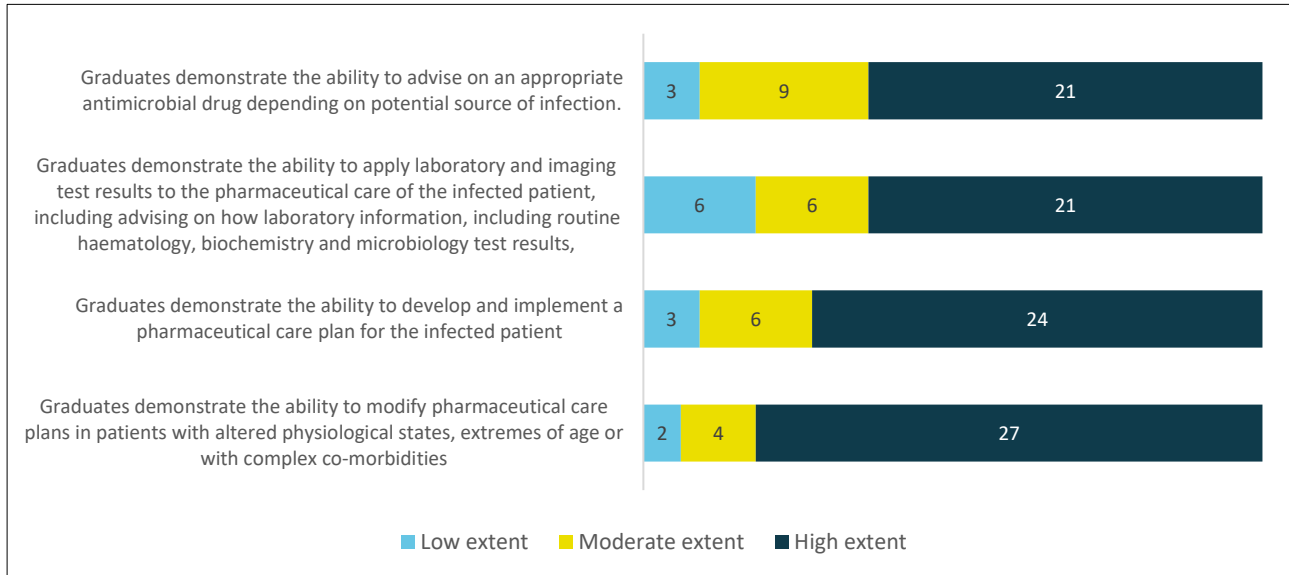


Figure 3. The extent to which pharmacy educators think their curriculum equips students with the skills to improve awareness of AMR (n=33).

The findings suggest that pharmacy educators perceive their curriculum to be effective in equipping students with the skills to improve awareness of AMR. The curriculum is seen as successful in preparing students to advise on appropriate antimicrobial drugs based on the source of infection (64%, n=21), apply laboratory and imaging test results in pharmaceutical care (64%, n=21), develop and implement pharmaceutical care plans (73%, n=24), and modify plans for patients with specific conditions (82%, n=27). These insights indicate that the curriculum adequately addresses the skills required to combat AMR and prepare future pharmacists for their role in managing infections and antimicrobial therapy.

A3. Attitude for foundations that build knowledge and awareness of AMR

Figure 4 describes the extent to which pharmacy educators think their curriculum promotes attitudes that improve awareness of AMR. During the survey, participants were presented with a preliminary inquiry that focused on educational content/curricula that should equip students with the attitude to improve awareness of AMR.

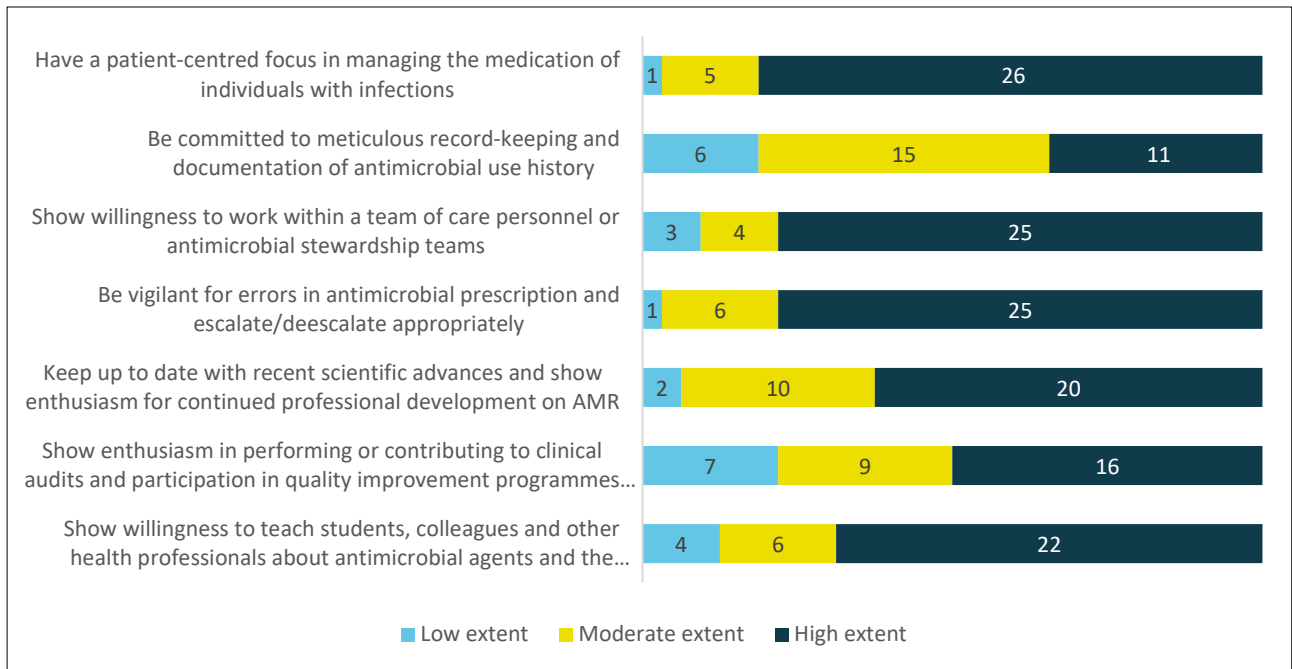


Figure 4. The extent to which pharmacy educators think their curriculum promotes attitudes that improve awareness of AMR (n=32).

The findings indicate that pharmacy educators believe their curriculum effectively promotes attitudes that improve awareness of AMR. There is a strong emphasis on patient-centred care in infection management (81%, n=26) and working in AMS or care teams (78%, n=21); however, areas for improvement include record-keeping and documentation of antimicrobial use history (19%, n=6), and performing or contributing to clinical audits and participation in quality improvement programmes relating to rational antimicrobial use (22%, n=7).

B. Knowledge, skills, and attitudes for appropriate use of antimicrobial agents

B1. Knowledge of appropriate use of antimicrobial agents

Figure 5 describes the extent to which pharmacy educators think their curriculum imparts knowledge for the appropriate use of antimicrobials.

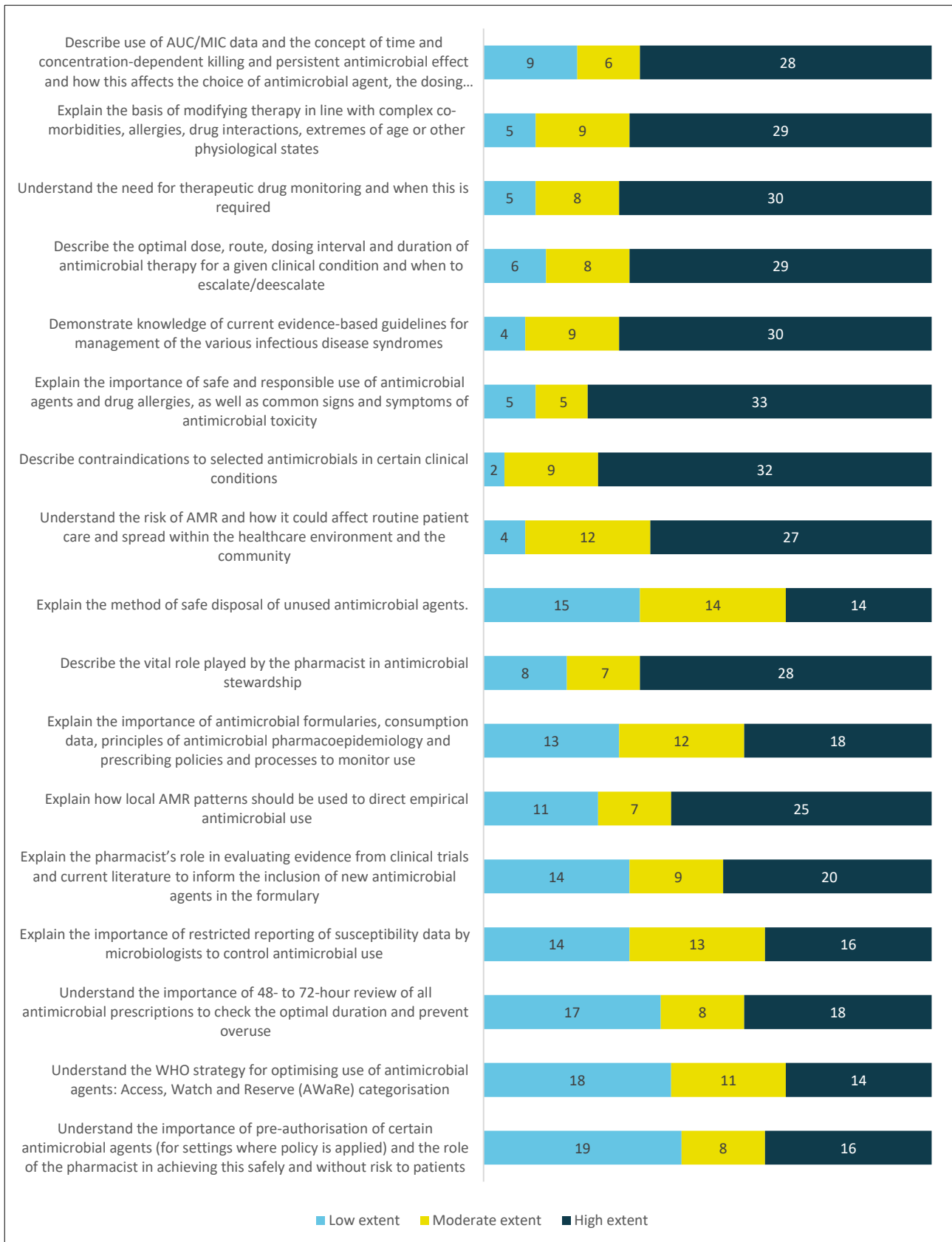


Figure 5. The extent to which pharmacy educators think their curriculum imparts knowledge for the appropriate use of antimicrobials (n=43).

The findings indicate that not many pharmacy educators believe their curriculum imparts knowledge for the topics related to the appropriate use of antimicrobials, and thus there are areas where improvement is needed. There is a strong emphasis on the curriculum that imparts knowledge on the safe use of antimicrobials, drug allergies and common

signs and symptoms of antimicrobial toxicity (77%, n=33). Potential gaps in the curriculum include emphasising the importance of pre-authorisation of certain antimicrobials and the role of pharmacists in achieving this safely and without risk to patients (44%, n=19) as well as understanding the WHO strategy to optimise antimicrobial agents (42%, n=18).

B2. Skills for appropriate use of antimicrobial agents

Figure 6 describes the extent to which pharmacy educators think their curriculum equips students with the skills for appropriate use of antimicrobials. During the survey, participants were initially presented with a preliminary query regarding whether their educational content/curricula should equip students with the skills to implement change about the appropriate use of antimicrobials.

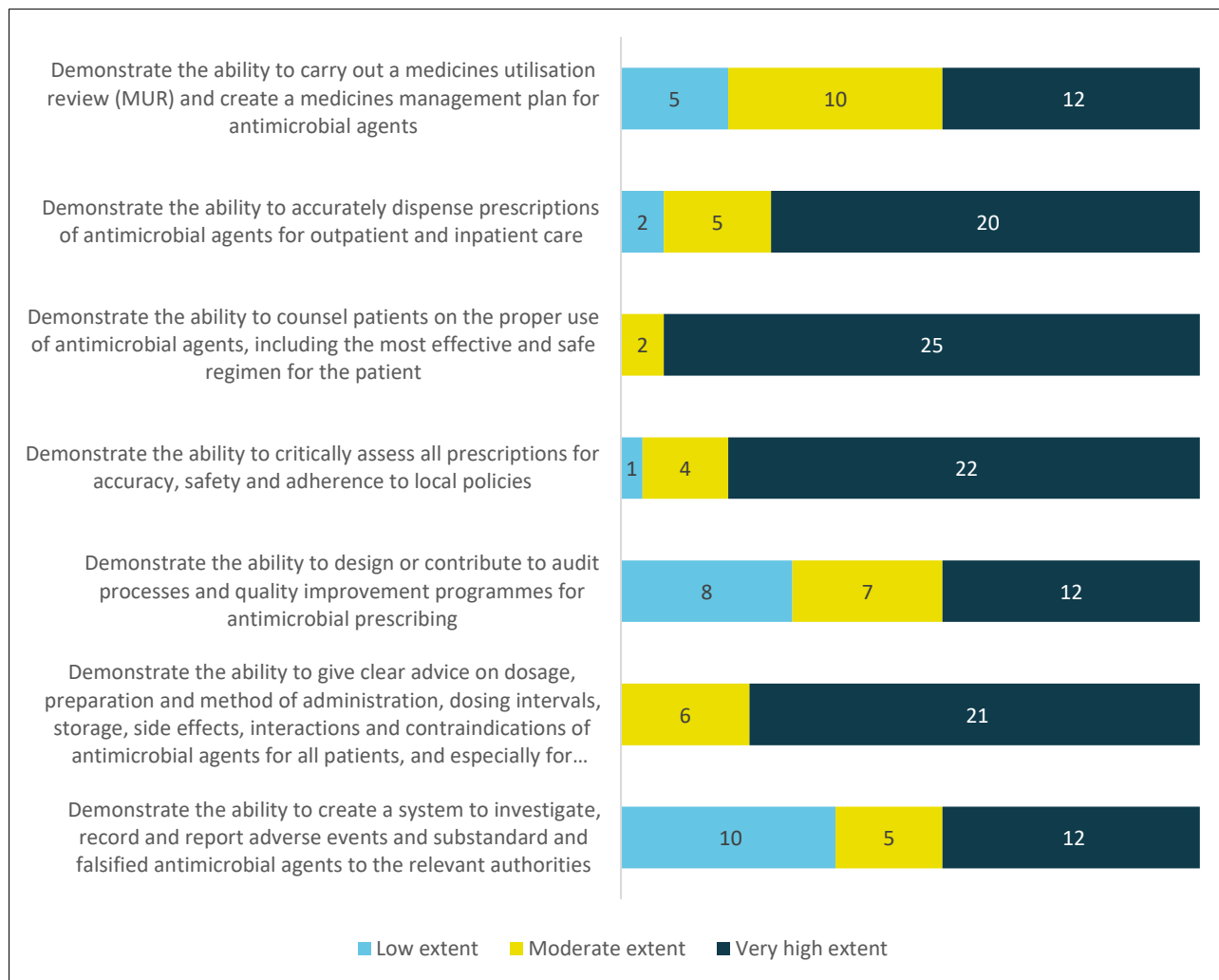


Figure 6. The extent to which pharmacy educators think their curriculum equips students with the skills for appropriate use of antimicrobials (n=27).

The findings indicate that educators believe that their curriculum equips students with the ability to counsel patients on the proper use of antimicrobials (93%, n=25), to critically assess all prescriptions for accuracy, safety and adherence to local policies (81%, n=22) and to give clear advice on dosage, administration, dose interval, storage, side effects, interactions and contraindications of antimicrobials for patients (78%, n=21). However, areas for improvement of the curriculum to equip students with skills for appropriate antimicrobial use include the ability to create a system to investigate, record and report adverse events and substandard and falsified antimicrobials to relevant authorities (37%, n=10).

B3. Attitude for appropriate use of antimicrobial agents

Figure 7 describes the extent to which the curriculum teaches attitudes that promote the appropriate use of antimicrobials.

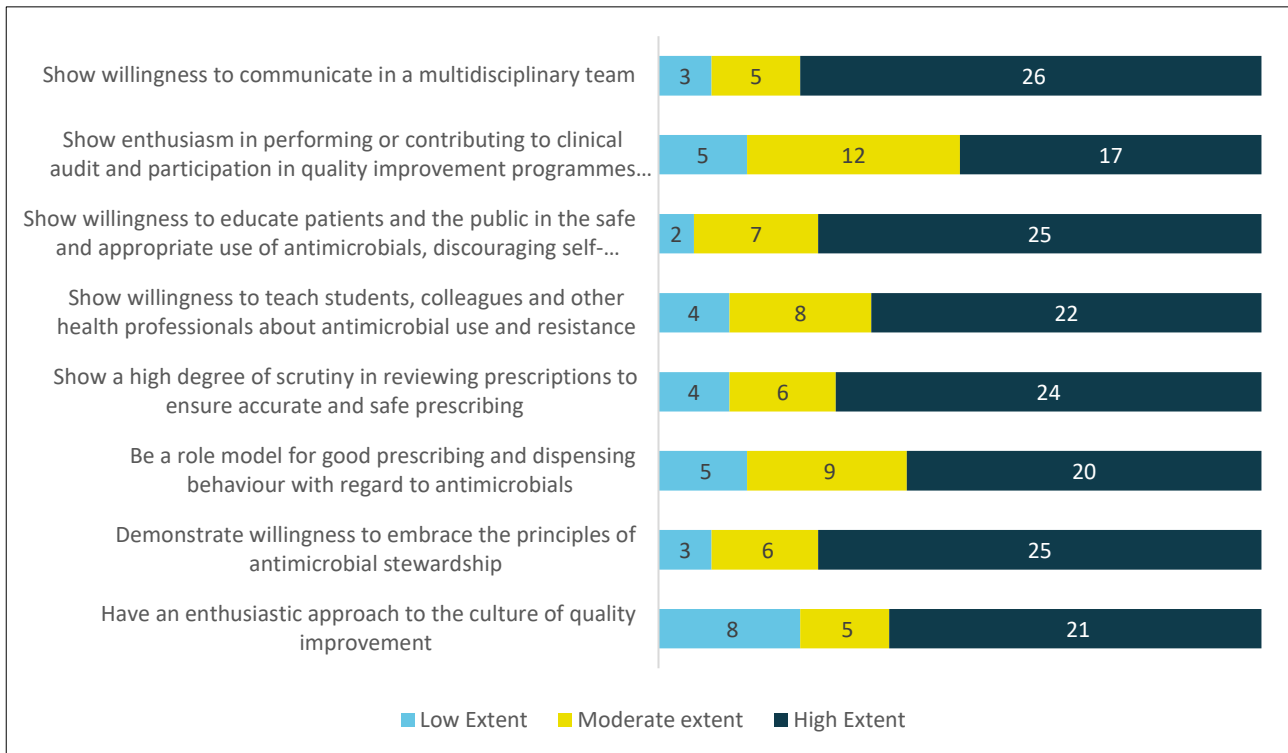


Figure 7. The extent of the curriculum teaches attitudes that promote the appropriate use of antimicrobials (n=34).

The findings indicate on the one hand that there is a willingness to communicate in a multidisciplinary team (76%, n=26). On the other hand, there is a low extent of willingness to perform or contribute to clinical audit and quality improvement programmes (15%, n=5) and an enthusiastic approach to the culture of quality improvement (24%, n=24). This highlights the need for educators to emphasise the importance of these activities and provide opportunities for students to engage in such initiatives. According to the results, information about audits seems always to be low and shows the potential gap in the overall themes.

C. Knowledge, skills and attitudes for infection prevention and control

C1. Knowledge of infection prevention and control

Figure 8 describes the extent to which the curriculum imparts knowledge for infection prevention and control. During the survey, respondents were posed a preliminary question regarding whether their curriculum was equipped with knowledge to understand the broad principles of infection prevention and control, including the importance of water, sanitation and hygiene in healthcare facilities to control and reduce the spread of AMR.

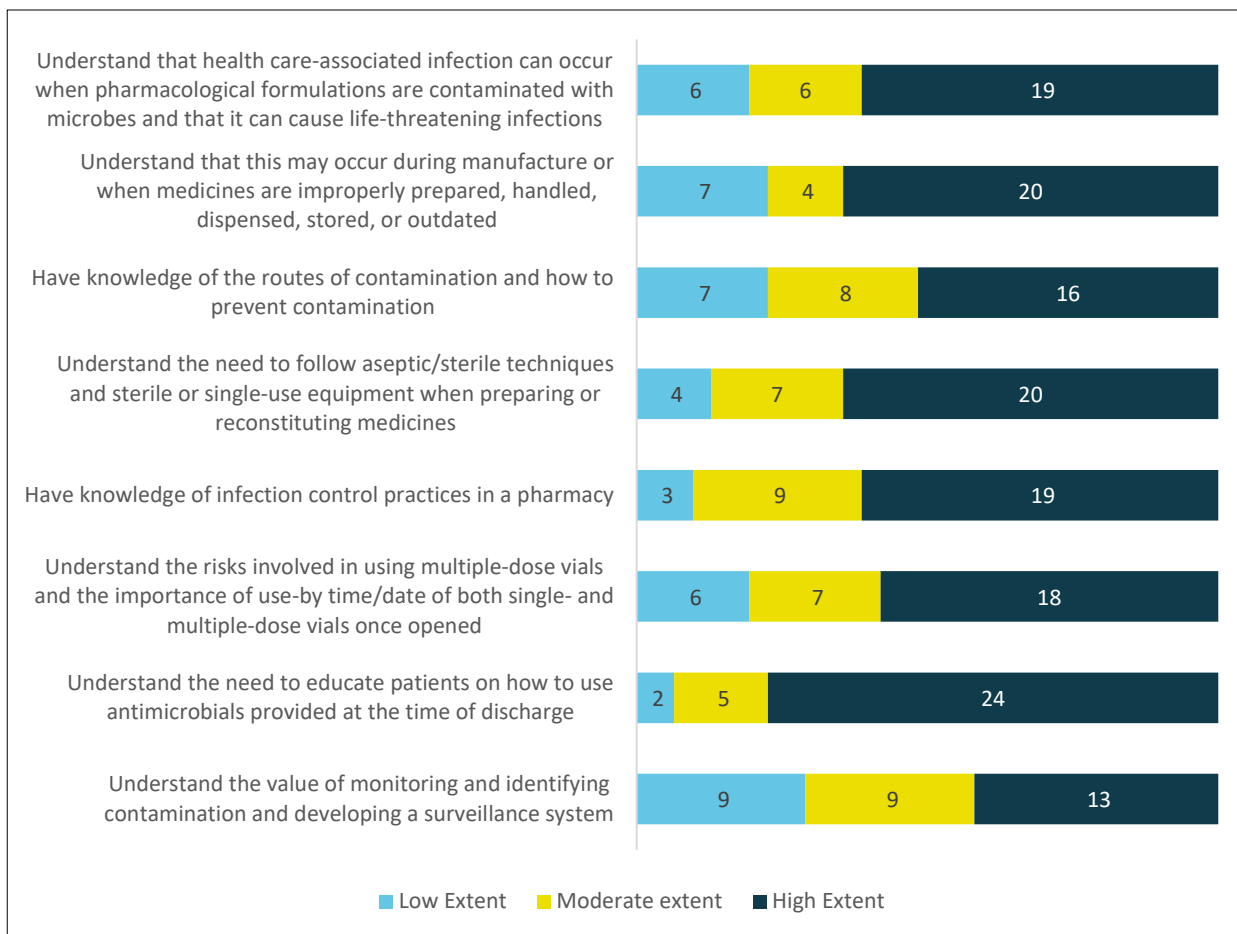


Figure 8. The extent to which the curriculum imparts knowledge for infection prevention and control (n=31).

The findings indicate that pharmacy educators believe their curriculum was seen to understand the need to educate patients on how to use antimicrobials provided at the time of discharge (77%, n=24). On the other hand, pharmacy educators reported a low extent of knowledge imparted in the context of understanding the value of monitoring and identifying contamination and developing a surveillance system (29%, n=9), routes of contamination and how to prevent contamination (23%, n=7) and understand contamination may occur during manufacture or when HCPs improperly prepared, handled, dispensed or stored medicines (23%, n=7).

C2. Skills for infection prevention and control

Figure 9 describes the extent to which the curriculum covers skills for infection prevention and control. During the survey, respondents were posed a preliminary question asking if they equipped students with the skills to implement change about infection prevention and control.

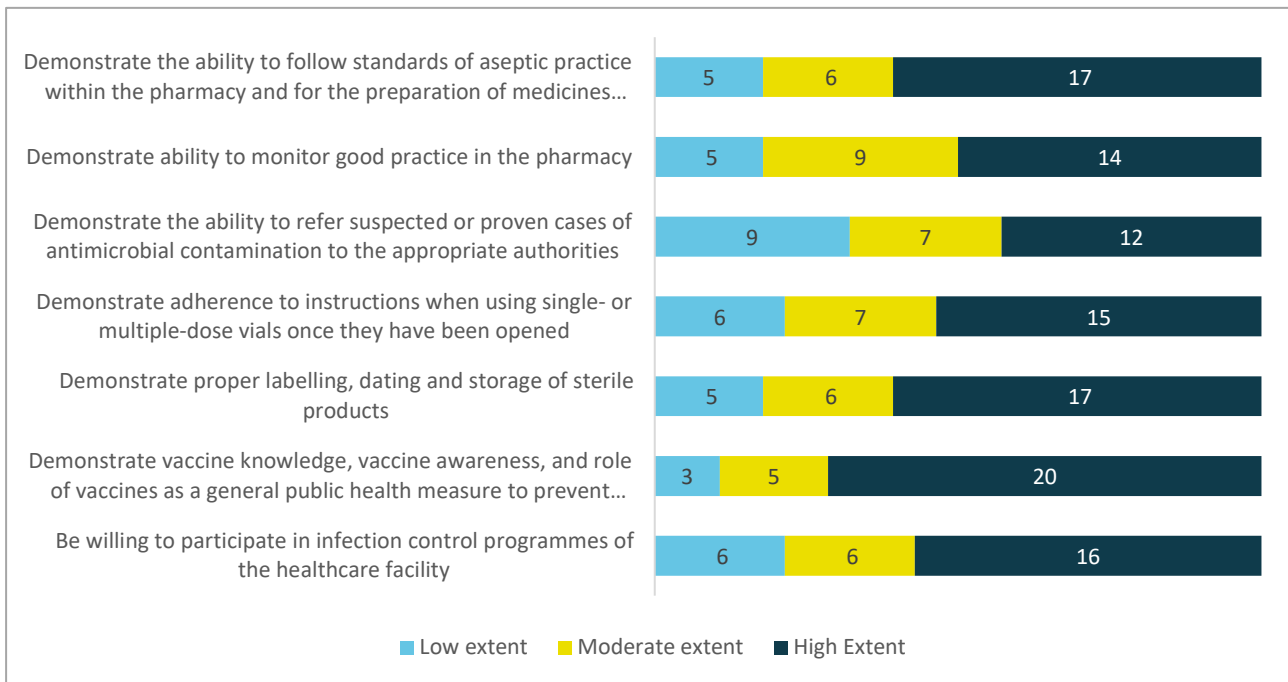


Figure 9. The extent to which the curriculum covers skills for infection prevention and control (n=28).

The findings indicate that pharmacy educators believe their curriculum covers the skills to demonstrate vaccine knowledge, awareness, and the role of vaccines as a public health measure to prevent infections (71%, n=20). However, there is room for improvement in the curriculum to demonstrate the ability to refer suspected or proven cases of antimicrobial contamination to the appropriate authorities (31%, n=9).

C3. Attitude for infection prevention and control

Figure 10 describes the extent to which the curriculum covers attitudes that promote infection prevention and control. During the survey, respondents were posed a preliminary question asking if their curriculum equipped students with the attitudes to implement change about infection prevention and control.

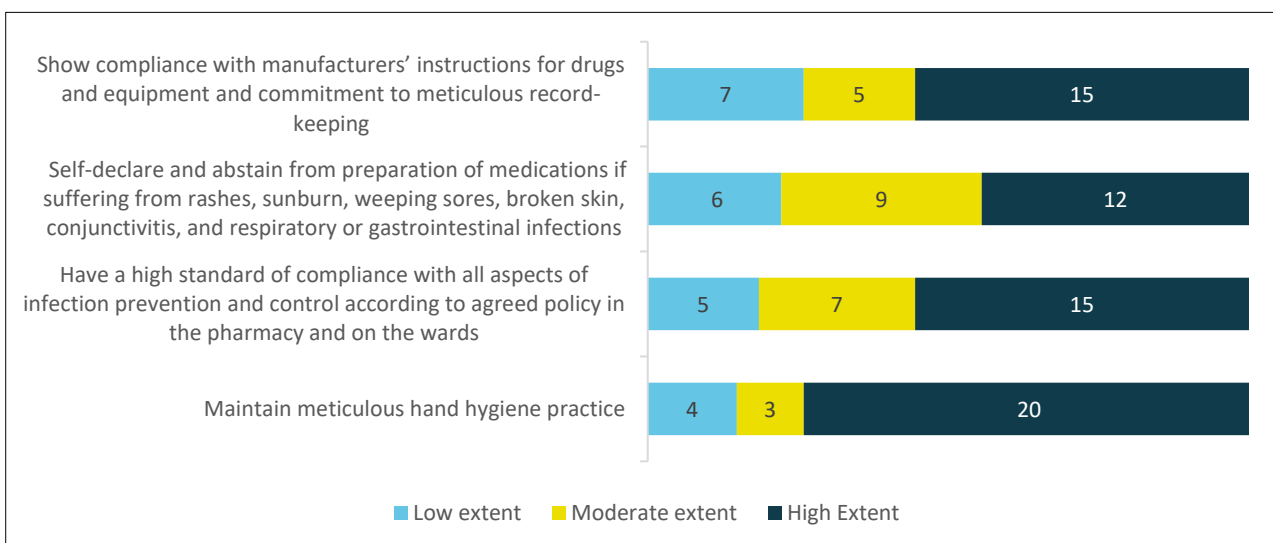


Figure 10. The extent to which the curriculum covers attitudes that promote infection prevention and control (n=27).

These findings suggest that while there is a strong emphasis on maintaining hand hygiene practices (74%, n=20), there may be room for improvement in other aspects of attitudes related to infection prevention and control, including

compliance with manufacturers’ instructions for drug and equipment and commitment to meticulous record-keeping (26%, n=7).

D. Knowledge, skills and attitudes for diagnostic stewardship and surveillance

D1. Knowledge of diagnostic stewardship and surveillance

Figure 11 describes the extent to which the curriculum provides knowledge regarding diagnostic stewardship and surveillance. During the survey, respondents were asked a preliminary question regarding whether their educational content/curriculum equipped students with the knowledge of the principles and processes of diagnostic stewardship, surveillance of AMR and AMS that underpin prophylaxis and treatment guidelines and AMR control strategies.

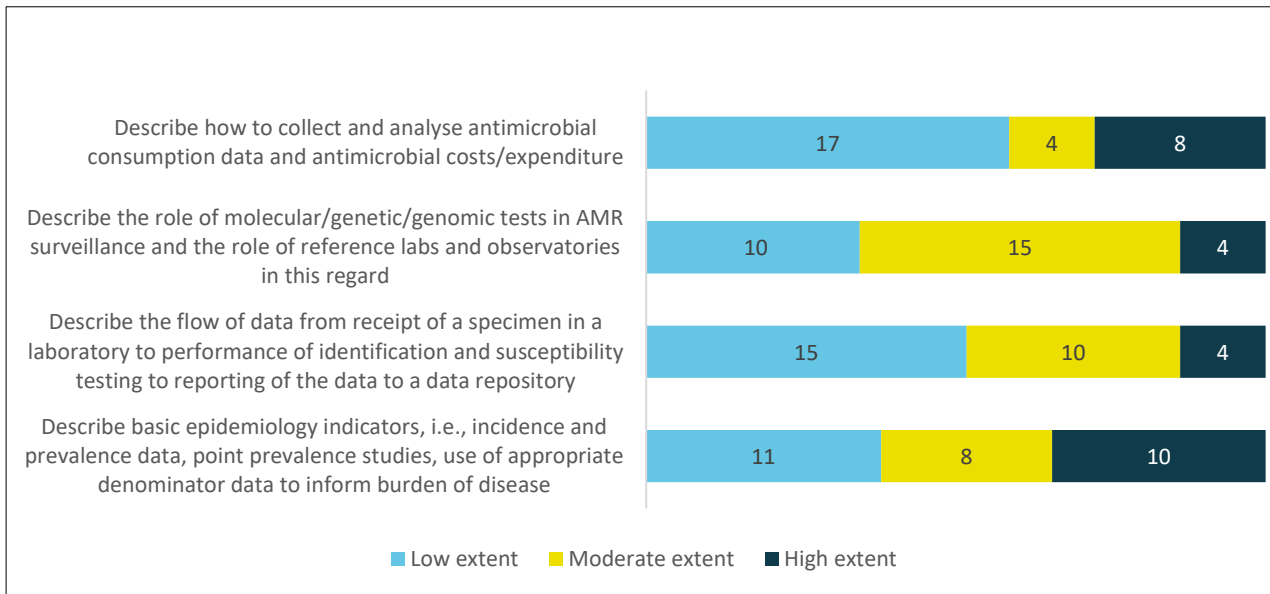


Figure 11. The extent to which the curriculum provides knowledge regarding diagnostic stewardship and surveillance (n=29).

These findings suggest that there may be room for improvement in all aspects of the knowledge regarding how to collect and analyse antimicrobial consumption data and antimicrobial costs/expenditure (59%, n=27), the role of molecular/genetic/genomic tests in AMR surveillance and the role of reference labs and observatories (34%, n=10), the flow of data from receipt of specimen in a laboratory to performance of identification and susceptibility testing (52%, n=15) and basic epidemiology indicators, i.e., incidence and prevalence data, point prevalence studies and use of appropriate denominator data (38%, n=11).

D2. Skills for diagnostic stewardship and surveillance

Figure 12 describes the extent to which the curriculum provides skills regarding diagnostic stewardship and surveillance. During the survey, respondents were asked a preliminary question regarding if their educational content/curriculum equipped students with the skills to implement change regarding diagnostic stewardship and surveillance.

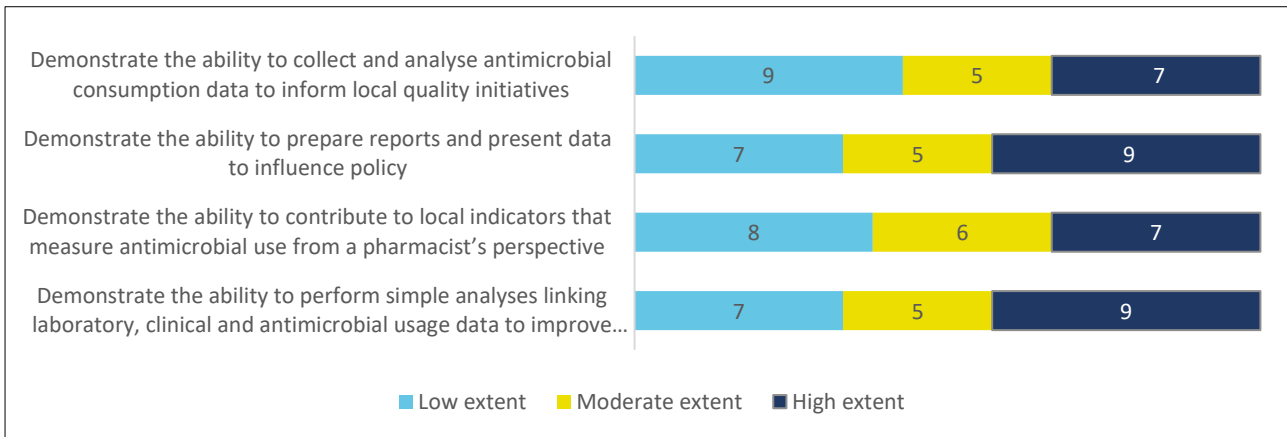


Figure 12. The extent to which the curriculum provides skills regarding diagnostic stewardship and surveillance (n=21).

These findings suggest that there may be room for improvement in all aspects of the skills regarding the ability to collect and analyse antimicrobial consumption data (43%, n=9), to prepare reports and present data (33%, n=7), to contribute to local indicators that measure antimicrobial use (38%, n=8) and to perform simple analysis linking laboratory, clinical and antimicrobial usage data (33%, n=7)

D3. Attitude for diagnostic stewardship and surveillance

Figure 13 describes the extent to which the curriculum promotes attitudes regarding diagnostic stewardship and surveillance. During the survey, respondents were asked a preliminary question regarding whether their educational content/curriculum equipped students with the attitude to implement change regarding diagnostic stewardship and surveillance.

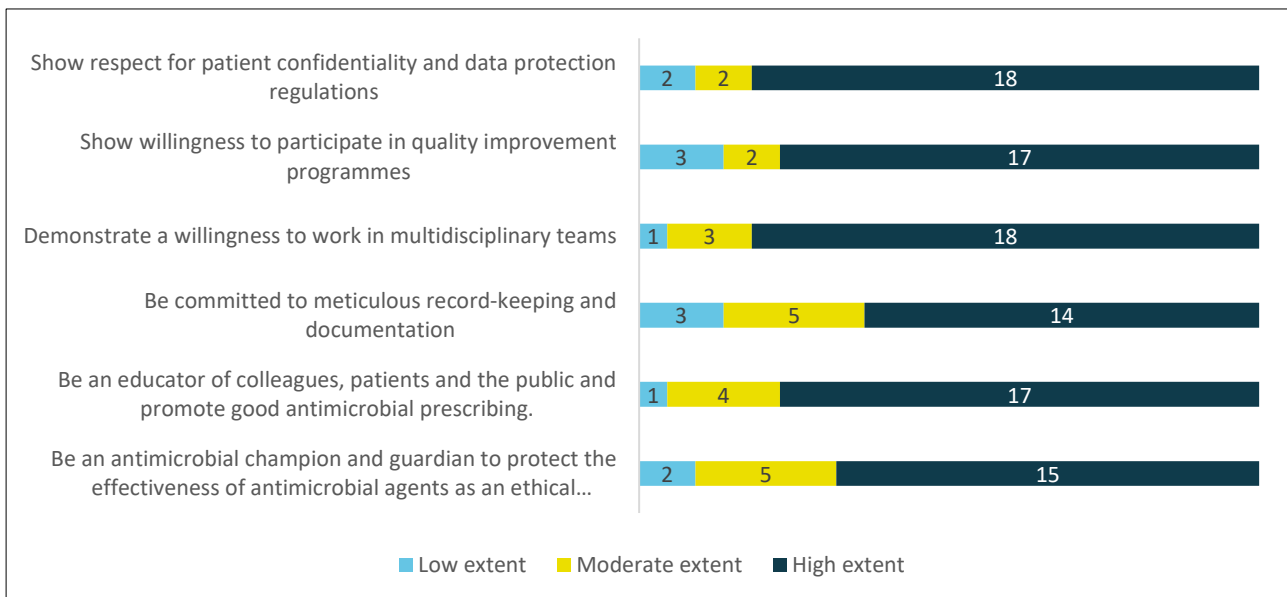


Figure 13. The extent to which the curriculum promotes attitudes regarding diagnostic stewardship and surveillance (n=22).

These findings indicate that a high percentage of pharmacy educators perceive that their curriculum promotes respect for patient confidentiality and data protection regulations (82%, n=18), participation in quality improvement programmes (77%, n=17), work in multidisciplinary teams (82%, n=18) and being an educator of colleagues, patients and the public for good antimicrobial prescribing (77%, n=17). However, there is room for improvement in being committed to meticulous record-keeping and documentation (14%, n=3).

E. Knowledge, skills and attitudes for ethics, leadership, communication and governance

E1. Knowledge of ethics, leadership, communication and governance

Figure 14 describes the extent to which the curriculum imparts knowledge regarding ethics, leadership, communication and governance for the prevention and control of AMR.

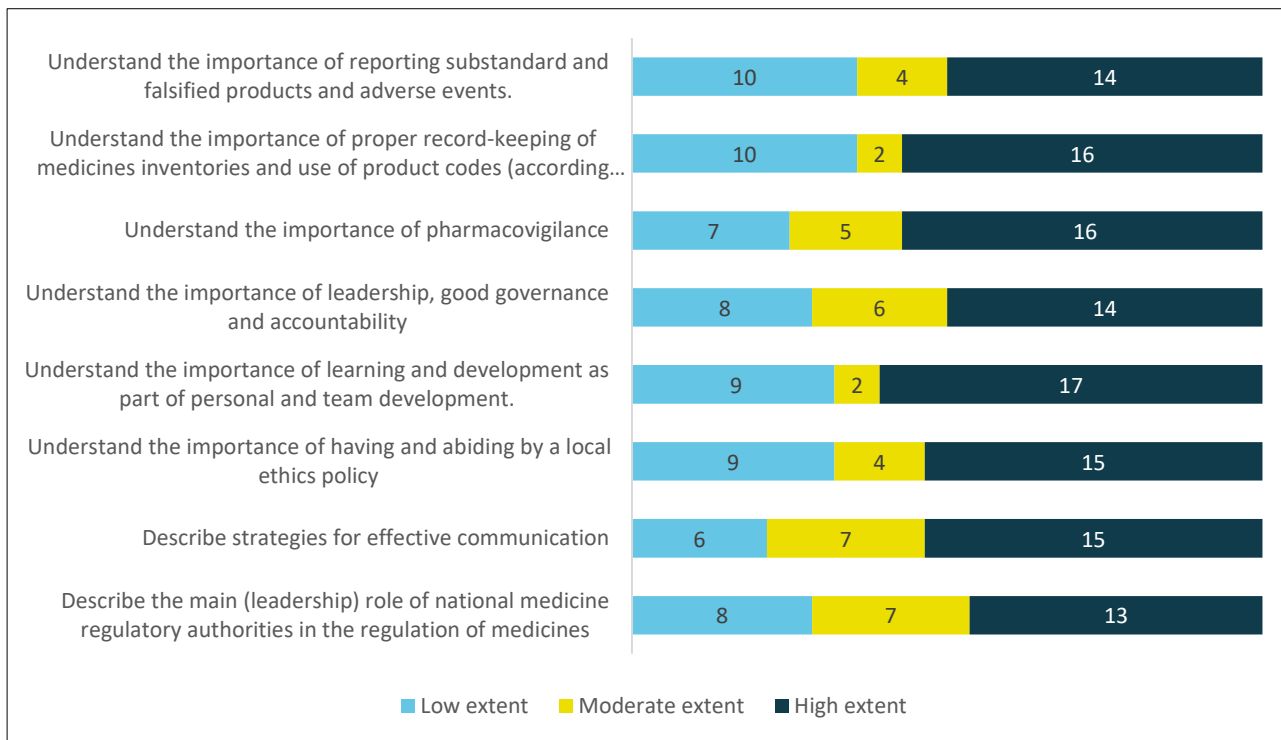


Figure 14. The extent to which the curriculum imparts knowledge regarding ethics, leadership, communication and governance for the prevention and control of AMR (n=28).

These findings indicate that there is a relatively low perception that the curriculum imparts knowledge of the importance of reporting substandard and falsified products and adverse events (36%, n=10), and proper record-keeping of AMR inventories and use of product codes for traceability (36%, n=10).

E2. Skills for ethics, leadership, communication, and governance

Figure 15 describes the extent to which the curriculum provides skills for ethics, leadership, communication and governance for the prevention and control of AMR.

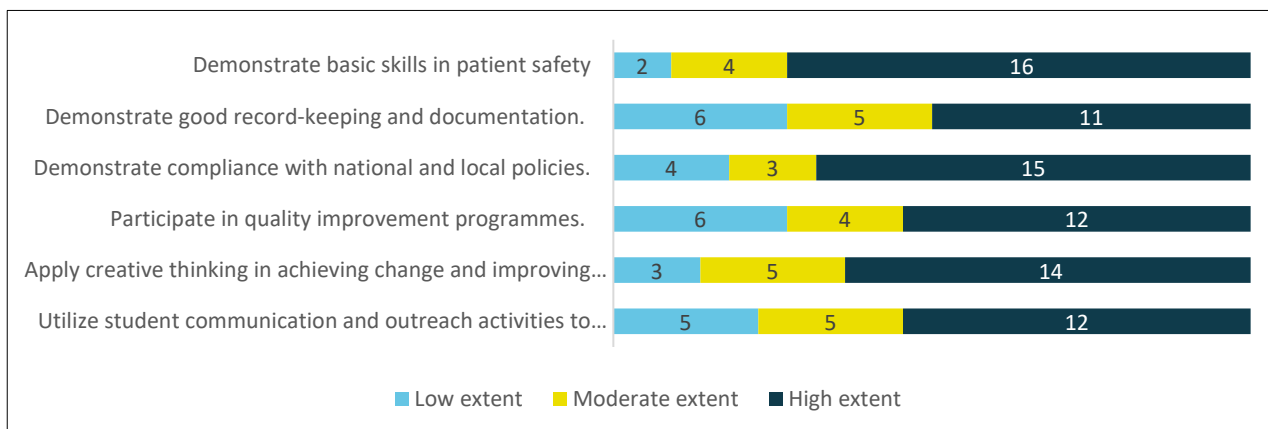


Figure 15. The extent to which the curriculum provides skills for ethics, leadership, communication and governance for the prevention and control of AMR (n=22).

The findings indicate that pharmacy educators believe their curriculum provides basic skills in patient safety (73%, n=16). However, there is room for improvement in good record-keeping and documentation (27%, n=6) and participation in quality improvement programmes (27%, n=6).

E3. Attitude for ethics, leadership, communication, and governance

Figure 16 describes the extent to which pharmacy educators think their curriculum promotes attitudes toward ethics, leadership, communication and governance for the prevention and control of AMR.

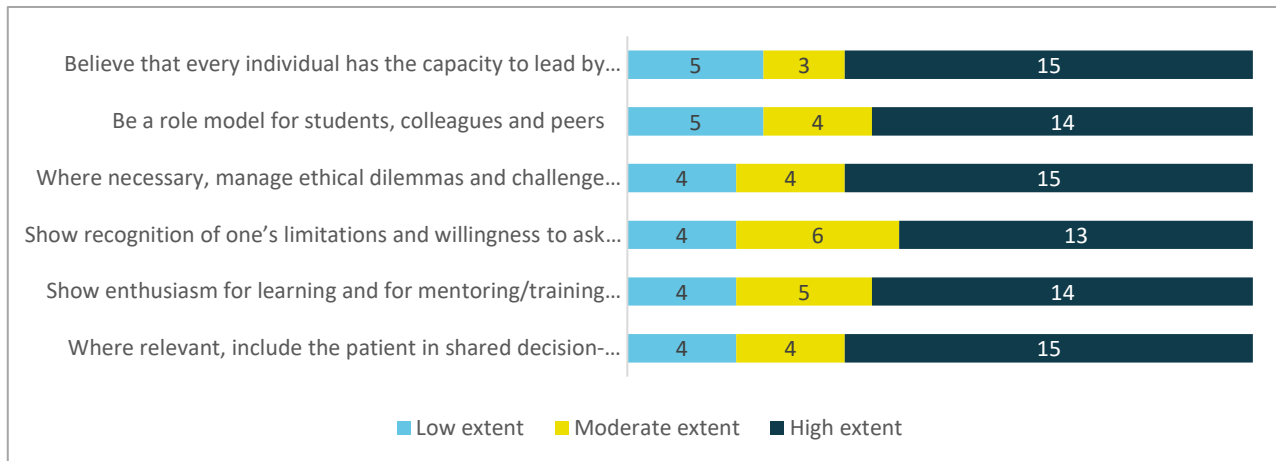


Figure 16. The extent to which pharmacy educators think their curriculum promotes attitudes toward ethics, leadership, communication and governance for the prevention and control of AMR (n=23).

These findings indicate that there is a relatively low perception that the curriculum promotes attitudes towards every individual who has the capacity to lead by example within their peer group (22%, n=5) and be a role model for students, colleagues and peers (22%, n=5).

F. Opinions section

Pharmacy educators were asked to provide their opinion on innovation in AMR education and training, which includes the following:

- Pharmacy schools conducting awareness programmes and sharing short servicing messages on AMR to HCPs and the public;
- Pharmacy schools including lectures on the use of new anti-infective agents and guidelines for immunocompromised patients in various courses;
- Pharmacy schools incorporating training, workshops and CPD programmes focused on AMS;
- Pharmacy schools collaborating with external organisations, such as their national agency for AMR and health products, for training initiatives within their national AMR plan; and
- Pharmacy schools offering elective courses that cover various aspects of skill development related to AMR, such as antibiotic allergy management, stewardship in different settings, and point-of-care testing.

These demonstrate a range of approaches taken by pharmacy educators to enhance AMR education and training. Collaborative efforts with external organisations, integration of AMR topics into existing courses, and the inclusion of dedicated sessions or elective courses focusing on specific aspects of stewardship and skills development highlight a comprehensive approach to addressing AMR. It is important to continue exploring and implementing innovative strategies to effectively educate pharmacy students and HCPs on AMR prevention and control.

The additional thoughts provided by the respondents with regard to the AMR education that future studies can cover included:

- There is a need to explore the role of pharmacy professional organisations in supporting continuous professional development for pharmacists in AMR education. Additionally, consider the implementation of national governance structures to facilitate educational programmes on AMR and AMS.
- There is a need to recognise the role of pharmacists in the pharmaceutical industry and the importance of sustainability. The use of tools like metagenomics to map microbial diversity is highlighted as an area of interest.
- There is a need to define how skills and attitudes related to AMR are assessed in students throughout the curriculum.
- There is a need to understand whether repeated education is provided or if all the necessary knowledge is covered in a single course, which can provide insights into the effectiveness and continuity of the educational approach.
- There is a need to understand the role of experiential learning in the knowledge, skill and attitude relating to AMR, noting that within their curricula, students undergo placements, with some experiencing both community and hospital pharmacy settings. The perception is that students who have exposure to hospital pharmacy settings may be more equipped with knowledge regarding the different issues surrounding AMR.

These shed light on several important considerations for AMR education in the pharmaceutical workforce, including the role of professional organisations, curriculum development at the institutional level, industry involvement, assessment methods, and the impact of experiential learning in different practice settings. These thoughts highlight potential avenues for future research and the need for comprehensive and well-rounded approaches to AMR education in pharmacy curricula

3.3 The relevance of the AMR educational component for pharmacy practice from practitioners' perspectives

Table 5 demonstrates the key messages from the findings of the practitioner' survey.

Table 5. Key messages from pharmacy practitioners' perspectives

| Survey theme | Key message from pharmacy practitioners |
|---|--|
| A. The knowledge, skills, and attitudes for AMR awareness | <ul style="list-style-type: none"> Pharmacy practitioners acknowledge the significance of comprehending both broad- and narrow-spectrum antimicrobials, along with the essential properties of antimicrobial classes. However, their recognition of the role of pharmacogenomics in antimicrobial therapy selection and resistance is currently lacking. There exists a notable gap in awareness among practitioners regarding drug-bug combinations. This presents an opportunity for education, particularly in the realms of pharmacogenomics and the optimisation of antimicrobial treatments. The survey underscores the necessity of honing skills to effectively manage intricate medical conditions within the context of AMR. Pharmacy practitioners express the value of imparting knowledge about antimicrobials and AMR to both students and colleagues. Nevertheless, the perceived importance of integrating clinical audits and quality improvement initiatives for the purpose of rational antimicrobial utilisation is limited. While pharmacy practitioners acknowledge the value of tracking antimicrobial use history, the commitment to maintaining detailed records of such history remains low. |
| B. The knowledge, skills, and attitudes for appropriate use of antimicrobial agents | <ul style="list-style-type: none"> Pharmacy practitioners acknowledge the significance of understanding the implications of AMR on patient care and community health. However, there is limited appreciation for the practical benefits of grasping the WHO's strategies for optimising antimicrobial use. The importance of sharing susceptibility data for control and grasping concepts like area under the curve/minimum inhibitory concentration (AUC/MIC) data and time/concentration aspects in pharmacy practice is not fully recognised by practitioners. There exists a lower level of awareness regarding these technical aspects. Pharmacy practitioners value the acquisition of skills that enable them to effectively guide patients on appropriate antimicrobial usage. They emphasise the necessity for precise guidance on dosages, preparations, and the accurate dispensing of prescriptions for both outpatient and inpatient settings. There is a limited perception of the benefits of medication utilisation review and management plans among pharmacy practitioners. The potential advantages of these strategies in improving patient outcomes are not widely acknowledged. Pharmacy practitioners express a willingness to educate patients about responsible antimicrobial use, discourage self-prescription and over-the-counter purchases, and contribute to educating students and colleagues about AMR. However, there is reduced enthusiasm for engaging in clinical audit and improvement initiatives. |
| C. The knowledge, skills, and attitudes for infection prevention and control | <ul style="list-style-type: none"> Pharmacy practitioners acknowledge the importance of patient education on antimicrobial use during discharge and possess a strong grasp of infection control practices within a pharmacy setting. However, there exists a notable gap in perceiving the value of comprehending risks associated with multiple-dose vials and adhering to use-by-time/date protocols in practical application. Pharmacy practitioners demonstrate a commitment to upholding good pharmacy practices, including proper labelling, and storage of sterile products. They also express a willingness to actively participate in healthcare facility infection control |

| | |
|---|---|
| | <p>initiatives. Nevertheless, their recognition of the utility in referring cases of antimicrobial contamination remains relatively low.</p> <ul style="list-style-type: none"> Pharmacy practitioners exhibit a positive attitude towards maintaining meticulous hand hygiene to prevent infections. However, the survey highlights a limited appreciation for the practical benefits of self-declaration and refraining from work under specific conditions to prevent the spread of infections. |
| D. The knowledge, skills, and attitudes for diagnostic stewardship and surveillance | <ul style="list-style-type: none"> Pharmacy practitioners acknowledge the limited recognition of describing molecular/genetic/genomic test roles in AMR surveillance, inadequate appreciation of the significance of comprehending data flow in laboratory processes and the usefulness of gathering and analysing antimicrobial consumption data for local quality initiatives in practice. There is little recognition of the potential of preparing and presenting data to influence policy. Pharmacy practitioners show little awareness of the value of skills in antimicrobial consumption data analysis, with limited understanding of the significance of skills in report preparation and policy influence. Pharmacy practitioners exhibit attitude towards strong consensus on upholding patient confidentiality and data protection regulations with high agreement on the willingness to collaborate in multidisciplinary teams. There is minimal recognition of the importance of dedicated record-keeping and documentation. |
| E. The knowledge, skills, and attitudes for ethics, leadership, communication, and governance | <ul style="list-style-type: none"> Pharmacy practitioners acknowledge the lack of awareness of curricula emphasising reporting substandard products and adverse events as well as proper record-keeping and traceability using product codes. Pharmacy practitioners acknowledge the existence of basic patient safety skills from the curriculum with the need for improvement in record-keeping and participation in quality improvement programmes. Pharmacy practitioners feel the curriculum encourages leading by example in peer groups and few believe in the curriculum’s promotion of being a role model for students and colleagues. |

Table 6. Characteristics of pharmacy practitioners’ respondents (n=123)

| Variable | Frequency, n (%) |
|---|------------------|
| Years of involvement in pharmacy education | |
| Less than 5 years | 26 (22) |
| 5–10 years | 21 (17) |
| 10–15 years | 19 (15) |
| Greater than 15 years | 57 (46) |
| Area of practice (*Select all that applies question) | |
| Community pharmacy | 49 (34) |
| Hospital pharmacy | 59 (41) |
| Industrial Pharmacy | 6 (4) |
| Medical representative | 7 (5) |
| Military and emergency pharmacy | 2 (1) |
| Regulatory pharmacy | 12 (8) |
| Social and administrative pharmacy | 10 (7) |
| Highest qualification | |
| BPharm | 43 (35) |
| Pharm D | 16 (13) |
| MPharm | 16 (13) |
| MSc | 27 (22) |

| Variable | Frequency, n (%) |
|-----------------------|------------------|
| PhD | 9 (7) |
| Others | 12 (10) |
| Region | |
| Africa | 42 (34) |
| Americas | 7 (6) |
| Europe | 29 (24) |
| Eastern Mediterranean | 20 (16) |
| South-East Asia | 12 (10) |
| Western Pacific | 13 (11) |

A. Knowledge, skills and attitudes for AMR awareness

A1. Knowledge for AMR awareness

Figure 17 describes the extent to which the statements are useful to pharmacy practitioners with regard to having knowledge on awareness of AMR.

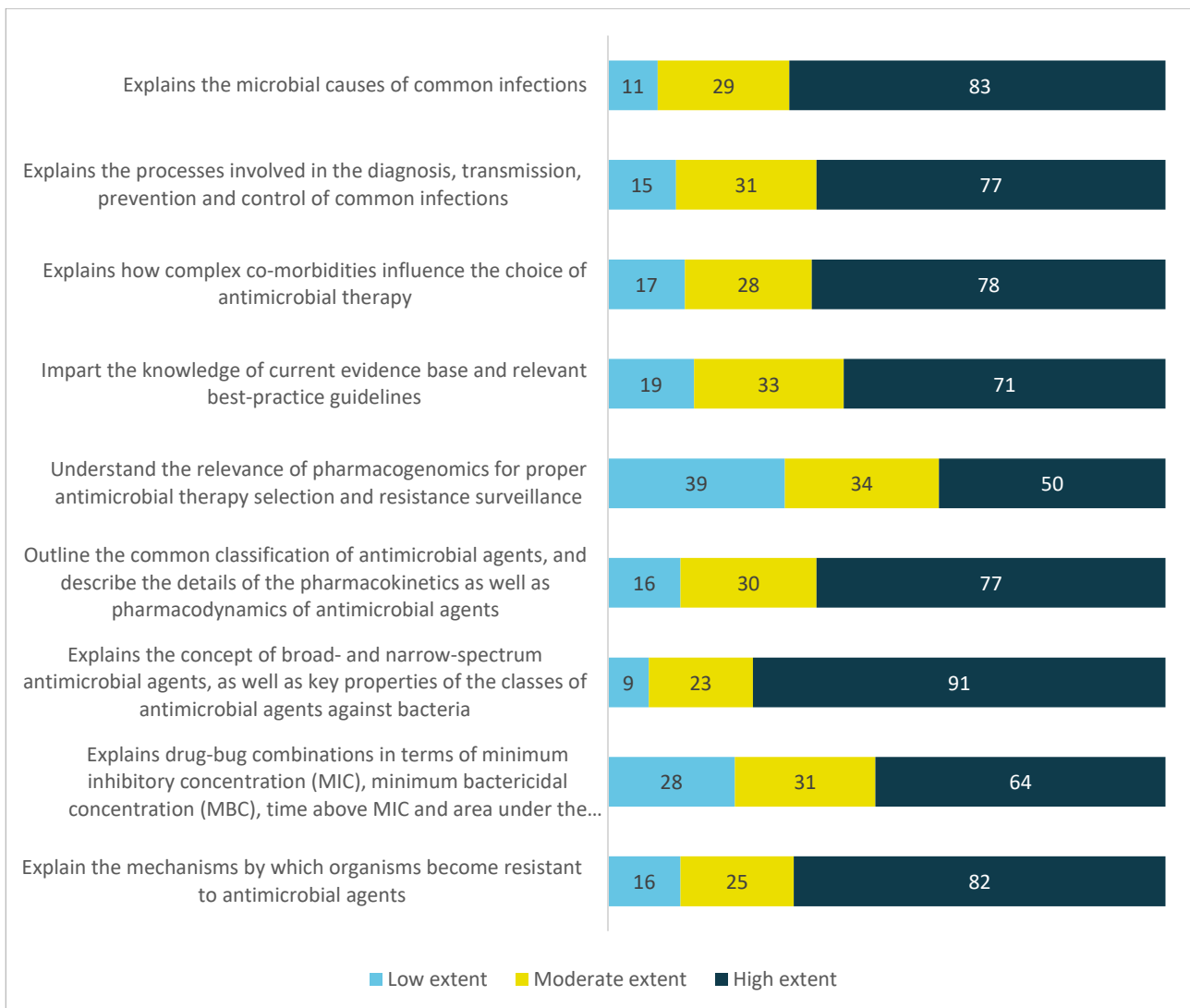


Figure 17. The extent to which the statements are useful to pharmacy practitioners with regard to having knowledge on awareness of AMR (n=123).

The findings indicate that practitioners believe that it is usefulness in understanding the concept of broad- and narrow-spectrum antimicrobials, and key properties of the classes of antimicrobials against bacteria (74%, n=91). However, they have low perception about the usefulness of the relevance of pharmacogenomics for proper antimicrobial therapy selection and resistance (32%, n=39) and drug-bug combinations in terms of minimum inhibitory concentration (MIC), minimum bactericidal concentration (MBC), time above MIC and area under the curve (23%, n=28). This indicates a potential area for improvement in educating pharmacy practitioners on the role of pharmacogenomics in optimising antimicrobial therapy and surveillance of resistance.

A2. Skills for AMR awareness

Figure 18 describes to what extent the statements are useful to practice with regard to having skills for raising awareness of AMR. During the survey, respondents were asked a preliminary question on whether their university or continuing education equipped pharmacy practitioners with the skills to implement change in awareness of AMR according to role and level of training.

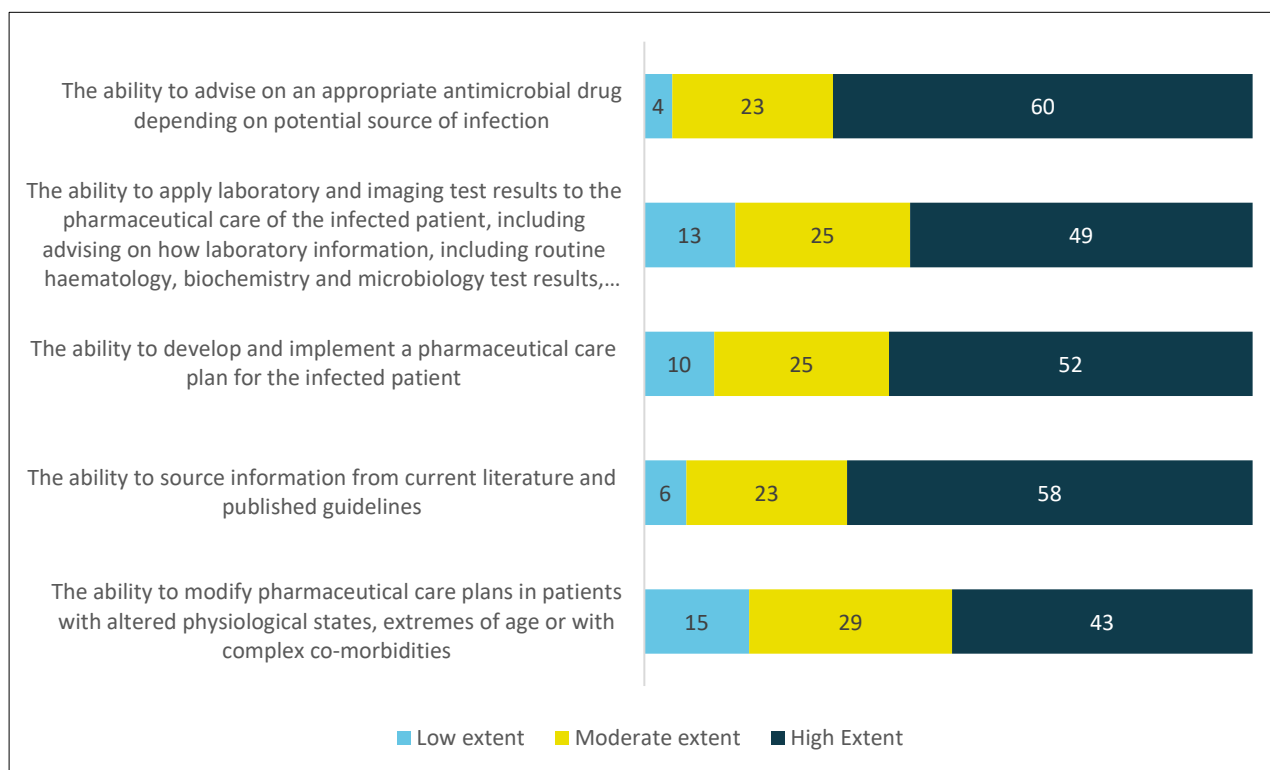


Figure 18. The extent to which the statements are useful to practice with regard to having skills for raising awareness of AMR (n=87).

The findings indicate that the ability to modify pharmaceutical care plans in patients with altered physiological states, extremes of age, or complex co-morbidities is the lowest perceived usefulness (17%, n=15) among the pharmacy practitioners. This highlights a potential area for improvement in addressing the specific needs of patients with complex medical conditions in the context of AMR awareness.

A3. Attitude towards AMR awareness

Figure 19 describes to what extent the statements are useful to practice with regard to promoting attitudes towards raising awareness of AMR. During the survey, respondents were asked a preliminary question on whether their university or continuing education equipped pharmacy practitioners with the attitudes to implement change in awareness of AMR according to role and level of training.

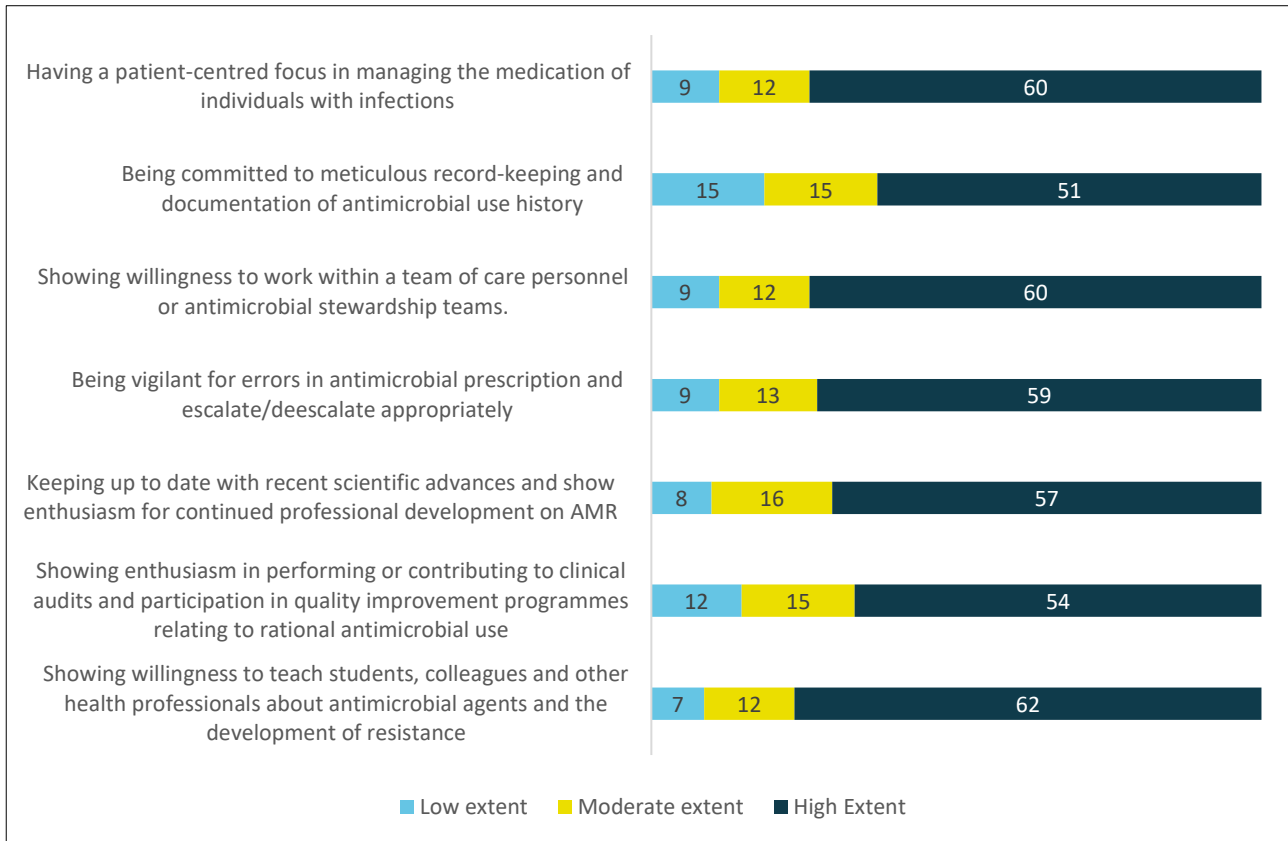


Figure 19. The extent to which the statements are useful to pharmacy practice with regard to promoting attitudes for raising awareness of AMR (n=81).

The findings indicate that pharmacy practitioners believe that showing willingness to teach students, colleagues and other healthcare professionals about antimicrobials and the development of AMR is useful in promoting attitudes for raising awareness for AMR (77%, n=62). However, there is a low perception about the usefulness of showing enthusiasm in performing or contributing to clinical audits and participation in quality improvement programmes relating to rational antimicrobial use (15%, n=12) and being committed to meticulous record-keeping and documentation of antimicrobial use history (19%, n=15).

B. Knowledge, skills, and attitudes for appropriate use of antimicrobial agents

B1. Knowledge for appropriate use of antimicrobial agents

Figure 20 describes the extent to which the statements are useful to pharmacy practice with regard to having knowledge of the appropriate use of antimicrobials.

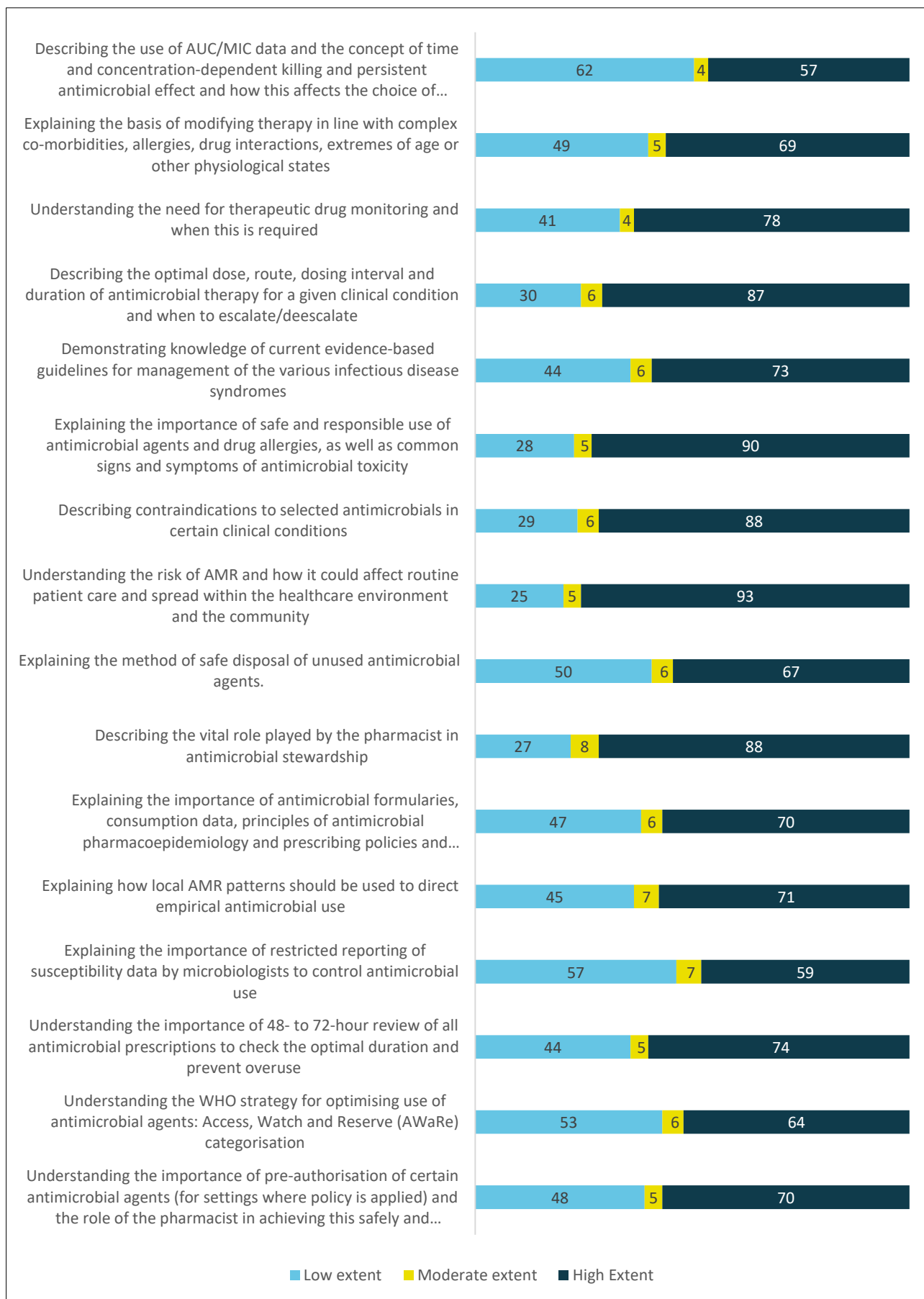


Figure 20. The extent to which the statements are useful to pharmacy practice with regard to having knowledge of the appropriate use of antimicrobials (n=123).

The findings indicate that pharmacy practitioners believe that understanding the risk of AMR and how it could affect routine patient care and spread within the healthcare environment and the community is useful knowledge regarding appropriate antimicrobial use (76%, n=93). However, there is a low perception about the usefulness of understanding the WHO strategy for optimising use of antimicrobial agents (43%, n=53), explaining the importance of reporting of susceptibility data to control antimicrobial use (46%, n=57) and describing the use of AUC/MIC data and concept of time and concentration dependent killing and persistent antimicrobial effect (50%, n=62).

B2. Skills for appropriate use of antimicrobials

Figure 21 describes the extent to which the statements are useful to pharmacy practice with regard to having skills in the appropriate use of antimicrobials. During the survey, respondents were asked a preliminary question on whether their university or continuing education equipped pharmacy practitioners with the skills to implement change in appropriate use of antimicrobials according to role and level of training.

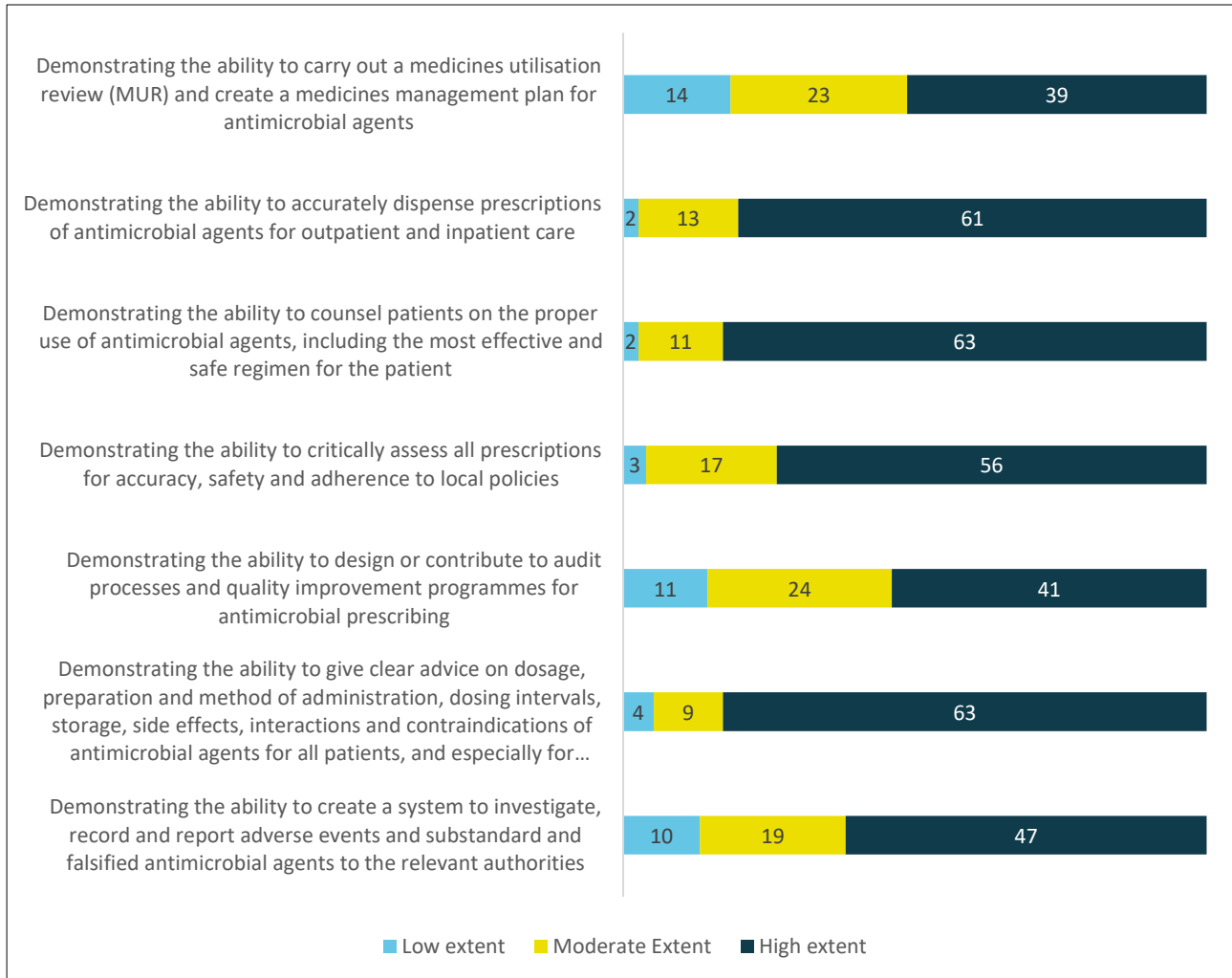


Figure 21. The extent to which the statements are useful to pharmacy practice regarding having skills in the appropriate use of antimicrobials (n=76).

The findings indicate that pharmacy practitioners believe that demonstrating the ability to counsel patients on the proper use of antimicrobial agents, including the most effective and safe regimen for the patient (83%, n=63), demonstrating the ability to give clear advice on dosage, preparation and method of administration, dosing intervals, storage, side effects, interactions and contraindications of antimicrobial agents for all patients, especially for vulnerable patients (83%, n=63) and demonstrating the ability to accurately dispense prescriptions of antimicrobials for outpatients and inpatient (80%, n=61) are useful skills for pharmacy practice. However, there is a low perception among the pharmacy practitioners about the usefulness of the ability to carry out a medicine utilisation review and create an AMR management plan for antimicrobials (18%, n=14).

B3. Attitude towards appropriate use of antimicrobial agents

Figure 22 describes the extent to which the statements are useful to pharmacy practice with regard to having the correct attitude towards the appropriate use of antimicrobials. During the survey, respondents were asked a preliminary question on whether their university or continuing education equipped pharmacy practitioners with the attitudes to implement change in appropriate use of antimicrobials according to role and level of training.

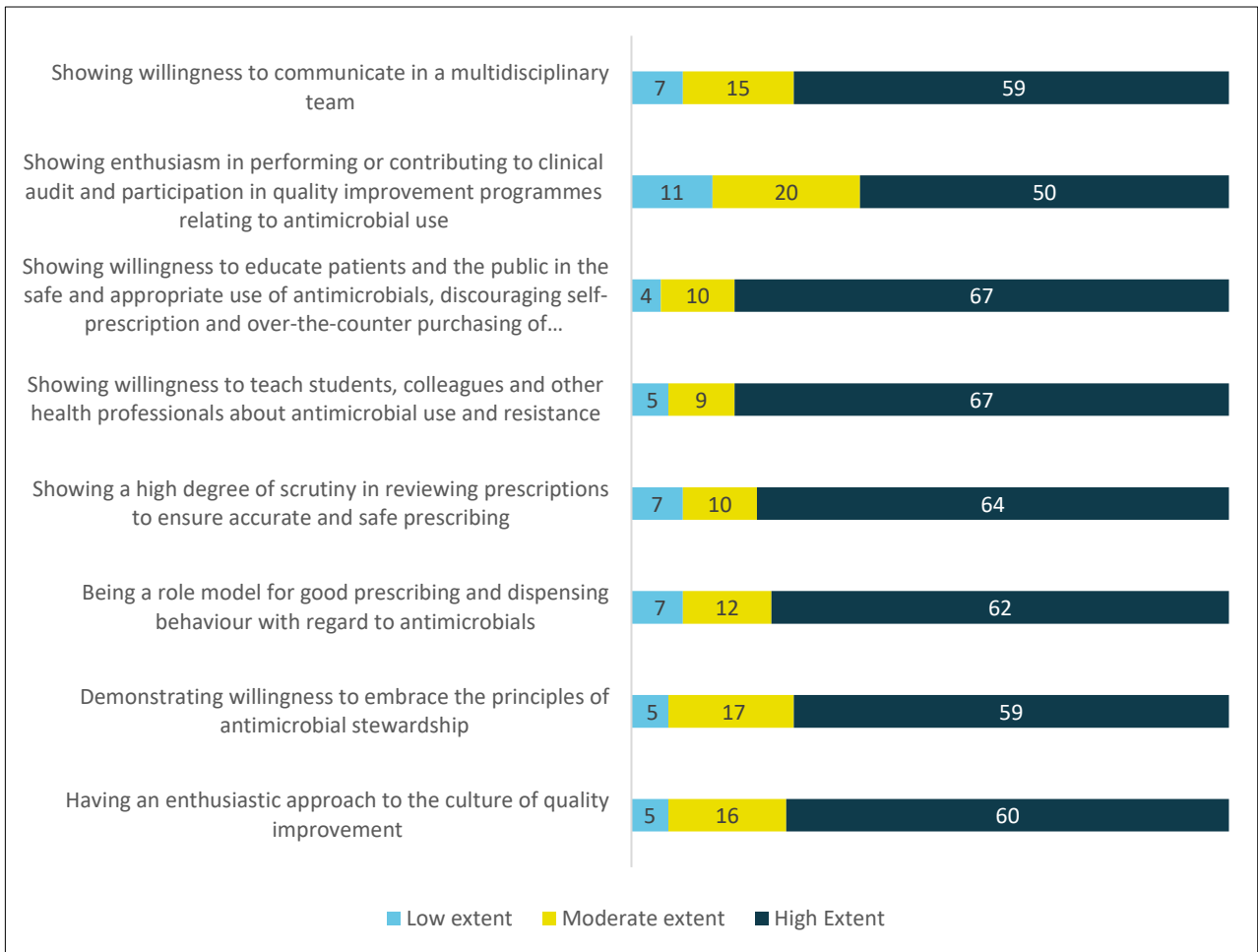


Figure 22. The extent to which the statements are useful to pharmacy practice with regard to having the correct attitude towards the appropriate use of antimicrobials (n=81).

The findings indicate that pharmacy practitioners believe that showing willingness to educate patients and the public in the safe and appropriate use of antimicrobials, discouraging self-prescription and over-the-counter purchasing of antimicrobial agents wherever possible (83%, n=67), willingness to teach students, colleagues, and other healthcare professionals about antimicrobial use and AMR (83%, n=67), a high degree of scrutiny in reviewing prescriptions to ensure accurate and safe prescribing (79%, n=64) and being a role model for good prescribing and dispensing behaviour with regard to antimicrobials (77%, n=62) are useful attitudes. However, there is a low perception about the useful attitude of showing enthusiasm in performing or contributing to clinical audit and participation in quality improvement programmes relating to antimicrobial use (14%, n=11).

C. Knowledge, skills, and attitudes for infection prevention and control

C1. Knowledge for infection prevention and control

Figure 23 describes the extent to which the statements are useful to pharmacy practice with regard to having knowledge of infection prevention and control. During the survey, respondents were asked a preliminary question on whether their university or continuing education equipped pharmacy practitioners with an understanding of the broad principles of infection prevention and control, including the importance of water, sanitation, and hygiene according to role and level of training.

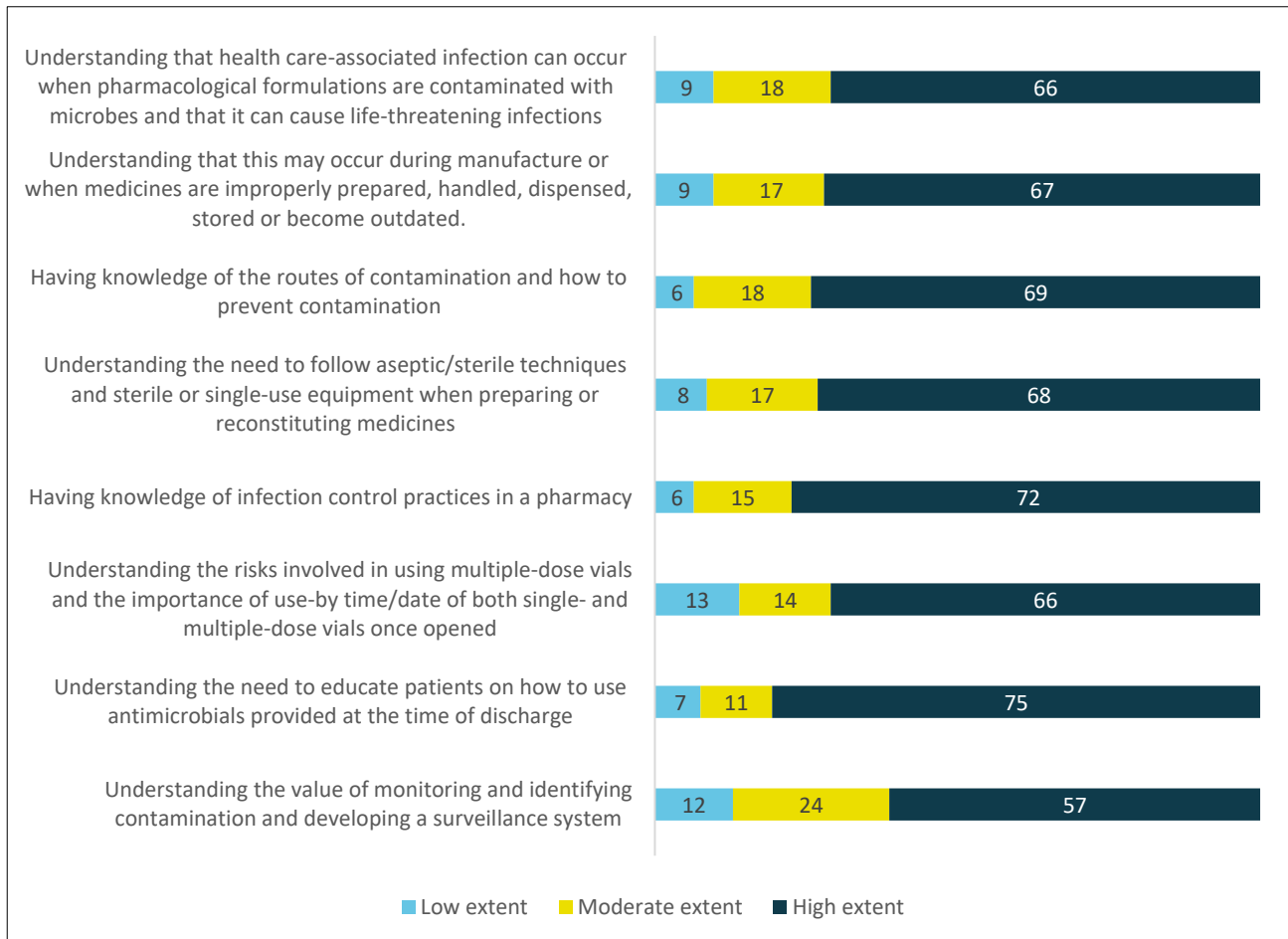


Figure 23. The extent to which the statements are useful to pharmacy practice with regard to having knowledge of infection prevention and control (n=93).

The findings indicate that pharmacy practitioners believe that understanding the need to educate patients on how to use antimicrobials provided at the time of discharge (81%, n=75) and having knowledge of infection control practices in a pharmacy are useful (77%, n=72). However, there is a low perception about the usefulness of the understanding the risks involved in using multiple-dose vials and the importance of use-by time/date of both single- and multiple-dose vials once opened for infection prevention and control (14%, n=13).

C2. Skills for infection prevention and control

Figure 24 describes the extent to which the statements are useful to pharmacy practice with regard to having skills for infection prevention and control. During the survey, respondents were asked a preliminary question on whether their university or continuing education equipped pharmacy practitioners with the skills to implement change with regard to infection prevention and control according to role and level of training.

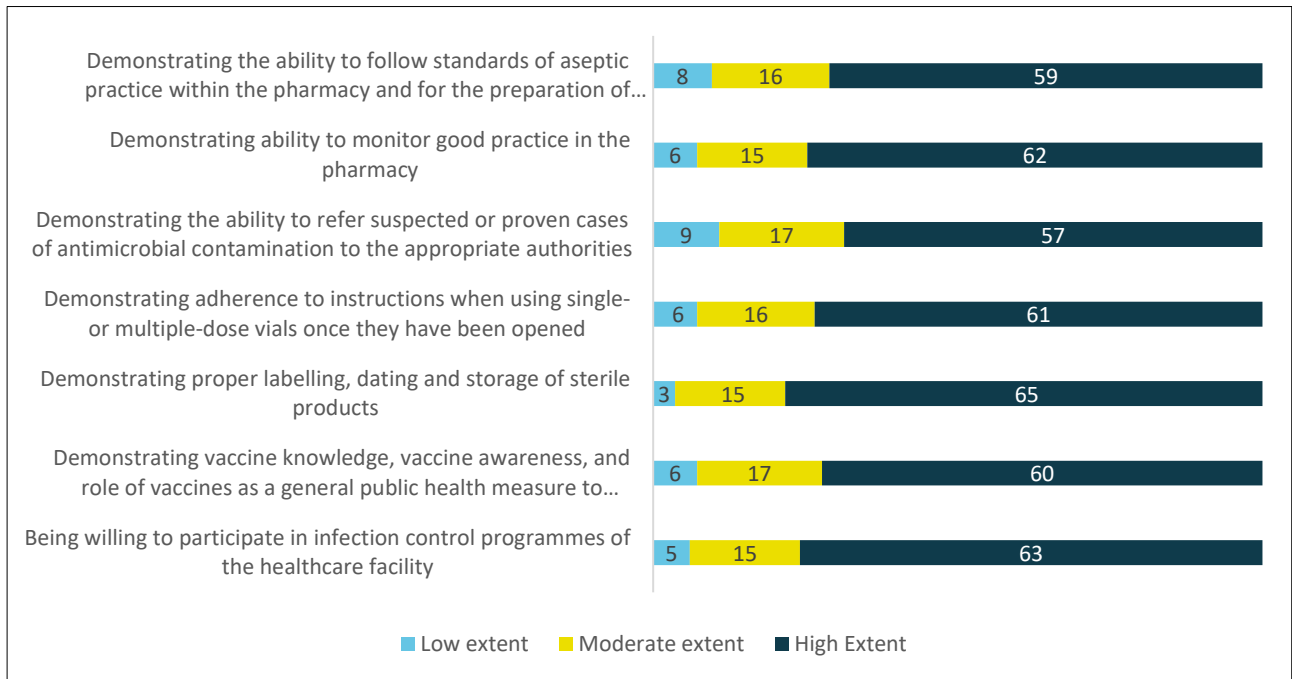


Figure 24. The extent to which the statements are useful to pharmacy practice with regard to having skills for infection prevention and control (n=83).

The findings indicate that pharmacy practitioners believe that the ability to monitor good practice in the pharmacy (75%, n=62), proper labelling, dating and storage of sterile products (78%, n=65), and being willing to participate in infection control programmes of the healthcare facility (76%, n=63) are useful skills for infection prevention and control. However, they have a low perception about the usefulness of the ability to refer suspected or proven cases of antimicrobial contamination to the appropriate authorities (11%, n=9).

C3. Attitude towards infection prevention and control

Figure 25 describes the extent to which the statements are useful to pharmacy practice regarding promoting attitudes towards infection prevention and control. During the survey, respondents were asked a preliminary question on whether their university or continuing education equipped pharmacy practitioners with the attitude to implement change regarding infection prevention and control according to role and level of training.

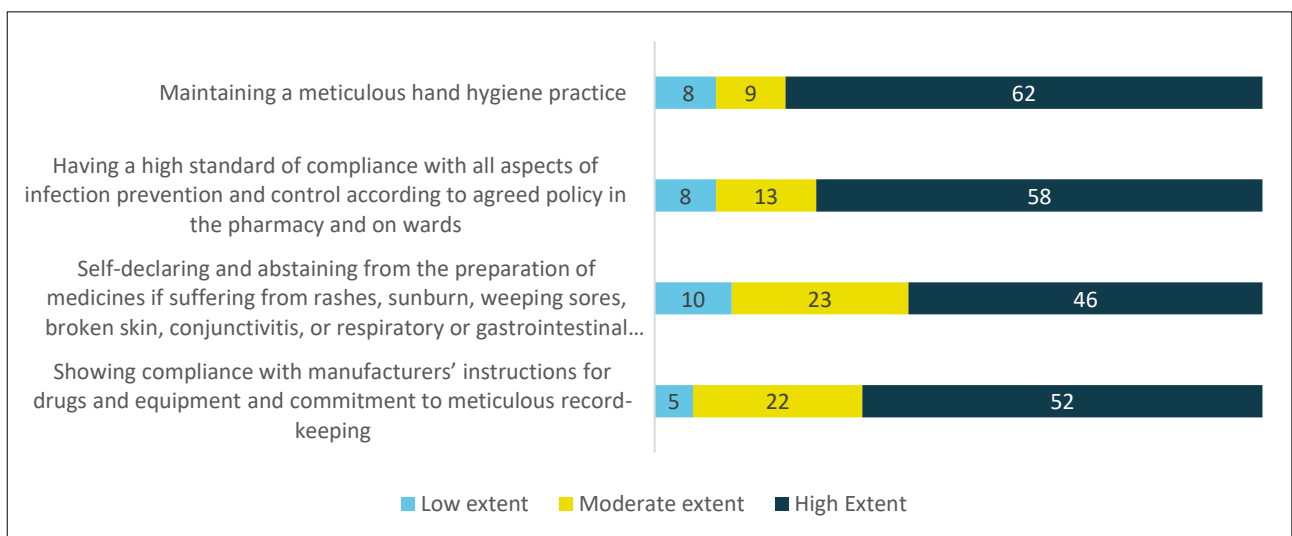


Figure 25. The extent to which the statements are useful to pharmacy practice with regard to promoting attitudes towards infection prevention and control (n=79).

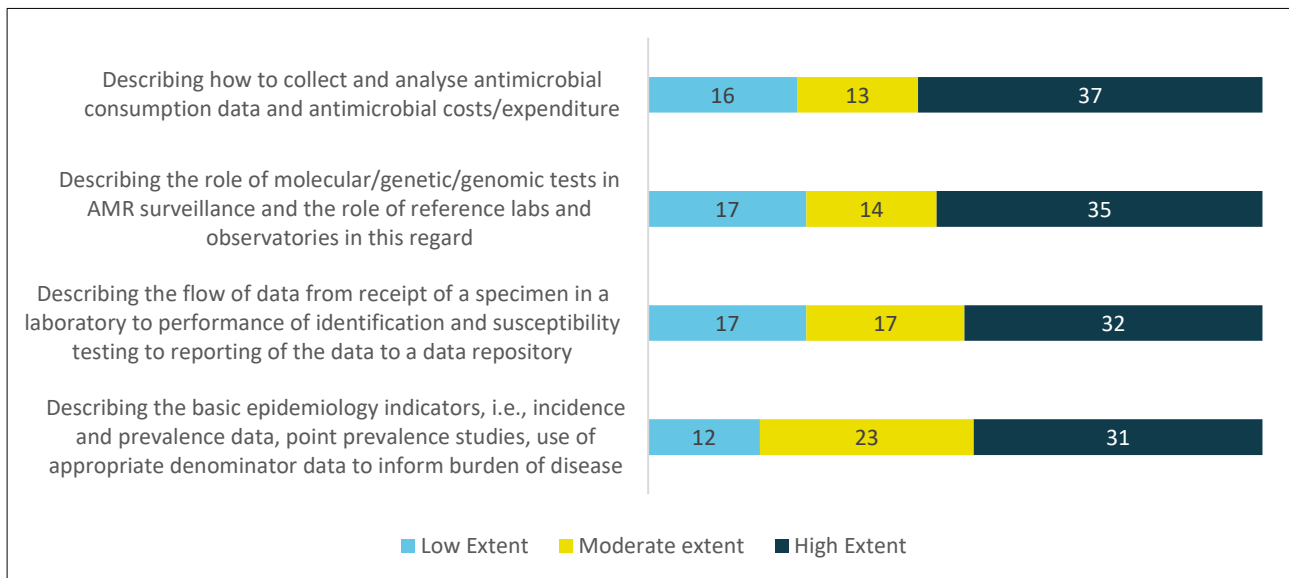
The findings indicate that pharmacy practitioners believe that maintaining a meticulous hand hygiene practice is useful attitude to promote infection prevention and control (78%, n=62). However, they have a low perception about the usefulness of self-declaring and abstaining from the preparation of work if suffering from rashes, weeping, sores, broken skin, conjunctivitis, or respiratory or gastrointestinal infections (13%, n=10).

D. Knowledge, skills and attitudes for diagnostic stewardship and surveillance

D1. Knowledge for diagnostic stewardship and surveillance

Figure 26 describes the extent to which the statements are useful to pharmacy practice with regard to having knowledge for diagnostic stewardship and surveillance. During the survey, respondents were asked a preliminary question on whether their university or continuing education equipped practitioners with the knowledge and understanding, relevant to their field and level of expertise, of the principles and processes of diagnostic stewardship, surveillance of AMR and AMS that underpin prophylaxis and treatment guidelines and AMR control strategies.

Figure 26. The extent to which the statements are useful to pharmacy practice with regard to having knowledge of



diagnostic stewardship and surveillance (n=66).

The findings indicate that there is low extend on pharmacy practitioner awareness about the usefulness of describing the role of molecular/genetic/genomic tests in AMR surveillance and the role of reference labs and observatories (26%, n=17) and the flow of data from receipt of a specimen in a laboratory to performance of identification and susceptibility testing to reporting of the data to a data repository (26%, n=17).

D2. Skills for diagnostic stewardship and surveillance

Figure 27 describes the extent to which the statements are useful to pharmacy practice with regard to having skills for diagnostic stewardship and surveillance. During the survey, respondents were asked a preliminary question on whether their university or continuing education equipped practitioners with the skills to implement change regarding diagnostic stewardship and surveillance.

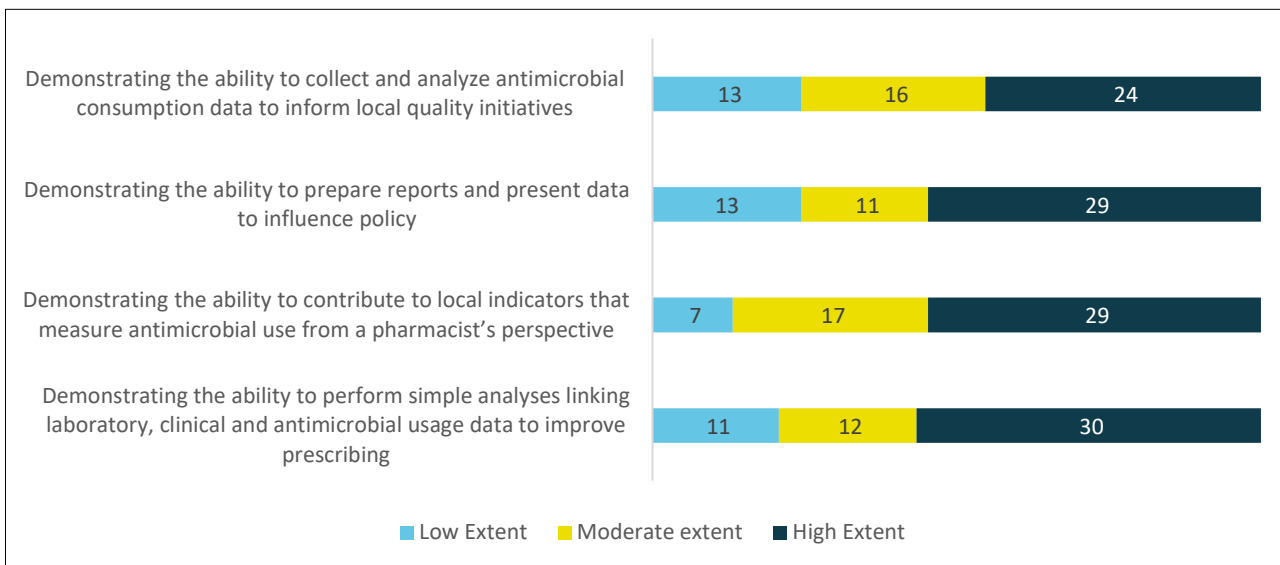


Figure 27. The extent to which the statements are useful to pharmacy practice with regard to having skills for diagnostic stewardship and surveillance (n= 53).

The findings indicate that there is low extend on pharmacy practitioner awareness about the usefulness of demonstrating the ability to collect and analyse antimicrobial consumption data to inform local quality initiatives (25%, n=13) and to prepare reports and present data to influence policy (25%, n=13) with regard to skills for diagnostic stewardship and surveillance.

D3. Attitude towards diagnostic stewardship and surveillance

Figure 28 describes the extent to which the statements are useful to pharmacy practice with regard to promoting attitudes towards diagnostic stewardship and surveillance. During the survey, respondents were asked a preliminary question on whether their university or continuing education equipped practitioners with the skills to implement change about diagnostic stewardship and surveillance.

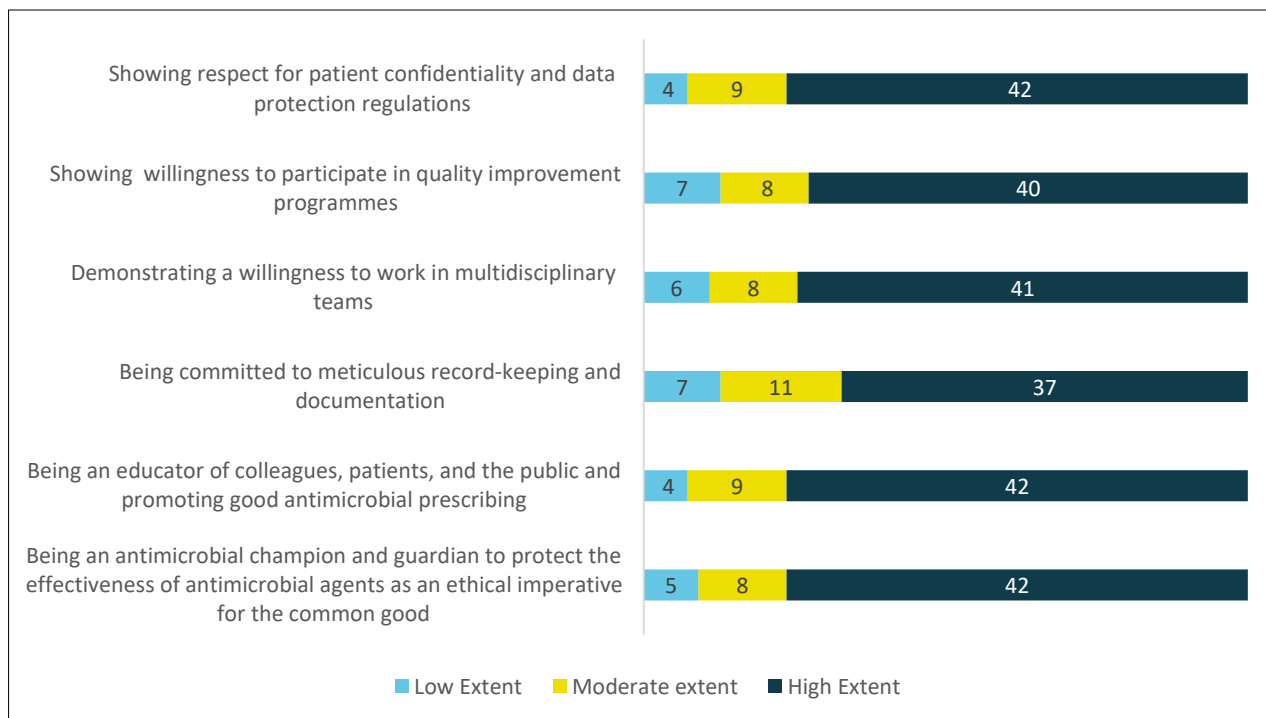


Figure 28. The extent to which the statements are useful to pharmacy practice with regard to promoting attitudes towards diagnostic stewardship and surveillance (n=55).

The findings indicate that pharmacy practitioners believe that showing respect for patient confidentiality and data protection regulations (76%, n=42), demonstrating a willingness to work in multidisciplinary teams (75%, n=41), being an educator of colleagues, patients and the public and promoting good antimicrobial prescribing (76%, n=42) and being an antimicrobial champion and guardian to protect the effectiveness of antimicrobials as an ethical imperative for the common good (76%, n=42) are useful attitudes towards promote diagnostic stewardship and surveillance. However, there is low extend on pharmacy practitioner awareness about being committed to meticulous record-keeping and documentation as a useful attitude in this regard.

E. Knowledge, skills, and attitudes for ethics, leadership, communication and governance

E1. Knowledge for ethics, leadership, communication and governance

Figure 29 describes the extent to which the statements are useful to pharmacy practice regarding knowledge of ethics, leadership, communication and governance for the prevention and control of AMR. During the survey, respondents were asked a preliminary question on whether their university or continuing education equipped practitioners with the knowledge of the concept of ethical practice, effective leadership, the importance of communication and good governance as important strategies that underpin the prevention and control of AMR.

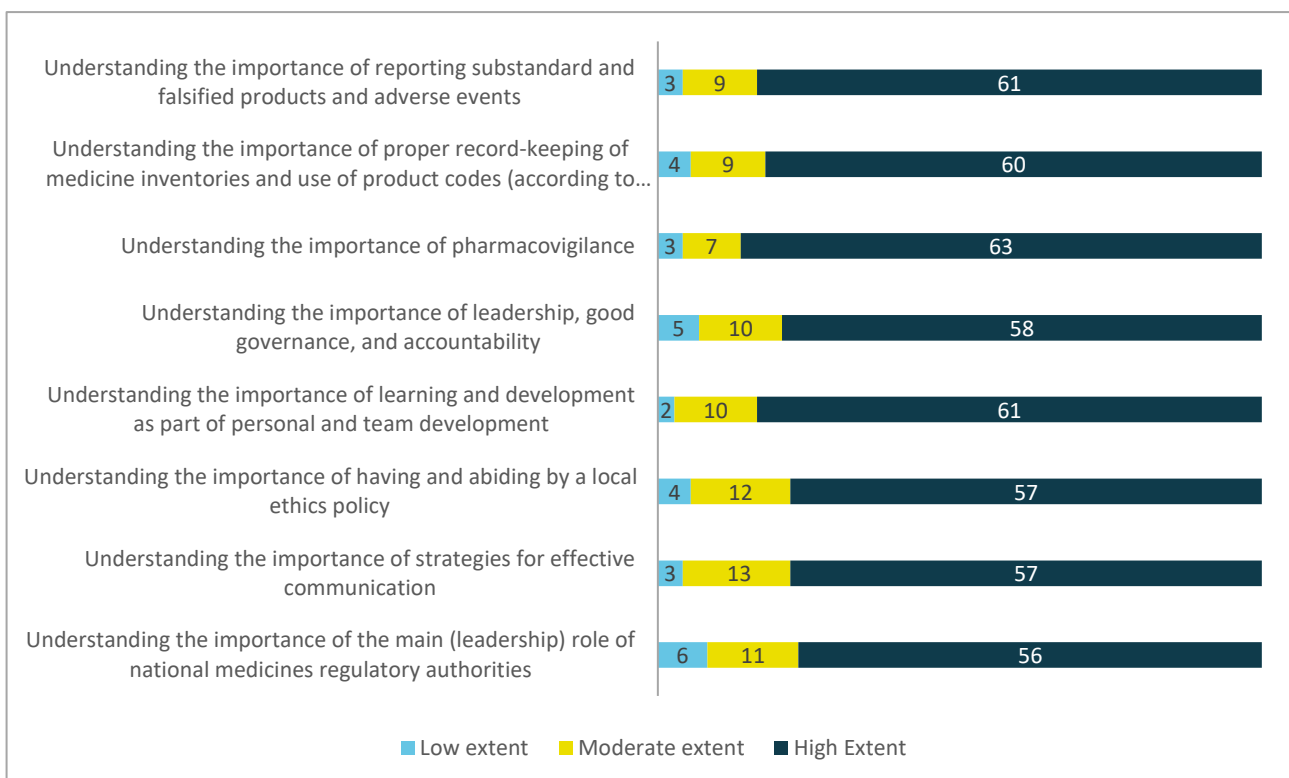


Figure 29. The extent to which the statements are useful to pharmacy practice regarding knowledge of ethics, leadership, communication and governance for the prevention and control of AMR (n=73).

The findings indicate that there is a high perspective for all the statements regarding the knowledge about of ethics, leadership, communication and governance for the prevention and control of AMR among pharmacy practitioners. They believe that understanding the importance of reporting substandard and falsified products and adverse events (84%, n=61), proper record-keeping of medicine inventories and use of product codes for traceability (82%, n=60), pharmacovigilance (86%, n=63), leadership, good governance and accountability (79%, n=58), learning and development as part of personal and team development (84%, n=61), having and abiding by a local ethics policy (78%, n=57), strategies for effective communication (78%, n=57), and the main role of national antimicrobial resistance regulatory authorities (77%, n=56) are useful to pharmacy practice in this regard.

E2. Skills for ethics, leadership, communication and governance

Figure 30 describes the extent to which the statements are useful to pharmacy practice about promoting attitudes for ethics, leadership, communication and governance for the prevention and control of AMR. During the survey, respondents were asked a preliminary question on what extent are the following statements useful to the practice.

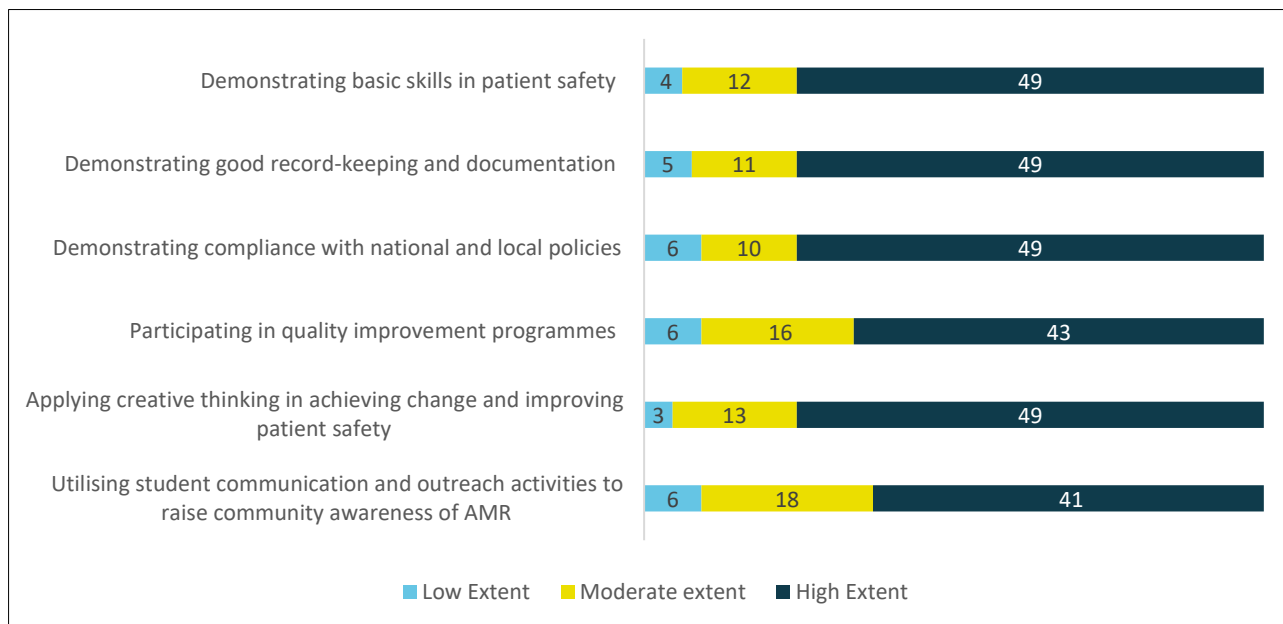


Figure 30. The extent to which the statements are useful to pharmacy practice with regard to promoting skills on ethics, leadership, communication and governance for the prevention and control of AMR (n=65).

The findings indicate that pharmacy practitioners believe that demonstrating basic skills in patient safety (75%, n=49), good record-keeping and documentation (75%, n=49), compliance with national and local policies (75%, n=49), applying creative thinking in achieving change and improving patient safety are useful to promote skills on ethics, leadership, communication and governance for the prevention and control of AMR.

E3. Attitude towards ethics, leadership, communication and governance

Figure 31 describes the extent to which the statements are useful to pharmacy practice with regard to promoting attitudes towards ethics, leadership, communication and governance for the prevention and control of AMR. During the survey, respondents were asked a preliminary question on what extent are the statements useful to the practice.

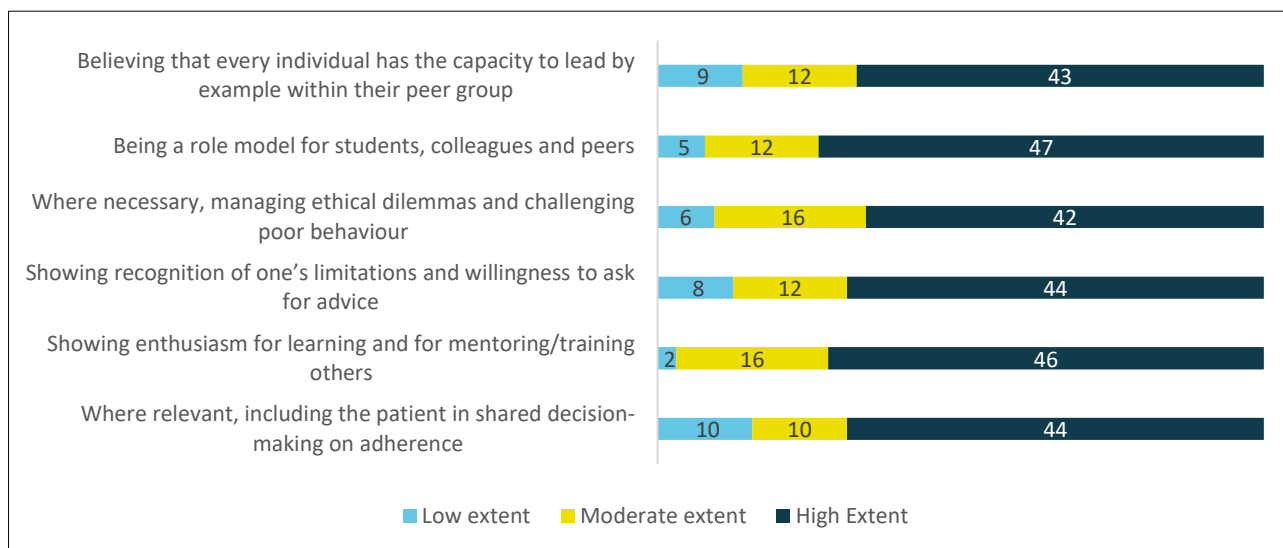


Figure 31. The extent to which the statements are useful to pharmacy practice with regard to promoting attitudes towards ethics, leadership, communication and governance for the prevention and control of AMR (n=64).

The findings indicate that pharmacy practitioners believe that being a role model for students, colleagues and peers (73%, n=47) is a useful attitude towards ethics, leadership, communication and governance for the prevention and control of AMR. However, there is low awareness about including patients in shared decision-making where relevant (16%, n=10).

F. Opinions and insights section

The feedback from pharmacy practitioners regarding AMR and AMS education reveals several important insights, including:

- **Need for formal qualifications and certification:** Pharmacy practitioners expressed the desire for formal qualifications and certification courses focused on AMR and AMS. They emphasised the importance of obtaining specialised knowledge and recognition in this field, particularly for community pharmacists.
- **Inclusion of pharmacists in decision-making:** There is a concern among practitioners about the lack of involvement of pharmacists in decision-making processes, including treatment protocols. They highlighted the need for pharmacists to have a voice and be included in discussions and changes related to antimicrobial prescribing.
- **Continuous professional education and updates:** Practitioners emphasised the importance of continuous professional education, including webinars and updates from regulatory bodies. They stressed the need to stay updated with new data, guidelines and information related to AMR to improve patient care and combat misinformation.
- **Integrating AMR education in pharmacy curricula:** Pharmacy practitioners recommended integrating AMR education into formal pharmacy education, both at the university level and through continuing education programmes. They believe that structured education focused on AMR will help pharmacists internalise the concepts and implement them throughout their careers.
- **Awareness, research, and implementation:** There was a call for increased awareness of AMR among HCPs and the community. Practitioners also emphasised the importance of research in AMS programmes and the need for practical implementation of AMR strategies in clinical and community settings.
- **Interprofessional education and collaboration:** The idea of interprofessional education was suggested to enhance engagement in AMR education. Collaboration among HCPs is seen as crucial in addressing AMR challenges effectively.
- **Adherence to prescribing and regulations:** The promotion of adherence to prescription-based dispensing of antimicrobials was highlighted as an important aspect of AMR prevention. Practitioners stressed the role of regulation as a driver for AMR awareness, education, stewardship and overall improvement.

Overall, the feedback underscores the importance of comprehensive AMR education, continuous professional development, involvement of pharmacists in decision-making, collaboration between health care professionals, and practical implementation of strategies to address AMR. It also highlights the need for increased awareness and research, as well as the integration of AMR education into pharmacy curricula.

3.4 AMR educational components for pharmacy practice from students' perspectives

Table 7 demonstrates the characteristics of the students who participated in the survey.

Table 7. Characteristics of pharmacy student respondents (n=106)

| Variable | Frequency, n (%) |
|--------------------------------|------------------|
| Academic degree in view | |
| BPharm | 37 (44) |
| PharmD | 29 (27) |
| MPharm | 30 (28) |
| Region | |
| Africa | 33 (31) |
| Americas | 4 (4) |
| Europe | 7 (7) |
| Eastern Mediterranean | 39 (37) |
| South-East Asia | 17 (16) |
| Western Pacific | 6 (6) |

Figure 32 shows respondents' feedback on their study of antimicrobials and AMR in their undergraduate degree at school as well as taking other additional courses relates to AMR outside their undergraduate school.

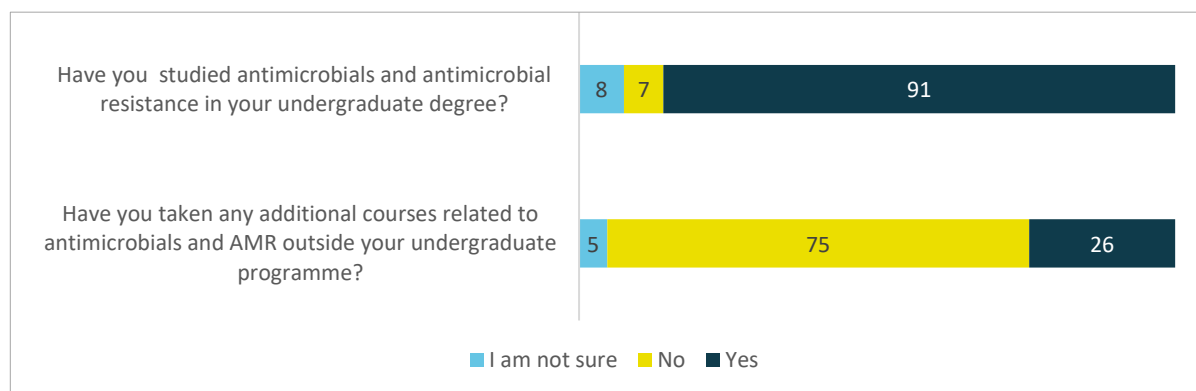


Figure 32. Students' perspective on their undergraduate AMR education and additional learnings (n=106).

The findings show that most pharmacy students (91/106) have studied antimicrobials and AMR as part of their undergraduate degree. This suggests a strong inclusion of AMR education in their core curricula. However, when it comes to additional courses outside their undergraduate programme, a smaller proportion of students (26/106) have taken such courses related to antimicrobials and AMR. This suggests that while there is significant coverage within regular curricula, fewer students have pursued further education in this area.

Overall, the findings highlight a positive trend in integrating AMR education into pharmacy undergraduate programmes, but there may be room to encourage more students to seek additional courses to deepen their understanding of antimicrobials and AMR.

Figure 33 shows respondents' feedback regarding areas relating to AMR education that students have taken courses in during their undergraduate degree.

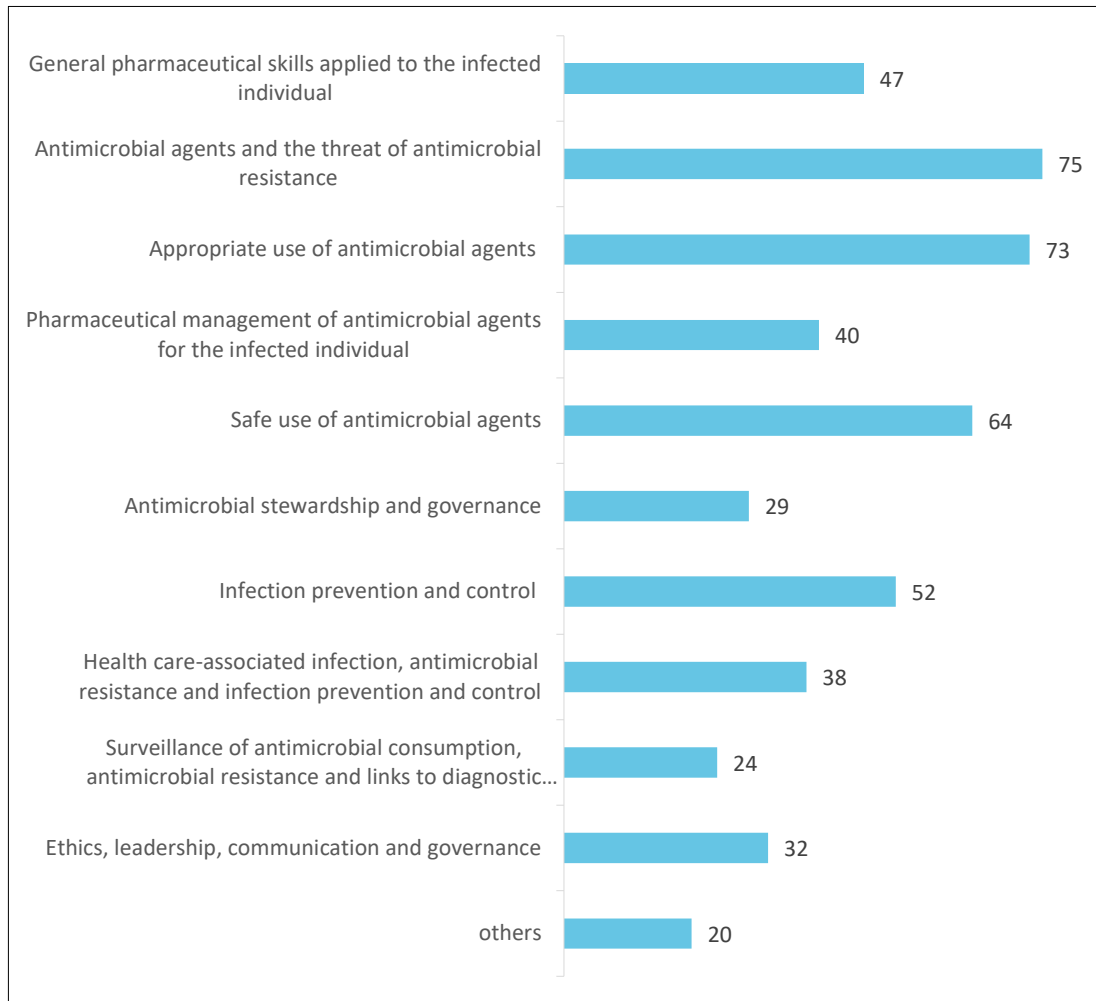


Figure 33. Areas related to AMR education that students have taken courses (n=106).

This shows that the area of “Antimicrobial agents and the threat of AMR” has the highest response with 75 respondents indicating that they have taken courses on this topic. On the other hand, “Surveillance of antimicrobial consumption, AMR and links to diagnostic stewardship” has only 24 responses. Overall, the data highlight a relatively strong emphasis on general pharmaceutical skills applied to infected individuals and the appropriate use of antimicrobial agents. However, there seems to be room for improvement in areas such as AMS, infection prevention and control, as well as diagnostic stewardship and surveillance.

Figure 34 shows respondents’ feedback on the approach to which AMR education courses are delivered in their undergraduate programmes.

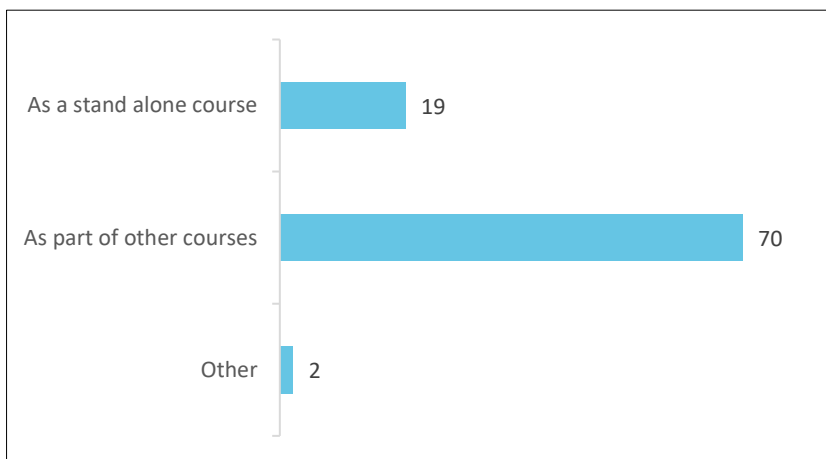


Figure 34. How AMR education courses are delivered (n=91).

The majority of respondents (70) reported that AMR education is integrated into other courses rather than being a standalone course. This suggests that AMR concepts are likely being incorporated into broader pharmacy-related subjects. Additionally, 19 students mentioned that they receive AMR education through dedicated standalone courses.

Figure 35 shows how students learn about concepts related to AMR in their pharmacy school education.

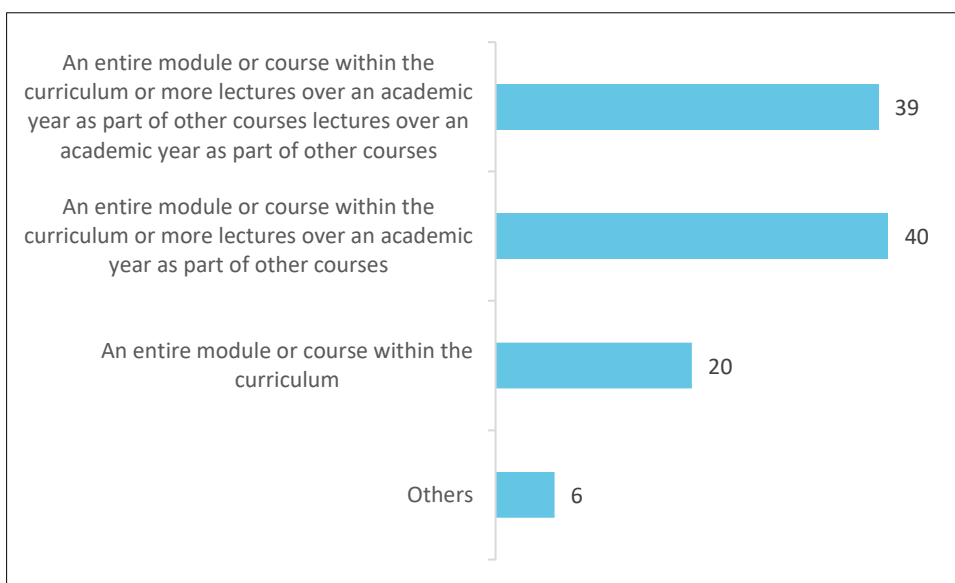


Figure 35. How students learn about concepts related to AMR in their pharmacy school education (n=105).

Most students (79) reported receiving education on AMR either through an entire module or course within the curriculum, or through more lectures spread over an academic year as part of other courses. Twenty students specifically mentioned that they had an entire module or course dedicated to AMR within the curriculum. A smaller number (six) mentioned other forms of AMR education that were not specified. Overall, it is evident that a substantial proportion of pharmacy students have been exposed to concepts related to AMR during their education.

Figure 36 shows respondents' feedback regarding perception on their knowledge on AMR and antimicrobials.

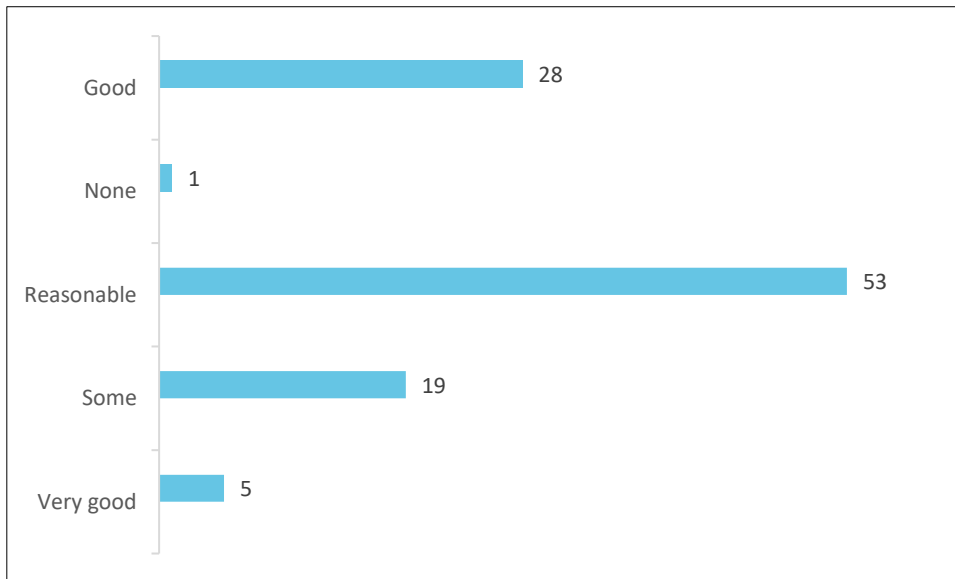


Figure 2. How students rate their knowledge of antimicrobials and AMR (n=106).

A significant number of students view their AMR education as reasonable (n=53), there is a spectrum of opinions, ranging from positive to those with limited exposure. This feedback underscores the importance of continually evaluating and enhancing AMR education in pharmacy curricula to ensure comprehensive understanding and preparedness among students.

Figure 37 shows respondents' feedback regarding their perception on how confident they feel about their skills to deliver antimicrobials related services after graduation

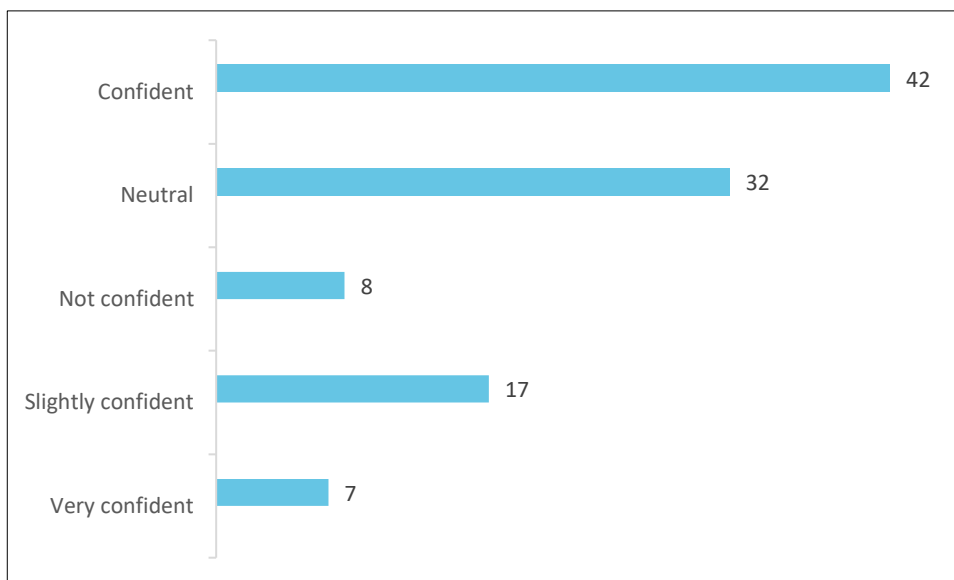


Figure 37. How confident students feel about their skills to deliver antimicrobials related services after graduation (n=106).

Most pharmacy students feel confident about their skills for antimicrobials related services after graduation. Specifically, 42 students expressed being "confident", 17 were "slightly confident" and seven were "very confident". On the other hand, a smaller number of students were "not confident" (eight) or felt "neutral" (32) about their AMR-related skills post-graduation. This suggests that a significant portion of pharmacy students perceive themselves to be well-prepared to address AMR challenges in their future careers, with only a minority expressing lower levels of confidence.

The additional thoughts shared by pharmacy students about their education on AMR provide valuable insights into their perspectives and needs. This includes:

Lack of depth and exploration

- Some students felt that their education on AMR was inadequate, leading them to seek supplementary resources like the open WHO course to gain a deeper understanding.
- A desire for more comprehensive lectures focused on AMR was expressed, indicating a need for more in-depth coverage of the topic in the curriculum.
- Students acknowledged the ongoing nature of learning about AMR and expressed optimism about gaining confidence in discussing the subject as their education progresses.

Course content and approach

- Students mentioned that the focus of lectures often revolved around classifying antimicrobials, while aspects like prevention and control were relatively neglected.
- A suggestion was made for international institutions like FIP to increase awareness regarding AMR and emphasise its importance.
- The importance of proper antibiotic usage based on guidelines and sensitivity tests was highlighted.

Curriculum enhancement

- Some students advocated a dedicated module or even a standalone course on AMR within pharmacy and pharmaceutical sciences education.
- The idea of incorporating AMR education into the curriculum was supported, with some suggesting more time allocation to increase awareness and knowledge delivery.

Real-world impact and advocacy

- Students recognised the need for advocacy in their communities to combat AMR.
- The suggestion of involving young people through panels, exchanges and awareness campaigns was made to spread knowledge and engage in the fight against AMR.
- Collaboration with organisations like WHO and FIP to involve youth volunteers in educating communities about AMR was proposed.

Awareness and control

- Students acknowledged the emergence of AMR as a global issue and the need for new antibiotics due to increasing resistance.
- Raising awareness and controlling over-the-counter antibiotic use were identified as important measures.

Integration and impact

- Some students learned about AMR through various subjects like microbiology, physiology and pharmacology.
- The impact of AMR education was highlighted in terms of informing students about the increasing resistance of old antibiotics.

Societal awareness and action

- Dissemination of AMR information to the public and increasing awareness to reduce its effects were seen as important steps.
- Collaborative efforts between organisations like the WHO and students were suggested to educate communities and address AMR-related issues.

Professional and prescriber education

- A call for educating prescribers about AMR was made, indicating the importance of involving HCPs, beyond pharmacy students.
- Integrating AMR as a dedicated course and sensitising students about its significance were recommended.

In conclusion, pharmacy students expressed a desire for more comprehensive and in-depth education on AMR. They recognised the need for advocacy, awareness campaigns and collaboration with organisations to address the growing issue of AMR. Recommendations include enhancing curriculum content, involving various healthcare disciplines, and disseminating knowledge to the broader community.

3.5 Case studies

One of the objectives of this report is to describe good practices in AMR education, including current trends, innovations, outcomes and challenges. Through the survey respondents and FIP network, stakeholders were asked to indicate their interest in sharing their experience in their approach and innovations to AMR education by submitting case studies. Individuals were followed up after the survey to complete the case study template.

Advancing AMR and AMS education: A case study from Hospital San Juan de Dios, Costa Rica

By Cristina Fernández-Barrantes, Hospital San Juan de Dios, CCSS, Costa Rica, Americas region

| Focus | Author's response |
|--|--|
| <p>AMR and AMS context within the region or country</p> | <p>The San Juan de Dios Hospital's Antimicrobial Stewardship Programme (ASP) began on 1 January 2018. A specific programme was created for the implementation, surveillance and feedback of a plan for the rational use of antimicrobials according to the local epidemiology, microbiological prevalence and the emergence of mechanisms of resistance. To achieve this objective, an interdisciplinary group was formed of an infectious disease specialist, a pharmacist, a microbiologist, a nurse and the Infection Prevention Control Unit.^{55,56}</p> <p>The Orthopaedic and Traumatology Service was selected because is our largest surgical service and contributes to a high percentage of requests for consultation to the Infectious Diseases Service and because of the high rates of infections associated with health care, especially surgical site infections.</p> <p>During the COVID-19 pandemic, the ASP objectives and result analysis were limited because our work focused on this healthcare emergency. Since 2022, surveillance of the use of antimicrobials by ASP included the "Watch" and "Reserve" categories of the AWaRe classification established by the WHO.</p> |
| <p>Current undergraduate, postgraduate, and continuing professional education to equip students and the workforce with knowledge and skills about AMR and AMS</p> | <p>The College of Pharmacists of Costa Rica has carried out different educational campaigns related to the AMR topic. Educational activities have included webinars, self-study courses and public health campaigns on social networks.</p> <p>During the second semester of 2021, San Juan de Dios's Pharmacy Service held online conferences every two weeks for pharmacists from all over the country interested in AMR & AMS</p> <p>The hospital pharmacy courses in the different pharmacy faculties have incorporated AMR & AMS into their curricula. However, it is still necessary to reinforce with specific courses on this subject, especially in undergraduate programme.</p> |
| <p>Examples of educational interventions or innovations in curriculum design, delivery or development to promote education in AMR and AMS.</p> | <p>The pharmacy service of the San Juan de Dios Hospital held a series of conferences related to ASP and the necessary skills that pharmacists require to suggest interventions in an ASP and how to integrate knowledge in an interdisciplinary team.</p> <p>The main topics of the conferences were:</p> <ul style="list-style-type: none"> • AMR from a One Health Perspective • Antimicrobial stewardship programmes: Conformation and clinical outcomes • Clinical microbiology: Gram positives, gram negatives, anaerobes, atypical bacteria • Antimicrobial drugs pharmacology |

| | |
|--|--|
| | <ul style="list-style-type: none"> • Interpretation of the antibiogram • PK/PD antimicrobials • Renal and hepatic dose adjustments • Antimicrobial administration • <i>Clostridium difficile</i> infection • Sepsis • Antimicrobial consumption calculation |
| <p>Outcomes, lessons learned, challenges and recommendations to strengthen AMR and AMS education.</p> | <p>The main achievements of the San Juan de Dios Hospital from 2018 to 2020 are described in Table 1.</p> <p>Our main challenges are:</p> <ul style="list-style-type: none"> • The multidisciplinary team should work full time on ASP to have more positive results, as lack of resources and lack of time have limited our work. • More academic education and training on the topic is necessary for professionals and for patients. • It is necessary to have a national policy on ASP to have more economic resources to develop these kinds of programmes in this region. |

Table 1. Results of process and outcome indicators of the San Juan de Dios Hospital ASP 2018–2020

| Outcome | Pre-ASP 2017 | 2018 | 2019 | 2020 |
|---|---|--------------------------|--|--|
| Cost USD | \$166,340 | \$128,418 (−\$37,922) | \$142,342 (+\$13,924) | \$109,754 (−\$32,588) |
| Antimicrobial Consumption defined daily doses per 100 beds-day | 428 | 292 (-136) | 428.4 (+136.4) | 184.6 (-243.8) |
| Length of therapy, days | No data | 16.2 (1–90) | 17.0 (1–90) | 11.0 (1–90) |
| Adherence to clinical guidelines | No data | 80% | 93% | 95% |
| Inpatient mortality | 2% | 1.7% | 0.9% | 0.9% |
| <i>Clostridioides difficile</i> infection | 9 cases | 2 cases | 8 cases | 3 cases |
| Main multidrug resistance microorganisms | MRSA: 82% <i>K. pneumoniae</i> ESBL: 68% *MRSA: Methicillin-resistant Staphylococcus aureus. ESBL: extended-spectrum β-lactamase. | No data | MRSA: 76% <i>K. pneumoniae</i> ESBL: 52% | MRSA: 48% <i>K. pneumoniae</i> ESBL: 13% |

Advancing AMR/AMS education in Croatia: Challenges, progress and future directions

By Darija Kuruc Poje, EAHP/General hospital "Dr Tomislav Bardek" Koprinnvica, Croatia, European region

| Focus | Author's response |
|---|---|
| <p>AMR and AMS context within the region or country</p> | <p>AMR rates are growing throughout Europe and Croatia is following this trend. Therefore, AMS interventions are very much appreciated. In 2017, the first official AMS team was formed⁵⁷ and it shared its experience through continuing professional education seminars and workshops in 2018. This was done to set an example and help with implementation in other hospitals.</p> <p>Although, first steps for implementing antibiotic stewardship programmes in hospital have been taken, COVID-19 has very much slowed further implementation.</p> |
| <p>Current undergraduate, postgraduate, and continuing professional education to equip students and the workforce with knowledge and skills about AMR and AMS.</p> | <p>Regarding the importance of AMR, an elective course on AMR was introduced at the faculty of pharmacy and medicinal biochemistry, University of Zagreb. A book on AMR was also published.⁵⁸ Students who enrol in the course get in-depth views and experiences in this area (microbiologist, infectious disease specialist clinical pharmacist, etc.).</p> <p>Also, a public healthcare campaign was held three years in a row by the hospital AMS team to promote to the public and primary care physicians' the importance of prudent antibiotic use.</p> <p>Furthermore, there is a plan to continue doing continuing professional education seminars and workshops, which had a lot of success in 2018.</p> |
| <p>Outcomes, lessons learned, challenges and recommendations to strengthen AMR and AMS education.</p> | <p>Outcomes: Our initiatives are currently in progress, with promising developments on the horizon.</p> <p>Lessons learned: Through our ongoing work, we have gained valuable insights that will inform our future efforts.</p> <p>Challenges: We have encountered a shortage of workforce and a shortage of time.</p> <p>Recommendations: To strengthen AMR and AMS education, we propose that more resources are dedicated to the workforce in order to implement antibiotic stewardship programmes in hospitals and communities as well as public education.</p> |

Challenges and opportunities in AMR and AMS education: A case study from Lebanon

By Hala Sacre and Pascale Salameh, Institut National de Santé Publique, d'Épidémiologie Clinique et de Toxicologie-Liban (INSPECT-LB), Lebanon, Eastern Mediterranean region

| Focus | Authors' response |
|--|---|
| <p>AMR and AMS context within the region or country</p> | <p>In Lebanon, in response to the WHO Global Action Plan, the Ministry of Public Health AMR Committee developed a national action plan to combat AMR in 2019.⁵⁹ This AMR committee was created in 2015 and several task forces derived from it: the AMR Public Awareness Task Force, the AMR Surveillance Task Force, the Hospital Acquired Infections Task Force, the Antimicrobial Use in Hospitals Task Force, the Antimicrobial Use in Pharmacies and Dispensaries Task Force, the Antimicrobial Use in Agriculture and Animals Task Force, and the Antimicrobial Use and the Lebanese Law Task Force.^{60,61}</p> <p>However, with the occurrence of the COVID-19 pandemic and the current socioeconomic crisis, no further actions were taken.</p> <p>From a research perspective, Lebanese studies have shown high levels of antibiotic resistance due to years of irrational use of antimicrobial agents in the community and hospital settings.^{62,63} Indeed, antibiotics have long been available in the community without a prescription, and their consumption is above the worldwide average.^{62,63} Errors in indication, dosage, and treatment course have been demonstrated when antibiotics are prescribed by non-specialised physicians or dispensed by pharmacists without a prescription.^{63,64}</p> <p>The current severe socioeconomic crisis in the country has worsened the chaotic situation of the pharmaceutical sector and led to medication shortages, which has further contributed to the misuse of medicines.^{65,66} It was initially anticipated that challenges in accessing and adhering to antimicrobial resistance would decrease antibiotic consumption in the community. However, the availability of substandard and falsified medicines from untrustworthy sources and difficulties in accessing medical care are expected to drive people to use inappropriate antibiotics without seeking medical advice.⁶⁷</p> <p>In parallel, some university hospitals implemented AMS programmes in accordance with the accreditation standards,⁶⁸ and educational interventions were steered toward schoolchildren as a personal initiative from some researchers.⁶⁹ Other projects related to AMR awareness among community pharmacists are also being prepared by competent authorities.</p> |
| <p>Current undergraduate, postgraduate, and continuing professional education to equip students and the workforce with knowledge and skills about AMR and AMS</p> | <p>Education of health professionals in Lebanon in AMR is still rudimentary. To our knowledge, chapters on antibiotics and infectious diseases are taught throughout undergraduate curricula as part of other courses, but there is no specific postgraduate programme except for medical doctors specialising in infectious diseases.⁷⁰</p> <p>While some graduate pharmacists may opt to specialise in infectious diseases during their residency training, it is not mandatory, and only a minority of pharmacy residents practising in Lebanon pursue this path.⁷⁰ Others may obtain certifications from international authorities through short courses and training programmes.</p> <p>Competent authorities, such as the Order of Pharmacists of Lebanon and the Lebanese Ministry of Public Health, have sporadically engaged in presenting some conferences for AMR, but not in the context of a clear and structured strategy.⁷⁰</p> |
| <p>Examples of educational interventions or innovations in curriculum design, delivery or development to promote education in AMR and AMS.</p> | <p>To cultivate responsible antibiotic usage among school students and promote their role as “antibiotic guardians”, a study was conducted to evaluate the effectiveness of a pharmacist-led educational tool.⁶⁹ The programme targeted elementary and middle-schoolchildren and aimed to improve their knowledge of antibiotic use and AMR. The findings of this stewardship programme were published in the <i>Pharmacy Education Journal</i>.⁶⁹</p> <p>Method: A prospective web-based cross-sectional pre-post study was conducted in Lebanese private schools from April 2020 to December 2021. The two different educational tools intended to educate schoolchildren about AMR were available in English and French in a</p> |

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| | <p>PowerPoint format and adapted to the educational needs of junior (7–11 years old) and senior (12–15 years old) schoolchildren. The content was examined by pharmacists, school teachers and parents and piloted with junior and senior students to address any pitfall related to the outline, the slide design, and the pertinence of the content. These educational tools comprised an overview of bacteria and viruses, the role of good and bad bacteria, hand and respiratory hygiene, immunity, the use of antibiotics, an overview of the AMR concept, and how to fight the problem. These educational tools are available here: https://inspect-lb.org/antimicrobial-resistance/</p> <p>Results: The results showed that the pharmacist-led intervention increased the general knowledge ($p=0.01$) and understanding about microbes (junior versus senior, $p=0.003$ versus $p=0.004$). In middle school, knowledge of the spread of infection ($p<0.001$) and the AMR concept ($p=0.001$) significantly changed post-test, while knowledge of antibiotic use and AMR concepts remained unchanged in elementary students.</p> <p>Conclusion: The successful learning impact of the educational tool designed and led by pharmacists highlights the crucial role of pharmacists as antibiotic experts in shaping the early pedagogic learning about antibiotics and AMR, starting as early as middle-school age.</p> |
| <p>Outcomes, lessons learned, challenges and recommendations to strengthen AMR and AMS education.</p> | <p>Outcomes: The outcomes of small research projects and interventions are positive in the short term, but nothing is known about the impact at the national level or in the long term, particularly in the absence of a comprehensive research strategy.⁷¹</p> <p>Lessons learned: Education of health professionals is insufficient. Public knowledge and practices are poor, laws are not enforced and bacterial resistance is high compared with other countries. Actions should be taken to improve the situation.</p> <p>Challenges: The socioeconomic crisis and deterioration of the healthcare system hamper the development of strategies or their implementation if they exist. Policymakers are busy working on several emergencies related to this crisis and are not aware enough of the importance of AMR. The population does not have enough access to specialised medical care, which leads them to use antibiotics without a prescription. Nevertheless, the lift of subsidies on acute medicines, including antibiotics, has led to price surges; therefore, access to antibiotics is limited to the wealthy. People from low socioeconomic levels might have recourse to illegal/substandard antibiotic preparations.</p> <p>Recommendations:</p> <ul style="list-style-type: none"> • The National Action Plan on AMR should be implemented as soon as possible⁵⁷. It might need to be adapted to the new worsened context. • The practice of antimicrobial use to avoid AMR should be regulated, and laws should be enforced. • The general population should be sensitised about the topic, using a complete media strategy. • Policymakers should engage in the entire process. • Technology-based tools should be included. • AMR-related projects should be structured into a comprehensive research and education strategy for a better effect on patient health. • The Lebanese Ministry of Public Health, in collaboration with the Order of Pharmacists of Lebanon, should take the lead in developing and implementing the related strategies.^{67,70,71} • Academic institutions should design and adapt their curricula to include courses dedicated to AMR in their initial and continuing education programmes targeting HCPs. • Research should be oriented towards comprehensive, long-term projects within the framework of a national research strategy.⁷¹ |

Advancing AMR/AMS education in Tanzania: Strategies, initiatives and recommendations

By Hamisi Msagama and Mary Kisima, Pharmaceutical Society of Tanzania, United Republic of Tanzania, African region

| Focus | Author's response |
|--|--|
| <p>AMR and AMS context within the region or country</p> | <p>AMR is prioritised as a healthcare problem in Tanzania with existing policies, guidelines and initiatives to raise awareness to both healthcare providers and members of the community as well as sustainable implementation of infection prevention control and AMR surveillance.</p> <p>Tanzania successfully implemented a five-year plan from 2017–22 with much improvement in all six strategic objectives. The existing National Action Plan on AMR 2023–28 is complemented by the National One Health strategic plan 2023–28 from the Prime Minister's Office, which promotes the use of a "One health" approach in addressing the threat of AMR.</p> <p>Different stakeholders such as the Ministry of Health, the Ministry of Livestock and Fisheries, the Ministry of Agriculture, international partners WHO, Food and Agriculture Organisation (FAO) and Fleming Fund, USAID, professional associations such as the Pharmaceutical Society of Tanzania, students' association like the Tanzania Pharmaceutical Students Association and non-governmental organisations are coordinated to implement the existing national action plan on AMR 2023/28</p> |
| <p>Current undergraduate, postgraduate, and continuing professional education to equip students and the workforce with knowledge and skills about AMR and AMS</p> | <p>AMR and AMS are taught in undergraduate education as part of a course to understand the mechanism of resistance and the drivers. No specific course on AMR and AMS is taught in either undergraduate or postgraduate education. Also, only pharmacy students are subjected to learn a little about AMR in the pharmaceutical microbiology course. Continuing professional education opens the door to different online courses and CPD organised by professional bodies to equip their members on the area of AMR and AMS. Some facilities have programmes aimed at improving understanding among their staff.</p> <p>The main channels to equip students with knowledge and skills about AMR has been through organised university campaigns, symposia and conferences, where experts present different selected topics.</p> <p>Professional associations, such as the Pharmaceutical Society of Tanzania working closely with the Commonwealth Pharmacy Association, have been able to bring closer the AMR courses to their members as part of CPD.</p> |
| <p>Examples of educational interventions or innovations in curriculum design, delivery or development to promote education in AMR and AMS.</p> | <p>Various educational interventions have been taking place in Tanzania to promote education in AMR and AMS. For example, the introduction of CPD programmes adopted from Commonwealth Pharmacy Association on AMS has helped members of the pharmaceutical society and others to increase their knowledge and education in AMR and AMS.</p> <p>Universities have been conducting workshops and symposia to facilitate resources and material dissemination as a way of promoting education in AMR. Muhimbili University of Health and Allied Sciences, the Catholic University of Health and Allied Sciences and many others have been at the forefront of educating students and healthcare providers on the causes, threats from, and how to overcome AMR.</p> <p>Other initiatives are coming from students' associations in organising capacity building and webinar sessions so as to facilitate transfer of knowledge from a number of experts in AMR and AMS. Some NGOs like One Health Society and the Rolling Back AMR initiative are basing their activities in promoting awareness and education from the level of students in primary schools up to university level.</p> |
| <p>Outcomes, lessons learned, challenges and recommendations to strengthen AMR and AMS education.</p> | <p>There is a noticeable change in perception and practice around healthcare providers and infection control measures in health facilities due to the educational and awareness programme taking place at different levels from universities to hospital settings.</p> <p>With a gradual development in curricula, there are many lessons to learn from the activities and educational programmes conducted. The main lesson is the readiness of the professionals — both students and those in hospital setting — to engage in educational and</p> |

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| | <p>awareness programmes when they are well structured in our context. Community/patient engagement in these educational programmes is the key to successful implementation. Another lesson learned is the need for a foundational course on the “One health” approach to university students so that they are nurtured and prepared to fight the threat of AMR and AMS in a multidisciplinary fashion.</p> <p>AMR and AMS education in Tanzania are facing some challenges. These include a lack of the specific education materials channelled to our local setting for better understanding of the scale and scope of the problem, few data available on the problem mostly in primary healthcare facilities, and no specific and dedicated AMR programme taught in university from undergraduate to postgraduate level. These limit the level of understanding of these upcoming healthcare providers.</p> <p>We recommend a strong and sustainable partnership to create AMR educational materials and courses in the Tanzanian context from the undergraduate level through to professional development. This will set a starting step into building an education foundation for generations. Also, professional associations like the Pharmaceutical Society of Tanzania in collaboration with the Ministry of Health and other partners should be given the capacity to conduct specific AMR education programmes in healthcare facilities to equip healthcare providers with the skills and knowledge to identify, respond to and report AMR arising in their facilities.</p> |
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Strengthening AMR and AMS education: The Pharmacist Antimicrobial Stewardship Network case study in Ireland

By the Ailbhe O'Mahoney, CPD quality assurance pharmacist, the Irish Institute of Pharmacy, the Health Service Executive AMR and Infection Control Team, Ireland, European region

| Focus | Authors' response |
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| <p>AMR and AMS context within the region or country</p> | <p>Ireland collaborates at national, EU and international levels to progress the AMR agenda, including contributing to the European AMR Surveillance System, and is a member of the EU AMR One Health Network.</p> <p>Ireland's first National Action Plan on AMR 2017–2020 (iNAP1), was published in October 2017.⁷² This plan was updated in November 2021 when iNAP2 2021–2025 was published. This National Action Plan provides for a co-ordinated cross-sectoral response to AMR, which has impacts daily on how we prevent and treat infection in Ireland.⁷³</p> <p>Alongside iNAP2, the Health Service Executive (HSE) AMR and Infection Control (AMRIC) Action Plan 2022–2025, and AMS guidance for all healthcare settings both identify pharmacists as a key stakeholder and highlight the need to maximise engagement of pharmacists with AMS.^{74,75}</p> |
| <p>Current undergraduate, postgraduate, and continuing professional education to equip students and the workforce with knowledge and skills about AMR and AMS</p> | <p>The Irish CPD model for pharmacists is based on a system of continuous learning and development that is self-directed, needs-based and outcomes-focused, with the aim of improving professional practice.⁷⁶ Instead of a specific number of hours or credits, pharmacists are required to reflect against the Core Competency Framework (CCF), which outlines the knowledge, behaviours and skills that all registered pharmacists should demonstrate.⁷⁷</p> <p>There are various opportunities available to pharmacists to update their knowledge of AMR, including formal and on-the-job learning, and eLearning programmes. HSE LanD is the HSE's online learning portal, available to staff working within hospital and community settings. AMRIC has created training programmes relating to AMS and AMR which are hosted on this platform.</p> |

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| | <p>AMRIC and the Irish Institute of Pharmacy (IIOF) have collaborated to develop an eLearning resource titled “AMS for community pharmacists”. In addition, pharmacists can stay informed about AMS and AMR developments through pharmacy publications, AMRIC newsletters and HSE websites.</p> |
| <p>Examples of educational interventions or innovations in curriculum design, delivery or development to promote education in AMR and AMS.</p> | <p>During the COVID-19 pandemic, the IIOF pivoted to add new learning delivery model to its CPD provision — a live webinar series. These webinars proved to be a rapid and flexible way to reach the pharmacy profession. The HSE AMRIC team and the IIOF collaborated to deliver a number of AMS update webinars, which led to the development of the Pharmacist Antimicrobial Stewardship Network (PAMS-net).</p> <p>PAMS-net is a dedicated page on the IIOF website for pharmacists to discuss and collaborate on AMS. PAMS-net welcomes pharmacists from all backgrounds, regardless of their experience in the field. The network aims to share knowledge and experience on AMS within and across sectors, foster innovation and creativity, and provide continuous professional development for pharmacists with an interest in AMS.</p> <p>The site, a discussion forum and a resource page were launched on the IIOF platform in August 2022.</p> |
| <p>Outcomes, lessons learned, challenges and recommendations to strengthen AMR and AMS education.</p> | <p>Since its launch, 220 pharmacists with diverse practice areas have enrolled in PAMS-net. Over 130 discussions and posts have been created. Some 82% of members reported in a post-webinar survey that joining PAMS-net impacted their practice positively.</p> <p>Researching communities of practice highlighted some areas to focus on to ensure success.⁷⁸ Challenges arose from the diversity of experience and knowledge of members, maintaining an accurate information resource, engaging users and moderation of the discussion forum.</p> <p>User guidelines were established. Participants must agree to terms of use before joining and while there are designated individuals responsible for answering queries, other members may also respond. AMRIC established a working group to provide guidance to AMRIC and the IIOF. Using resources and guidelines created by AMRIC a plan was devised to establish a rhythm of posting. In addition to the forum, educational events are organised regularly, and made available afterwards to PAMS-net members.</p> <p>Recommendations to strengthen education include flexible training delivery guided by needs and preferences of learners. Peer discussions can be a form of CPD, participation in a forum such as the PAMS-net is another way to engage in CPD.⁷⁹</p> <p>In a dynamic environment, it is important to harness CPD opportunities to expand knowledge of AMR and AMS. Providing a forum for the purpose of supporting pharmacists to deliver AMS is one such way. Measuring and reporting on the impact of the group, through objective data or anecdotal evidence, can help to demonstrate the impact on practice and the value of the group in combating AMR.</p> |

Enhancing AMS education in Norway: A case study of the Norwegian Pharmacy Association’s initiatives and impact

By Janne Smedberg, senior adviser regulatory affairs, The Norwegian Pharmacy Association, Norway, European region

| Focus | Author’s response |
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| <p>AMR and AMS context within the region or country</p> | <p>Norway has strict national treatment guidelines for antibiotics to promote correct use and prevent overuse and antibiotic resistance. All antibiotics are prescription-only. It is expected that pharmacists support this by counselling patients about the importance of using prescribed antibiotics correctly.</p> |
| <p>Current undergraduate, postgraduate, and continuing</p> | <p>All pharmacy students in Norway learn about the strict national treatment guidelines for antibiotics to promote correct use and prevent overuse and antibiotic resistance.</p> |

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| <p>professional education to equip students and the workforce with knowledge and skills about AMR and AMS</p> | |
| <p>Examples of educational interventions or innovations in curriculum design, delivery or development to promote education in AMR and AMS.</p> | <p>The Norwegian Pharmacy Association with representatives from all members in collaboration with the Antibiotic Centre for Primary Care has developed a national pharmacy practice standard securing uniform and up-to-date patient counselling in pharmacies this year.</p> <p>First, a guideline including patient information for every antibiotic prescribed in Norway was developed. This includes, for instance, how to take the medicine, storage information, and if avoiding direct sunlight is recommended when taking the medicine. This guideline is comprehensive and should be used by pharmacists as an education tool. Then a two-page short version of this guideline was developed for use at the dispensing-counter when filling prescriptions. Lastly, a one-page national practice standard was developed based on the guideline.</p> <p>Additionally, short patient-leaflets about eye infection, cystitis and upper respiratory infections were developed. These should be used during patient counselling in the non-dispensing part of the pharmacy, where the customer seeks Over-the-counter or other items for sale without prescription. All pharmacies will implement it during 2023. This should ensure that all patients receive uniform and up-to-date counselling on correct use of prescribed antibiotics at the pharmacy.</p> |
| <p>Outcomes, lessons learned, challenges and recommendations to strengthen AMR and AMS education.</p> | <p>Because of the strict national treatment guidelines for antibiotics and the fact that all antibiotics are prescription-only, Norway has little overuse or antibiotic resistance.</p> <p>A lesson learnt from this is that we did not have a national pharmacy practice standard securing uniform and up-to-date patient counselling before this year. We hope that this effort will ensure that all patients receive uniform and up-to-date counselling on correct use of prescribed antibiotics at the pharmacy.</p> <p>The challenge in Norway is to keep prescribers aware of the strict treatment guidelines so that they prescribe the correct antibiotics and only when absolutely needed, and to make sure all pharmacists in Norway comply with the new national standard. We believe such a national standard is a good way to develop a pharmaceutical workforce prepared to deliver quality services for AMS.</p> |

AMR and AMS challenges in Lebanon: A case study on education, implementation and future strategies

By Luna El Bizri, Saint Joseph University of Beirut, Lebanon, Eastern Mediterranean region

| Focus | Author's response |
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| <p>AMR and AMS context within the region or country</p> | <p>AMR in Lebanon is a serious problem in both clinical and non-clinical settings. Animals as well as foodstuffs and the environment are significant reservoirs of AMR and could be the origin for AMR in the Lebanese community concerning <i>E. coli</i> and <i>Staph. aureus</i>.</p> <p>In Lebanon, the Ministry of Public Health enforced the implementation of evidence-based practices in hospitals through its hospital accreditation programme and recommendations for implementing stewardship programmes were made. In 2019, The MoPH launched its "National action plan on combating AMR". Unfortunately, the COVID-19 pandemic, then the different crises that hit Lebanon, froze the project.</p> <p>According to studies, community pharmacists dispense approximately 30% of antibiotics in community settings, despite the law prohibiting dispensing antibiotics with no prescription.</p> |

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| | <p>Other HCPs, mostly paediatricians, are misusing antimicrobial prescribing. Patients are not aware of the consequences of AMR and are pushing pharmacists to dispense antibiotics for simple ailments. AMR educational interventions at the primary healthcare level is a necessity for all players.</p> |
| <p>Current undergraduate, postgraduate, and continuing professional education to equip students and the workforce with knowledge and skills about AMR and AMS</p> | <p>Many schools of pharmacy have sensitised students about AMR and many activities have been conducted to spread awareness, especially during World Antimicrobial Awareness Week. Students study microbiology to understand microbes, diseases and treatments. In practice, they understand what AMR is and how to fight it. They lack understanding of the effect of “Greening pharmacies” and its effect on AMR.</p> <p>After graduation, activities are less extensive. Pharmacists, particularly in community, need extensive education and empowerment to change their practices and influence the community to decrease AMR habits (overuse and misuse of antimicrobials and what to do with expired medicines).</p> |
| <p>Examples of educational interventions or innovations in curriculum design, delivery or development to promote education in AMR and AMS</p> | <ul style="list-style-type: none"> • A pharmacist-led educational tool to boost knowledge of students in schools about AMR. • A social media educational video series during World Antimicrobial Awareness Week delivered by students and intended for communities and the public. • A social media educational tool dedicated to pharmacy students to raise awareness about AMR. • A framework of educational competencies for pharmacists where “Special attention was given to AMR battle, rational use, and safe disposal of medications”, drawn up by the Lebanese Order of Pharmacists in 2020 and based on the “Nine-star pharmacist” |
| <p>Outcomes, lessons learned, challenges and recommendations to strengthen AMR and AMS education.</p> | <p>In Lebanon, the fight against AMR is far from over. Although the implementation of AMS programmes has begun in academic hospitals, due to the severe shortage of medicines, particularly in public hospitals, it is becoming increasingly difficult to implement these programmes efficiently in hospital settings.</p> <p>As a rapid overview of the Lebanese community situation, we detect:</p> <ul style="list-style-type: none"> • Malpractice: Over-prescription or bad prescribing by primary HCPs (GPs, FM), e.g., antibiotic prescription was unnecessary, antibiotic prescription was not aligned with laboratory culture findings, or the dose or duration were not appropriate. • Self-medication by patients • Easy access to antibiotics in the community pharmacies • The related law is not enforced. <p>It is critical to relaunch the “National action plan” and to adopt strategies that are suitable for the Lebanese context (political, economic crisis-fragile infrastructure). For example, use simple interventions, focus on how to improve patient safety, and adapt feasible and high-impact interventions. In the future (period of country recovery: financial support, human resources), it is essential to include all stakeholders in the fight against AMR and to implement a broad national action plan that includes all primary healthcare prescribers.</p> <p>Reinforcement of laws and proposing new policies on</p> <ol style="list-style-type: none"> (1) tackling AMR for humans, plants, animals and the environment sectors (2) regulating antibiotics consumption and their safe disposal at different levels <p>will boost the fight against AMR.</p> |

Enhancing AMR and AMS education across the European Union: Insights from the “Happy patient” project

By Maarten Lambert, University of Groningen, Netherlands; Ria Benko, University of Szeged, Hungary; Athina Chalkidou, University of Copenhagen, Denmark; Jesper Lykkegaard, University of Southern Denmark, Denmark; Malene Plejdrup Hansen, Aalborg University, Denmark; Carl Llor, Institut Català de la Salut, Spain; Pia Touboul, Nice University Hospital, France; Indre Treciokiene, Vilnius University, Lithuania; Maria-Nefeli Karkana, University of Crete, Greece; Anna Kowalczyk, Medical University of Lodz, Poland; and Katja Taxis, University of Groningen, Netherlands, European region

| Focus | Authors' response |
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| AMR and AMS context within the region or country | <p>It is estimated that AMR is responsible for 33,000 deaths per year in the EU and cost EUR 1.5 billion per year in healthcare costs and productivity losses.⁸⁰ Although overall consumption of antibiotics by humans has decreased over the past years, the relative use of broad-spectrum antibiotics has increased. Moreover, there are large differences between countries and resistance patterns remain high, indicating that improvements and reductions in antibiotic consumption can be achieved.⁸¹</p> <p>There is full understanding of the need to tackle AMR, with several action plans and guidelines being adopted, including the “EU guidelines on the prudent use of antimicrobials in human health”.⁸⁰ These include the need for educational intervention and AMR and AMS.</p> |
| Current undergraduate, postgraduate and continuing professional education to equip students and the workforce with knowledge and skills about AMR and AMS. | <p>Pharmacists in the EU are among the few professions granted automatic recognition of qualifications under the “Directive on the recognition of professional qualifications” and may apply for the European professional card, allowing them to work in other EU countries.⁸² Nevertheless, pharmacy curricula differ vastly between countries, ranging from four years of university education in many countries up to six years of university education and two years of specialisation in the Netherlands before being allowed to act as a community pharmacy owner. Education for pharmacy technicians or assistants varies as much, from limited courses and on-the-job training up to a four-year full-time curriculum.</p> |
| Examples of educational interventions or innovations in curriculum design, delivery or development to promote education in AMR and AMS | <p>The “Happy patient” project (www.happypatient.eu) is funded by the EU to implement a multicomponent intervention in primary care, including community pharmacies, to optimise the use of antibiotics and reduce AMR.⁸³ It is implemented directly in professional practice and includes educational (through e-learning and written materials) and audit and feedback interventions. A promising and novel method of registering antibiotic dispensing has been implemented and successfully received by community pharmacists from four EU countries with different patterns of antibiotic use and resistance.⁸⁴ Currently, the study is expanded to over 100 community pharmacies in five EU countries</p> |
| Outcomes, lessons learned, challenges and recommendations to strengthen AMR and AMS education. | <p>There are large differences in dispensing practices throughout the EU, with pharmacists from different countries focusing on different aspects of the dispensing process (providing information, performing safety checks, collaborating with prescribers). Many practising pharmacists seem not to be fully aware of their roles and responsibilities as described by EU guidelines. Nevertheless, pharmacists from all five countries were open to being educated on these guidelines and to improve their practice accordingly.</p> <p>Although the pharmacists who participated in this project were volunteers and therefore likely to be more motivated than the average to work on the problem of AMR, these pharmacists had very little to no experience with previous interventions aimed at improving antibiotic use. This seems to show that, although the European Commission has made tackling AMR a top priority, its action plans and guidelines have only limited impact on practising pharmacists.</p> <p>Challenges include the limited time of practising pharmacists (i.e., limited means to employ more pharmacists or spending too much time on administrative actions), limited knowledge of pharmacists on their role as gatekeepers to the use of antibiotics, patient expectations and attitudes towards extended pharmacy services and difficulties with collaborating with prescribers.</p> |

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| | <p>Large differences in practice between EU countries imply the need for EU-wide implementation of AMR education. This includes creating awareness of EU guidelines, and educational interventions, which should be concrete and directly usable in practice. EU pharmacists were enthusiastic about face-to-face intervention meetings and audit-and-feedback meetings that let them reflect on their own practice.</p> |
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Strengthening AMR and AMS education in Nigeria: Challenges, innovations and recommendations

By Onyedibe Harriet, University of Port Harcourt, Rivers State. Nigeria, African region

| Focus | Author's response |
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| <p>AMR and AMS context within the region or country</p> | <p>AMR is a clinical and public health global threat. Nigeria recognises AMR as a global threat and, in alignment with the World Health Organization (WHO) fight against AMR, developed a National Action Plan for AMR (2017–2022).⁸⁵</p> <p>This action plan is strategically focused on five areas: increasing awareness and knowledge of AMR and AMR related issues; building a “One health” AMR surveillance system; intensifying infection prevention and control in the tripartite sectors; promoting rational access to antibiotics and AMS; and investing in AMR research and development. Despite this action, there is still a poor knowledge of AMR impact among the public as some still adopt practices that impede efforts against AMR. There are minimal AMS programmes across healthcare facilities even at the tertiary level. Some facilities do not have any active committee overseeing use of antimicrobials. There is limited work with respect to development AMR surveillance system.⁸⁶</p> |
| <p>Current undergraduate, postgraduate and continuing professional education to equip students and the workforce with knowledge and skills about AMR and AMS</p> | <p>The pharmacy school undergraduate curriculum captures the introduction of antimicrobial agents. This covers the different types of antimicrobial agents and their various indications and clinical uses. This also exposes the students to a basic knowledge of AMR, the need for rational use of antimicrobial agents and the role of pharmacists in reducing the increasing level of AMR.</p> <p>There is not much in-depth discussion on AMS programmes as an intervention to curb the AMR menace at the undergraduate level.</p> <p>AMS programme is globally adopted through AMS workshops. Thus, occasionally pharmaceutical companies partner with health-related organisations to organise AMS workshops for HCPs.</p> <p>These are not statutory trainings but are based on the discretion of the pharmaceutical companies. Some tertiary healthcare facilities do not have a running AMS programme. Inadequate knowledge and skills could be a contributing factor, not just systems, structures and policy.</p> |
| <p>Examples of educational interventions or innovations in curriculum design, delivery or development to promote education in AMR and AMS.</p> | <p>An AMS programme is included at the undergraduate level. To make this undergraduate learning more exciting, it can include case studies of other countries (e.g., two countries from each continent). Strategies engaged in these countries have reduced the burden of AMR and sustained the rational use of antimicrobial agents, and the possibility of adopting similar strategies in another country with a high AMR burden. Students are exposed to country policies and how these policies affect (positively or negatively) the fight against AMR.</p> <p>Illiterate-friendly educational content has been developed for use outside academic institutions to educate regular citizens on AMR.</p> <p>AMR and AMS continuing education programmes have been developed for professionals.</p> |
| <p>Outcomes, lessons learned, challenges and recommendations to</p> | <p>My knowledge of AMR, its impact on health, and follow-ups on the global trends in the fight against AMR across different health-related organisations have streamlined my practice to be an antimicrobial steward ensuring the rational use of antibiotics.</p> |

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| <p>strengthen AMR and AMS education.</p> | <p>I have learned that adequate knowledge influences the pattern of practice among health professionals. An AMS programme is an intervention tool every healthcare professional, veterinarian, and other qualified professionals that handle antimicrobial agents must embrace, irrespective of areas of practice.</p> <p>A major challenge is gross illiteracy among Nigerians on the detrimental effect of antimicrobial misuse and abuse and its contributing factor to the increasing levels of AMR in the country. Many times, individuals try to pressure or cajole health professionals into prescribing or dispensing antimicrobial agents to them when there is no clinical need. In the event of refusal by a healthcare professional, the individual can decide to source the agent from a non-professional due to the chaotic drug distribution channels that are present in the nation. There is poor knowledge of the AMS programme among health professionals.</p> <p>There is a need for a robust curriculum that captures the basic principles of the AMS programme at the undergraduate level. There should be statutory occasional continuing education, a workshop for health professionals on AMS programmes, and a global effort towards the fight against AMS. There should be illiterate-friendly educational content for non-professionals/citizens aimed at educating them to change their perspective on antimicrobial use and take responsibility in the fight against AMR.</p> |
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Enhancing AMR and AMS education in the United Arab Emirates: Strategies, outcomes and recommendations

By Shabaz Mohiuddin Gulam, lecturer, Gulf Medical University and chair, clinical pharmacy department, Thumbay University Hospital, United Arab Emirates; Sherief Khalifa, vice chancellor for quality and institutional effectiveness, and dean, College of Pharmacy, Gulf Medical University, United Arab Emirates; and Dixon Thomas, associate professor and associate dean, clinical, College of Pharmacy, Gulf Medical University, United Arab Emirates, Eastern Mediterranean region

| Focus | Authors' response |
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| <p>AMR and AMS context within the region or country</p> | <p>AMR is on rise and is a growing concern in the United Arab Emirates (UAE). The national AMR Surveillance report of UAE states that carbapenem-resistant <i>Acinetobacter</i> spp., <i>Pseudomonas aeruginosa</i>, <i>Enterobacteriales</i> (all), <i>Escherichia coli</i> and <i>Klebsiella pneumoniae</i> along with extended-spectrum beta-lactamases (ESBL)-producing <i>Enterobacteriales</i> (all), <i>E. coli</i> and <i>K. pneumoniae</i> are the critical priority organisms. Apart from these resistance among gram-positive organisms is also on rise.⁸⁷</p> <p>The overuse of broad-spectrum antimicrobials is common and post COVID-19 there has been trend towards increasing use of antipseudomonal and anti-methicillin-resistant <i>Staphylococcus aureus</i> (MRSA) agents on an empiric basis. A lack of stratified antibiograms adds to higher use of broad-spectrum agents in general wards. De-escalation of therapy, even after positive cultures, to a narrow spectrum agent rarely happens in patients with sepsis. The antimicrobial therapies are mostly appropriate among inpatients, however upon discharge the duration of therapy is an area that needs improvement.⁸⁸</p> |
| <p>Current undergraduate, postgraduate and continuing professional education to equip students and the workforce with knowledge and skills about AMR and AMS</p> | <p>The undergraduate and postgraduate pharmacy programmes in the country teach AMS in their curricula with variable level of details. Undergraduate and postgraduate pharmacy programmes of the Gulf Medical University (GMU) offer a dedicated course on AMS and infectious diseases rotations.⁸⁹ There are many opportunities for pharmacy practitioners to update and learn new competencies in AMS through fellowship, American board certification or other continuing education. The GMU offers a two-year fellowship programme in clinical pharmacy research that has a specialty track in infectious diseases with a heavy weight on AMS. Cleveland Clinic Abu Dhabi offers a short two-week hands-on certification course on AMS.⁹⁰ The healthcare regulatory authorities conduct workshops in AMS in collaboration with the leading schools in the region. Other national, regional and international conferences in the field of AMR are common in UAE.</p> |

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| <p>Examples of educational interventions or innovations in curriculum design, delivery or development to promote education in AMR and AMS.</p> | <p>The Commission for Academic Accreditation of the UAE Ministry of Education instructed that pharmacy programmes in the UAE must include content on AMR and strategies to tackle resistance in April 2021.</p> <p>Involvement of pharmacists who are on national AMS committees in curricular design and revision is important to incorporate local issues in pharmacy curricula. In building capacity for stewardship of antimicrobials to combat AMR, the curricular designs are integrating didactic with experiential components. If AMR and AMS are taught as embedded content in courses related to microbiology or pharmacotherapeutics, curricular design to add an exclusive course in AMS as done by the GMU promotes education in AMR and AMS.</p> <p>Practice experiences in clinical settings under the supervision of an infectious diseases pharmacist is essential for mastery in learning. From being an elective, infectious diseases rotation is becoming part of mandatory rotations.⁸⁹</p> |
| <p>Outcomes, lessons learned, challenges and recommendations to strengthen AMR and AMS education.</p> | <p>Outcomes:</p> <ul style="list-style-type: none"> • In-depth understanding and knowledge in clinical pharmacology of antimicrobials and mechanisms of resistance. • Knowledge of core and supplemental stewardship interventions to optimise antimicrobial use. • Participation in stewardship interventions and monitoring of process measures and outcome measures related to stewardship. <p>Lessons learned:</p> <ul style="list-style-type: none"> • AMR and AMS essential for the graduate competencies. • Students acknowledge the need to tackle AMR and appreciate the competencies gained in stewardship. • Advance pharmacy practice experience interns and master’s in clinical pharmacy students participate in stewardship interventions on daily basis. • Participation of students in stewardship interventions like prospective audit (and feedback), de-escalation of antimicrobials, IV to oral conversions, pharmacokinetic monitoring, promoting appropriate duration of therapy, renal dosage adjustments, creation of antibiotic formulary, patient education, screening of drug interactions and adverse drug reactions under the supervision of preceptor at the practice site. • Participation of students in monitoring the antibiotic use measures in terms of costs, defined daily doses and days of therapy under the supervision of preceptor at the practice site. <p>Challenges:</p> <ul style="list-style-type: none"> • Resistance patterns of pathogens in the region are different, hence recommendations from international guidelines and textbooks cannot always be translated to clinical practice. Non-practitioners teaching this component is a challenge. <p>Recommendations:</p> <ul style="list-style-type: none"> • Stewardship should be taught by practising clinical pharmacists. • Infectious diseases modules should be taught by board certified infectious diseases pharmacists. • Didactic education should be supplemented by the practice experiences in stewardship under the supervision of a qualified preceptor. • Need for post graduate year 2 residency and fellowships in infectious diseases. |

Advancing AMS education and capacity building: A Commonwealth Pharmacists Association case study

By Victoria Rutter, Frances Garraghan, Maxencia Nabiryo, Chiko Savieli, Meghna Joshi-von Heyden, and Helena Rosado, Commonwealth Pharmacists Association, [The Commonwealth](#)

| Focus | Authors' response |
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| <p>AMR and AMS context within the region or country</p> | <p>The Commonwealth Pharmacists Association (CPA) is a membership body for national pharmacy associations across the Commonwealth.^{91,92} We work in partnership with organisations and governments to enhance AMS practices in countries alarmingly affected by AMR.</p> <p>It is estimated that 4.95 million annual deaths in low- and middle-income countries (LMICs) are associated with AMR.⁹³ National AMR action plans exist; however, they are at various stages of implementation and with different levels of success. This highlights the urgent need to scale up interventions to fight AMR in these countries.</p> <p>Our recent work, funded by the UK Department for Health and Social Care's Fleming Fund, has supported development and innovation in 22 LMIC countries, through AMR/AMS education and surveillance, as well as improved prescribing practices.⁹⁴ The CPA works in partnership with the Tropical Health and Education Trust and the Change Exchange to deliver AMS education programmes for healthcare practitioners.</p> |
| <p>Current undergraduate, postgraduate and continuing professional education to equip students and the workforce with knowledge and skills about AMR and AMS.</p> | <p>Through our Commonwealth Partnerships for Antimicrobial Stewardship (CwPAMS) programme, we have developed a suite of educational resources suitable for pharmacists at different stages of practice. These include e-learning CPD modules, AMS explainer videos, webinars and an award-winning AMS board game. Through an innovative health partnership model, these resources have helped create opportunities for CwPAMS participants to engage with other HCPs, to share their knowledge and experiences, and to further develop AMR/AMS awareness and best practice.⁹⁵</p> <p>As part of CwPAMS, our "Chief pharmaceutical officers' global health fellowship" programme supported a total of 29 UK pharmacist fellows (across two cohorts) developing their leadership confidence and skills.^{96,97}</p> <p>Our "Surveillance and prescribing support for AMS resource capacity building" (SPARC) programme enabled further expansion and strengthening of our work through the delivery of: (i) a new mobile app to support prudent antimicrobial prescribing in human and animal health; (ii) point prevalence survey training and data collection on the use of antimicrobials; and (iii) support and training for continuous quality improvement in AMS.⁹⁸</p> |
| <p>Examples of educational interventions or innovations in curriculum design, delivery or development to promote education in AMR and AMS.</p> | <p>The CPA's innovative programmes are led and supported by specialist pharmacists who work collaboratively with health psychologists and educationalists in the development and delivery of AMS training. The training and team development is fluid throughout, with the aim of supporting behaviour change and continuous quality improvement that is embedded into daily practice.</p> <p>The digital CPD platform offers free 24/7 access to 112 hours of self-directed learning across seven courses, covering pharmacy practice topics such as AMS, infectious diseases (tuberculosis, malaria) and non-communicable diseases (diabetic retinopathy).⁹⁹ The evidence-based content aims to improve knowledge of AMR/AMS as well as actively promote sustainable change in daily pharmacy practice for safe and rational use of antimicrobials, aiming to reduce AMR and enhance AMS. With expert input from behavioural scientists, all courses now incorporate behaviour change components to enhance pharmacy practice.</p> <p>The CPA's point prevalence survey (PPS) training also adopts a sustainability approach, training healthcare practitioners to undertake PPS. Results are used to review data trends</p> |

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| | <p>within institutions, helping to champion and influence evidence-based behaviour changes across the health ecosystem, from multi-disciplinary clinical teams through to hospital directors and policy makers.¹⁰⁰⁻¹⁰²</p> |
| <p>Outcomes, lessons learned, challenges and recommendations to strengthen AMR and AMS education.</p> | <p>Outcomes Since its inception, our CwPAMS programme has facilitated the training of over 6,500 healthcare workers across eight LMICs, with over 80% of learners reporting improved AMS knowledge and practice after training. A total of 19 UK-LMIC partnerships have also been established to deliver 26 projects to improve AMS capacity and capability in LMICs.⁹⁶</p> <p>Our chief pharmaceutical officers’ global health fellowship programme successfully increased 29 fellows’ knowledge and skills in global health and leadership, resulting in significant improvements in their ability to work under pressure in resource-limited settings.^{96, 103}</p> <p>Our SPARC programme supported 26 hospital sites across five LMICs, where over 100 healthcare workers were empowered to conduct a global-PPS, serving a population of over 12 million patients and more than 10,000 healthcare workers across all sites. In addition, from the continuous quality improvement training and the development of a community of practice, 15 hospitals in Malawi, Nigeria and Zimbabwe created AMS Action Plans.⁹⁸</p> <p>Lessons learned Continuous engagement of influential AMR personnel in LMIC countries enabled the promotion and sustainability of our CwPAMS programme. Working in partnership also created opportunities for bidirectional learning between UK and LMIC pharmacists. Chief pharmaceutical officer global health fellows, for example, reported gaining skills and inspirational experiences from LMIC health systems, and used them to further support effective AMS in their UK health institutions.^{96, 103}</p> <p>Challenges Working across international boundaries to achieve our goals is always a challenge. However, our AMR programme team has adopted strategies to overcome these challenges and to ensure that we are able to support pharmacists and other healthcare practitioners to tackle AMR in their own countries. Strategies included, for example, the recruitment of technical representatives in each CwPAMS country and working closely with the national pharmaceutical associations to support local coordination and advocacy among relevant stakeholders.</p> <p>Recommendations AMR is a global threat. Strengthening AMR/AMS awareness and education must be a multi-disciplinary collaborative approach which embraces the skills of a diverse range of professionals, embedding behaviour change techniques into educational interventions.</p> |

Advancing AMR and AMS education in Egypt: A case study of interdisciplinary efforts and curriculum innovations

By Wafaa N. Eltayeb, professor of microbiology, Misr International University, Egypt, African region

| Focus | Author’s response |
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| <p>AMR and AMS context within the region or country</p> | <p>On 8 May 2017, the Egyptian government was assessed by The WHO Egypt country office in developing an AMR national action plan as part of the worldwide effort to combat AMR. A strong coordination between several departments within the Ministry of Health and Population, including infection prevention and control, surveillance, central administration of pharmaceutical affairs, central public health laboratories, environmental health sector, quality control, training and research, the national information centre, and the curative sector, resulted in construction of a coordination committee.</p> |

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| | <p>A national AMR action plan (2017–2020) was set to be in line with the “Global action plan on antimicrobial resistance 2015”. The need for increased capacity within nations and the WHO for data collecting, research and health information was considered a demand. Also, measures to build national capacity were identified and supported by the AMS programme, increasing public awareness, investing in novel medicines, etc.</p> |
| <p>Current undergraduate, postgraduate and continuing professional education to equip students and the workforce with knowledge and skills about AMR and AMS</p> | <p>In our undergraduate programme we are addressing antimicrobial agents and resistance in different courses. In the pharmaceutical microbiology course we provide students with knowledge on the control of microorganisms in different settings. A brief historical background on the development of antimicrobials is mentioned to pave the way and raise an alarm for students on how rapidly we are returning to the pre-antimicrobial era. Then we briefly cover the types and chemical classes of antimicrobials, emphasising the mechanism of action to let students comprehend resistance mechanisms. Also, students in the lab are provided with experimental methods to investigate microbial susceptibility. In other courses students also go through the clinical use of antimicrobials as well as AMS.</p> <p>In the biotechnology course they are also educated on fermentation production methods. We aim to equip our graduates with knowledge and skills to plan for their future career.</p> |
| <p>Examples of educational interventions or innovations in curriculum design, delivery or development to promote education in AMR and AMS.</p> | <p>We as course coordinators correlate between our research in resistance and curriculum development. Also, in our department we set research goals to tackle resistance by searching for novel antimicrobial agents using soil metagenomics and bioinformatics.</p> <p>At the undergraduate level we apply a problem-based learning case entitled “Antimicrobial: A global threat”. This title is what the students will read when they start learning about the case.</p> <p>A wide range of interventions is recommended to globally tackle AMR. Antibiotic use is a major driving force behind AMR. Inappropriate use and poor infection prevention and control are driving such problems, especially in healthcare facilities. The hospital sector is of considerable importance because of the high volumes of antimicrobial substances used by relatively small populations. The World Health Organization has also recently listed ESKAPE (<i>Enterococcus faecium</i>, <i>Staphylococcus aureus</i>, <i>Klebsiella pneumoniae</i>, <i>Acinetobacter baumannii</i>, <i>Pseudomonas aeruginosa</i>, and <i>Enterobacter species</i>) pathogens in the list of 12 bacteria against which new antibiotics are urgently needed. The students begin to discuss the problem.</p> |
| <p>Outcomes, lessons learned, challenges and recommendations to strengthen AMR and AMS.</p> | <p>As the workforce of pharmacy graduates in Egypt is in the early stages of clinical pharmacy, we as an institution design our programme to ensure that the graduate will be able to address clinical pharmacy as well as pharmaceutical industry topics. AMR and AMS are no different in their need for clinical directed courses as well as pharmaceutical sciences.</p> <p>We try to achieve the balance in our programme by setting learning outcomes. Listed below are some of the learning outcomes for pharmaceutical microbiology. The student will be able to:</p> <ul style="list-style-type: none"> • Apply comprehended knowledge concerning the application of microbiology in pharmacy. • Demonstrate different terms and values related to control of microorganisms in hospitals and the pharmaceutical industry. • Correlate responses of microorganisms with different control methods used in different disciplines. • Demonstrate comprehended knowledge on different chemical classes of different antibiotics and chemically synthesised antimicrobials to control infections. • Articulate properties of antimicrobial agents by focusing on the mechanism of action, spectrum of activity and adverse drug reactions, and the problem of AMR by outlining the biochemical and genetics mechanisms. |



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| | <ul style="list-style-type: none">• Raise public awareness for antimicrobial misuse and abuse to prevent social health problems. <p>As AMR will always be a threat, we strongly direct our students to independently continuously learn or even be part of a team to address the health problems and its solutions. In other courses, such as pharmacotherapy and medical microbiology, clinical perspective will be applied. We also address the role of the pharmacist in pharmaceutical industry to adopt infection control.</p> |
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4 Conclusions and ways forward

This comprehensive report sheds light on AMR education and practice within the pharmacy field across various regions. It is evident that pharmacy educators have made significant strides in imparting awareness of AMR, appropriate antimicrobial use, infection prevention and diagnostic stewardship skills. However, there remain notable areas for improvement in pharmacy curricula. Pharmacogenomics, record-keeping, prescription scrutiny and adverse event investigation are identified as areas where enhancements are needed. Additionally, teaching contamination risks, monitoring and fostering self-declaration attitudes should be emphasised. Furthermore, curricula improvements are required in diagnostic data analysis, reporting, teamwork and ethical decision-making. The report underscores the importance of emphasising reporting substandard products, leadership, effective communication and sound governance for more effective AMR prevention and control.

Pharmacy practitioners, while acknowledging the importance of antimicrobial knowledge, reveal gaps in their understanding of pharmacogenomics and clinical audits, as well as a limited interest in detailed record-keeping. They also demonstrate varying degrees of appreciation for AMR optimisation strategies and the value of medication utilisation review. In the realm of infection prevention and control, practical aspects are sometimes overlooked, such as the risks associated with certain practices and the benefits of self-declaration and infection prevention measures. Regarding diagnostic stewardship and surveillance, there is limited comprehension of test roles and data significance, along with a need for increased awareness of data presentation's policy influence. Pharmacy practitioners do value patient confidentiality but need to prioritise dedicated record-keeping. In ethics, leadership, communication and governance, there is recognition of curricula gaps in reporting, record-keeping and quality programmes, but views on curricula's role modelling effectiveness are mixed.

The report also examines the perspectives of pharmacy students, who mostly receive antimicrobial and AMR education during their undergraduate programmes, often integrated into broader subjects. While students generally find their AMR education reasonable and express confidence in delivering antimicrobial-related services after graduation, they are eager to contribute more comprehensively to addressing the global issue of AMR through enhanced education and community engagement.

The case studies provide valuable insights into the diverse approaches taken to address AMR through education. For instance:

- In Costa Rica, an interdisciplinary team's implementation of the AMS programme at San Juan de Dios Hospital is commendable. Their approach, which included educational campaigns such as webinars and public health initiatives, showcases a commitment to raising awareness and promoting responsible antibiotics use. Nevertheless, challenges stemming from resource limitations and the absence of specific AMR courses in undergraduate programmes reveal areas for improvement.
- Croatia's initiation of AMR efforts in 2017, followed by educational seminars and the introduction of an elective AMR course at the University of Zagreb, reflects a proactive approach. Public healthcare campaigns further underscore the commitment to prudent antibiotics use. However, the persistent challenges of workforce shortages and the need for more structured strategies necessitate ongoing attention.
- Lebanon's development of a national action plan in 2019, despite the setbacks caused by the COVID-19 pandemic and socioeconomic crises, is a significant step forward. The initiation of efforts by the Ministry of Public Health to combat AMR is commendable, although overuse and misuse of antibiotics by healthcare providers and patients pose significant challenges. The urgent need for AMR education at the primary healthcare level highlights a crucial gap.
- In Tanzania, prioritising AMR with policies and initiatives demonstrates a commitment to addressing this global threat. The integration of AMR education into undergraduate programmes is a positive step, although the limited availability of local educational materials and insufficient data in primary healthcare facilities present hurdles that must be overcome.
- Ireland's collaborative approach and emphasis on pharmacist involvement in the fight against AMR are commendable. The self-directed continuing education for pharmacists, facilitated through various learning

- opportunities and webinars, is a proactive initiative. However, challenges related to diversity among network members need addressing, and recommendations for flexible training and impact measurement hold promise.
- Norway’s strict antibiotic guidelines and prescription-only antibiotics have yielded low AMR rates, and pharmacists play an essential role in patient counselling. Education, guidelines, and patient leaflets contribute to responsible antibiotic use. However, challenges involving prescriber awareness and pharmacist compliance underscore the ongoing need for vigilance and coordination.
 - In the European Union, where AMR is recognised as a significant threat, varying dispensing practices among member countries necessitate intervention. The “Happy patient” project’s EU-funded initiative to optimise antibiotics use, encompassing educational interventions and audit and feedback mechanisms, demonstrates a commitment to harmonising practices and promoting responsible antibiotics use.
 - Nigeria’s acknowledgment of AMR as a global threat and the development of a national action plan are crucial steps. While pharmacy school curricula introduce antimicrobial agents and basic AMR concepts, the limited discussion of antimicrobial stewardship highlights an area for improvement. Organising occasional AMS workshops by pharmaceutical companies is a positive step, but not all healthcare facilities have active AMS programmes. Recommendations, including incorporating AMS into undergraduate curricula and creating accessible educational content for the public, hold promise.
 - In the United Arab Emirates, AMR is a growing concern; while pharmacy programmes teach AMR, addressing regional resistance patterns is challenging. There is need to involve practising pharmacists, prioritising practical training, and establishing post graduate year 2 residencies in infectious diseases.
 - The “Commonwealth partnerships for antimicrobial stewardship” programme offers educational resources and fosters knowledge sharing, while also emphasising behaviour change. Over 6,500 healthcare workers in low- to middle-income countries have benefited from their training, resulting in improved AMS practices.
 - In Egypt, pharmacy education incorporates AMR and AMS topics, including microbial control, antibiotics, mechanisms of action and clinical use. Problem-based learning and research promote awareness but there still exist challenges with regard to antibiotics misuse. The programme aims to prepare graduates for clinical and industry roles related to AMR and AMS, emphasising continuous learning and the pharmacist’s role in infection control.

Based on the findings presented in this report, several potential pathways forward can be explored to advance pharmaceutical education and training on AMR. These options consider the insights provided by pharmacy educators, practitioners and students in the survey.

Pursuing these next steps has the potential to enhance the pharmaceutical education system, equipping future pharmacists with the essential knowledge, skills and attitudes needed to effectively address AMR and advocate AMS.

Way forward in pharmacy education

In considering the way forward, we can explore several potential avenues to enhance pharmaceutical education and training in the context of AMR.

One key option that stood out in the results of the survey is to continue strengthening the educational components related to AMR within pharmacy curricula. Pharmacy educators can persist in their efforts to emphasise and enrich these components, encompassing critical subjects such as microbiology, infection diagnosis, transmission prevention, antimicrobial therapy, pharmacokinetics and pharmacodynamics.

Additionally, there is an opportunity to expand curricula with a deeper focus on pharmacogenomics, an area highlighted for improvement by survey respondents. Addressing this aspect would better equip students to comprehend the genetic factors influencing antimicrobial use responses and resistance. Furthermore, exploring the integration of the World Health Organization’s strategy for optimising antimicrobial agent usage, known as the “Access, Watch and Reserve” (AwaRe) categorisation, into curricula can provide students with a comprehensive understanding of global approaches to effective AMR management.

Simultaneously, fostering skills development among pharmacy students remains crucial according to our respondents. Pharmacy education can continue its mission of equipping students with practical skills essential for effective AMR management. These skills encompass the ability to counsel patients on proper antimicrobial use, critically assess prescriptions for accuracy, safety and adherence to local policies, and provide clear guidance on dosages, administration and potential side effects. Additionally, establishing systems for investigating, recording and reporting adverse events and substandard or falsified antimicrobials is imperative.

Pharmacy education is well positioned to emphasise the importance of creating and utilising these systems, as they play a pivotal role in enhancing students' capacity to contribute to the safety and responsible use of antimicrobials. Moreover, actively encouraging students to develop skills for collecting and analysing antimicrobial consumption data, preparing comprehensive reports, and effectively presenting data is vital. These competencies are indispensable for surveillance and monitoring of AMR trends, facilitating the early detection and management of resistance patterns.

In addition, there are several pathways to consider regarding the pharmaceutical education based on the pivotal themes presented in this report:

1. Promoting knowledge, skills and attitudes for effective AMR management:

- Emphasis on patient-centred care in infection management within pharmacy curricula.
- Cultivation of a culture of working in AMS or care teams, extending beyond pharmacy to other healthcare professional curricula.
- Acknowledgment of the significance of record-keeping and documentation of antimicrobial use history, along with active participation in clinical audits and quality improvement programmes related to rational antimicrobial use within pharmacy education.
- Cultivation of a culture of quality improvement and multidisciplinary teamwork among students, fostering collaboration in the management of AMR.

2. Ensuring the appropriate use of antimicrobial agents:

- Strengthen pharmacy education by updating curricula to include pre-authorisation and prescription review, as well as skills for adverse event investigation and AMR management.
- Prioritise teaching AMS principles to students, focusing on prescription scrutiny and understanding resistance mechanisms.
- Improve technical knowledge among pharmacy students, covering aspects like susceptibility data, pharmacokinetics/pharmacodynamics and time/concentration parameters.
- Equip students with skills to guide patients on proper antimicrobial usage, including dosages and preparations, for both outpatient and inpatient settings.

3. Expanding on infection prevention and control:

- Enhancement of knowledge regarding the broad principles of infection prevention and control within pharmacy education, with an emphasis on factors like water, sanitation, and hygiene (WASH) in healthcare facilities to control and mitigate the spread of AMR.
- Comprehensive education on advanced topics, including the collection and analysis of antimicrobial consumption data, the role of molecular/genetic/genomic tests in AMR surveillance, and the flow of data in laboratory testing processes.

4. Strengthening diagnostic stewardship and surveillance:

- Elevation of students' skills in collecting and analysing antimicrobial consumption data, creating reports and contributing to local indicators measuring antimicrobial use within pharmacy education.
- Enhancement of skills related to performing straightforward analyses that establish connections between laboratory, clinical and antimicrobial usage data, thereby promoting effective diagnostic stewardship.
- Fostering attitudes of unwavering commitment to meticulous record-keeping and documentation to ensure the precision and reliability of data associated with AMR.

5. Promoting ethics, leadership, communication and governance:

- Amplification of students' attitudes regarding ethics, leadership, communication and governance within pharmacy education.
- Encouragement of students to serve as role models for their peers and future colleagues, fostering a culture of mentorship and positive influence.
- Promotion of knowledge of environmental pollution of antimicrobial agents, and sustainability.
- Promotion of a multi-disciplinary approach and interprofessional education that seamlessly integrates AMR education and training across various professions such as medicine, pharmacy, nursing, veterinary medicine and agriculture. This collaborative approach will nurture a holistic understanding of AMR's biological, clinical and societal dimensions.

By focusing on these options, pharmaceutical education can evolve to produce a cadre of future pharmacists who are not only well-informed about AMR but also equipped with the practical skills and attitudes necessary to combat this global health challenge effectively. The integration of AMR context into curricula will enrich students' understanding of AMR, while emphasising the development of essential skills will enable them to actively contribute to the responsible use of antimicrobials and the containment of AMR.

Collaborative transformation

However, academia cannot act alone. As the global threat of AMR continues to escalate, a collaborative effort is needed, one that aligns with global imperatives, such as the FIP Development Goals, universal health coverage, UN Sustainable Development Goals 3 and 4, and a "One health" approach. Comprehensive educational and practical interventions can be adopted to transform the pharmaceutical workforce to meet the needs of minimising AMR. To effectively tackle the complex challenges presented by AMR, it is imperative to foster collaboration among all pertinent stakeholders. This includes pharmacy educators, practitioners, students and medicines policy makers and government bodies. Through the pooling together of their expertise, insights and dedication, a synergistic approach can be established to enhance pharmaceutical education, science and practice worldwide. This collaborative transformation involves the integration of recommendations from each stakeholder group, resulting in a well-rounded and dynamic response to AMR. Moreover, collaboration with the governments, as seen in the development of national AMR strategies, can promote interprofessional education that includes all healthcare workers as part of the AMR education initiative.

Leadership of professional organisations: FIP policies

Professional leadership organisations must also play a role in supporting the pharmaceutical workforce by facilitating education and training related to AMR. FIP advocates pharmacists' key important role in the education of AMR and the public. In its [2023 statement](#), FIP recommends the development of the healthcare workforce through education and continuing professional development on AMR and AMS for AMR championship and advocacy. FIP advocates the inclusion of AMR concepts, its impact, and measures to reduce its emergence and spread in basic education curricula. This educational foundation should start at the earliest levels of education, ensuring that future generations are well-informed about AMR. Collaboration with all HCPs and veterinary societies is another key element in the statement of policy. FIP also acknowledges the importance of the broader understanding of the responsible antibiotic use concept and that relevant education on antimicrobial use is readily accessible to individuals across society. Lastly, integrating AMS principles into both pre-service and in-service education and training programmes is imperative. This approach promotes interprofessional learning and collaboration among healthcare and veterinary professionals, equipping them with the knowledge and skills necessary to effectively combat AMR. Collectively, these strategies aim to address AMR comprehensively through education and awareness.

Conclusions

The insights shared by pharmacy educators, practitioners and students throughout this report converge on the urgency to strengthen pharmaceutical education on AMR and AMS. While the current educational landscape already sporadically includes some courses on AMR, curricula need to evolve consistently to encompass pharmacogenomics, technical knowledge, rational antimicrobial use, patient counselling, infection control and prevention, awareness about AMR and diagnostic stewardship. This transformation will empower the pharmaceutical workforce to become proactive advocates and agents of change in combating AMR.

Addressing AMR demands a united front comprising all stakeholders, including healthcare professionals, the private sector, academia and civil society. Pharmaceutical education can pivot towards a more comprehensive and impactful approach to AMR. This unified effort will not only enhance pharmaceutical practices but also contribute significantly to achieving the broader goals of global health, sustainable development and improved patient outcomes.

It is vital that the pharmaceutical workforce, including educators, practitioners, scientists and students, is equipped with the relevant and up-to-date knowledge, skills and attitudes required to avoid this pressing issue. The time to act is now, and by equipping the pharmaceutical workforce, we can collectively forge a more resilient future against the threat of AMR.

References

1. World Health Organization. Health workers' education and training on antimicrobial resistance: curricula guide Internet: 2019. updated [accessed: 2nd October]. Available at: <https://www.who.int/news/item/17-10-2019-global-symposium-on-health-workforce-accreditation-and-regulation-december-2019>.
2. World Health Organization. Antimicrobial resistance: global report on surveillance Internet: 2014. updated [accessed: 2nd October]. Available at: <https://www.who.int/publications/i/item/9789241564748>.
3. World Health Organization. Antimicrobial resistance Internet: 2021. updated [accessed: 2nd October]. Available at: <https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance>.
4. O'Neill J. Tackling drug-resistant infections globally: final report and recommendations. [Internet]. 2016. [Cited: 2nd October 2023]. Available at: https://amr-review.org/sites/default/files/160518_Final%20paper_with%20cover.pdf.
5. Llor C, Bjerrum L. Antimicrobial resistance: risk associated with antibiotic overuse and initiatives to reduce the problem. *Ther Adv Drug Saf.* 2014;5(6):229-41. [Cited: 2nd October 2023]. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4232501/>.
6. Shrestha J ZF, Cannady, Jr P. . Antimicrobial Stewardship: 2023. updated [accessed: Available at: <https://www.ncbi.nlm.nih.gov/books/NBK572068/>].
7. Palagin I, Rachina S, Sukhorukova M et al. Current Antimicrobial Stewardship Practice and Education in Russian Hospitals: Results of a Multicenter Survey. *Antibiotics.* 2021;10(8):892. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/34438942/>.
8. World Health Organization. Global action plan on antimicrobial resistance Internet: 2015. updated [accessed: 2nd October]. Available at: <https://www.who.int/publications/i/item/9789241509763>.
9. International Pharmaceutical Federation. Pharmacists combat antimicrobial resistance Internet: 2021. updated [accessed: 28th September]. Available at: <https://www.fip.org/antimicrobial-resistance>.
10. International Pharmaceutical Federation. Transforming global pharmacy Internet: 2020. updated [accessed: 2nd October]. Available at: <https://developmentgoals.fip.org/about/#:~:text=The%20FIP%20Development%20Goals%2C%20launched,decade%20globally%2C%20regionally%20and%20nationally>.
11. International Pharmaceutical Federation. Antimicrobial Stewardship Internet: 2021. updated [accessed: 2nd October]. Available at: <https://developmentgoals.fip.org/dg17/>.
12. International Pharmaceutical Federation. Fighting antimicrobial resistance: the contributions of pharmacists. Internet: [Internet]. 2015. [Cited: 28th September 2023]. Available at: <https://www.fip.org/file/163>.
13. International Pharmaceutical Federation. FIP Statement of policy- control of antimicrobial resistance Internet: 2017. updated [accessed: Available at: <https://www.fip.org/files/content/priority-areas/antimicrobial-resistance/fip-statement-of-policy-on-amr.pdf>].
14. World Health Organization. WHO competency framework for health workers' education and training on antimicrobial resistance Internet: 2018. updated [accessed: 2nd October]. Available at: <https://www.who.int/publications/i/item/who-competency-framework-for-health-workers%E2%80%99-education-and-training-on-antimicrobial-resistance>.
15. International Pharmaceutical Federation. What community pharmacy teams need to support good hygiene as part of people's self-care. The Hague: [Internet]. 2023. [Cited: 2nd October 2023]. Available at: <https://www.fip.org/file/5479>.
16. Young CEaV. e-Bug: Educating young people on microbes and antimicrobial resistance UK Health Security Agency Blog: 2016. updated [accessed: 24 August]. Available at: <https://ukhsa.blog.gov.uk/2016/02/08/e-bug-educating-young-people-on-microbes-and-antimicrobial-resistance/>.
17. Tarín-Pelló A, Marco-Crespo E, Suay-García B et al. Innovative gamification and outreach tools to raise awareness about antimicrobial resistance. *Frontiers in Microbiology.* 2022;13:977319. [Cited: 2nd October 2023]. Available at: <https://www.frontiersin.org/articles/10.3389/fmicb.2022.977319/full>.
18. Ogunnigbo O, Nabiryo M, Atteh M et al. Exploring the antimicrobial stewardship educational needs of healthcare students and the potential of an antimicrobial prescribing app as an educational tool in selected African countries. *Antibiotics.* 2022;11(5):691. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/35625335/>.
19. Fuhrmeister ER, Larson JR, Kleinschmit AJ et al. Combating Antimicrobial Resistance Through Student-Driven Research and Environmental Surveillance. *Frontiers in Microbiology.* 2021;12:577821. [Cited: 2nd October 2023]. Available at: <https://www.frontiersin.org/articles/10.3389/fmicb.2021.577821/full#:~:text=The%20Prevalence%20of%20A>

- [ntibiotic%20Resistance%20in%20the%20Environment%20\(PARE\)%20is,areas%20where%20prevalence%20is%20high.](#)
20. Abdu-Aguye SN, Barde KG, Yusuf H et al. Investigating Knowledge of Antibiotics, Antimicrobial Resistance and Antimicrobial Stewardship Concepts Among Final Year Undergraduate Pharmacy Students in Northern Nigeria. *Integrated Pharmacy Research and Practice*. 2022;187-95. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/36582301/>.
 21. Khalid GM, Jatau AI, Ibrahim UI et al. Antibiotics self-medication among undergraduate pharmacy students in Northern Nigeria. *Medicine Access@ Point of Care*. 2019;3:2399202619846847. [Cited: Available at: https://www.academia.edu/80900332/Antibiotics_self_medication_among_undergraduate_pharmacy_students_in_Northern_Nigeria?f ri=21318].
 22. World Health Organization. Antimicrobial stewardship programmes in health-care facilities in low-and middle-income countries: a WHO practical toolkit Internet: 2019. updated [accessed: 2nd October]. Available at: <https://www.who.int/publications/i/item/9789241515481>.
 23. Nathwani D, Varghese D, Stephens J et al. Value of hospital antimicrobial stewardship programs [ASPs]: a systematic review. *Antimicrobial Resistance & Infection Control*. 2019;8:1-13. [Cited: 2nd October 2023]. Available at: <https://aricjournal.biomedcentral.com/articles/10.1186/s13756-019-0471-0#citeas>.
 24. World Health Organization. WHO global strategy for containment of antimicrobial resistance Internet: 2001. updated [accessed: 2nd October]. Available at: <https://www.ncbi.nlm.nih.gov/books/NBK97127/>.
 25. Khan Y, Kritiotis L, Coetzee R et al. An antimicrobial stewardship curriculum to incorporate in the South African Bachelor of Pharmacy degree program. *American journal of pharmaceutical education*. 2020;84(7). [Cited: 2nd October 2023]. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7405307/>.
 26. Clay MA, Sikon AL, Lypson ML et al. Teaching while learning while practicing: Reframing faculty development for the patient-centered medical home. *Academic Medicine*. 2013;88(9):1215-9. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/23887006/>.
 27. Gonzalo JD, Chang A, Dekhtyar M et al. Health systems science in medical education: unifying the components to catalyze transformation. *Academic Medicine*. 2020;95(9):1362-72. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/32287080/>.
 28. Myers JS, Jaeger J. *Faculty development in quality improvement: crossing the educational chasm*. SAGE Publications Sage CA: Los Angeles, CA; 2012. p. 96-7.
 29. Baxley EG, Lawson L, Garrison HG et al. The Teachers of Quality Academy: A learning community approach to preparing faculty to teach health systems science. *Academic Medicine*. 2016;91(12):1655. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/27332866/>.
 30. Revolinski S, Pawlak J, Beckers C. Assessing pharmacy students' and preceptors' understanding of and exposure to antimicrobial stewardship practices on introductory pharmacy practice experiences. *Pharmacy*. 2020;8(3):149. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/32825361/>.
 31. Lin K, Travlos DV, Wadelin JW et al. Simulation and introductory pharmacy practice experiences. *American journal of pharmaceutical education*. 2011;75(10). [Cited: 2nd October 2023]. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3279018/>.
 32. Ernst EJ, Klepser ME, Bosso JA et al. Recommendations for Training and Certification for Pharmacists Practicing, Mentoring, and Educating in Infectious Diseases Pharmacotherapy: Joint Opinion of the Society of Infectious Diseases Pharmacists and the Infectious Diseases Practice and Research Network of the American College of Clinical Pharmacy. *Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy*. 2009;29(4):482-8. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/19323625/>.
 33. Chahine EB, El-Lababidi RM, Sourial M. Engaging pharmacy students, residents, and fellows in antimicrobial stewardship. *Journal of pharmacy practice*. 2015;28(6):585-91. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/24399574/>.
 34. MacDougall C, Schwartz BS, Kim L et al., editors. *An interprofessional curriculum on antimicrobial stewardship improves knowledge and attitudes toward appropriate antimicrobial use and collaboration*. Open forum infectious diseases; 2017: Oxford University Press US.
 35. Burger M, Fourie J, Loots D et al. Knowledge and perceptions of antimicrobial stewardship concepts among final year pharmacy students in pharmacy schools across South Africa. *Southern African Journal of Infectious Diseases*. 2016;31(3):27-33. [Cited: 2nd October 2023]. Available at: <https://sajid.co.za/index.php/sajid/article/view/83>.
 36. Justo JA, Gauthier TP, Scheetz MH et al. Knowledge and attitudes of doctor of pharmacy students regarding the appropriate use of antimicrobials. *Clinical Infectious Diseases*. 2014;59(suppl_3):S162-S9. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/25261543/>.
 37. Barlam TF, Cosgrove SE, Abbo LM et al. Implementing an antibiotic stewardship program: guidelines by the Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America. *Clinical*

- infectious diseases. 2016;62(10):e51-e77. [Cited: 2nd October]. Available at: <https://academic.oup.com/cid/article/62/10/e51/2462846?login=false>.
38. Dellit TH, Owens RC, McGowan JE et al. Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America guidelines for developing an institutional program to enhance antimicrobial stewardship. *Clinical infectious diseases*. 2007;44(2):159-77. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/17173212/>.
 39. Labi A-K, Obeng-Nkrumah N, Bjerrum S et al. Physicians' knowledge, attitudes, and perceptions concerning antibiotic resistance: a survey in a Ghanaian tertiary care hospital. *BMC health services research*. 2018;18:1-12. [Cited: 2nd October 2023]. Available at: <https://bmchealthservres.biomedcentral.com/articles/10.1186/s12913-018-2899-y>.
 40. Garau J, Bassetti M. Role of pharmacists in antimicrobial stewardship programmes. *International journal of clinical pharmacy*. 2018;40:948-52. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/30242589/>.
 41. Barsoumian AE, Hartzell JD, Bonura EM et al. Factors Influencing Selection of Infectious Diseases Training for Military Internal Medicine Residents. *Clinical Infectious Diseases*. 2018;67(10):1582-7. [Cited: 10/2/2023]. Available at: <https://doi.org/10.1093/cid/ciy322>.
 42. Ji W, Hayat K, Ye D et al. Antimicrobial stewardship programs in Northwest China: A cross-sectional survey of perceptions, involvement, and perceived barriers among hospital pharmacists. *Frontiers in Pharmacology*. 2021;12:616503. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/33995017/>.
 43. Hayat K, Rosenthal M, Gillani AH et al. Perspective of key healthcare professionals on antimicrobial resistance and stewardship programs: a multicenter cross-sectional study from Pakistan. *Frontiers in pharmacology*. 2020;10:1520. [Cited: 2nd October 2023]. Available at: <https://www.frontiersin.org/articles/10.3389/fphar.2019.01520/full>.
 44. Firouzabadi D, Mahmoudi L. Knowledge, attitude, and practice of health care workers towards antibiotic resistance and antimicrobial stewardship programmes: A cross-sectional study. *Journal of evaluation in clinical practice*. 2020;26(1):190-6. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/31115129/>.
 45. Saengcharoen W, Chongsuivatwong V, Lerkiatbundit S et al. Factors influencing dispensing of antibiotics for upper respiratory infections among Southern Thai community pharmacists. *Journal of clinical pharmacy and therapeutics*. 2008;33(2):123-9. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/18315777/>.
 46. Kimbowa IM, Eriksen J, Nakafeero M et al. Antimicrobial stewardship: Attitudes and practices of healthcare providers in selected health facilities in Uganda. *PloS one*. 2022;17(2):e0262993. [Cited: 2nd October 2023]. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8812957/#:~:text=Antimicrobial%20stewardship%20attitudes%20of%20healthcare,compared%20to%20all%20healthcare%20providers>.
 47. Mudenda S, Hankombo M, Saleem Z et al. Knowledge, attitude, and practices of community pharmacists on antibiotic resistance and antimicrobial stewardship in Lusaka, Zambia. *medRxiv*. 2020:2020.08. 27.20181826. [Cited: 2nd October 2023]. Available at: <https://www.jelsciences.com/articles/ibres1343.php#:~:text=Conclusion,use%2C%20resistance%2C%20and%20AMS>.
 48. Dillip A, Embrey M, Shekalaghe E et al. What motivates antibiotic dispensing in accredited drug dispensing outlets in Tanzania? A qualitative study. *Antimicrobial resistance and infection control*. 2015;4(1):1-8. [Cited: 2nd October 2023]. Available at: <https://aricjournal.biomedcentral.com/articles/10.1186/s13756-015-0073-4>.
 49. Zaka El-din M, Samy F, Mohamed A et al. Egyptian community pharmacists' attitudes and practices towards antibiotic dispensing and antibiotic resistance; a cross-sectional survey in Greater Cairo. *Current Medical Research and Opinion*. 2019;35(6):939-46. [Cited: 2nd October 2023]. Available at: <https://www.tandfonline.com/doi/abs/10.1080/03007995.2018.1544119>.
 50. Hayat K, Jamshed S, Rosenthal M et al. Understanding of pharmacy students towards antibiotic use, antibiotic resistance and antibiotic stewardship programs: a cross-sectional study from Punjab, Pakistan. *Antibiotics*. 2021;10(1):66. [Cited: 2nd October, 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/33445511/>.
 51. Khan FU, Khan A, Shah S et al. Exploring undergraduate pharmacy students perspectives towards antibiotics use, antibiotic resistance, and antibiotic stewardship programs along with the pharmacy teachers' perspectives: a mixed-methods study from Pakistan. *Frontiers in Pharmacology*. 2021;12:754000. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/34819859/>.
 52. Azechi T, Sasano H, Sato K et al. Evaluation of Knowledge Regarding the Use of Antibiotics among Pharmacy Undergraduates in Japan. *Journal of Microbiology & Biology Education*. 2022;23(3):e00146-22. [Cited: 2nd October 2023]. Available at: <https://journals.asm.org/doi/10.1128/jmbe.00146-22>.

53. Popoola OO, Yasin D, Essam A et al. The knowledge and perception of pharmacy students and recent graduates in IPSF toward antimicrobial stewardship. *Pharmacy Education*. 2022;22(1):682-7. [Cited: 2nd October 2023]. Available at: <https://pharmacyeducation.fip.org/pharmacyeducation/article/view/1532>.
54. Magnuson M. The new Path of Distinction equips student pharmacists to optimize antibiotic use to reduce resistance School of Pharmacy, University of Wisconsin-Madison: 2020. updated [accessed: 2nd October]. Available at: <https://pharmacy.wisc.edu/school-introduces-pharmd-path-focused-on-antimicrobial-stewardship/>.
55. Programa de Optimización de Antimicrobianos. Informe. Resultados PROA-Hospital San Juan de Dios Año 2020, Hospital San Juan de Dios, Caja Costarricense de Seguro Social, San José, Costa Rica, 2021
56. Pan American Health Organización. Recommendations for Implementing Antimicrobial Programs in Latin America and the Caribbean: Manual for Public Health Decision-Makers
57. Kuruc Poje D, Mađarić V, Janeš Poje V et al. Antimicrobial stewardship effectiveness on rationalizing the use of last line of antibiotics in a short period with limited human resources: a single centre cohort study. *BMC Res Notes*. 2019;12(1):531. [Cited: 2nd October 2023]. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6702748/>.
58. Al Ke. Antimicrobial resistance - challenges and solutions.: 2021. updated [accessed: 2nd October]. Available at: <https://amr.bones.hr/o-knjizi-antimikrobna-rezistencija/>.
59. Ministry of Public Health RoL. National action plan on combating antimicrobial resistance: 2019. updated [accessed: 28th September]. Available at: https://cdn.who.int/media/docs/default-source/antimicrobial-resistance/amr-spc-npm/nap-library/final--lebanese-amr-nap-lebanon-march-2019.pdf?sfvrsn=6268953e_1.
60. R M. Antimicrobial Resistance Surveillance in Lebanon, A Bird Eye View: 2015. updated [accessed: 28th September]. Available at: <https://www.moph.gov.lb/userfiles/files/Education/AMRSurveillanceBirdEye.pdf>.
61. Republic of Lebanon Ministry of Public health. Antimicrobial resistance: 2015. updated [accessed: 28th September]. Available at: <https://www.moph.gov.lb/en/Pages/11/1207/antimicrobial-resistance#/en/Pages/11/2607/antimicrobial-resistance>.
62. Lahoud N, Rizk R, Hleyhel M et al. Trends in the consumption of antibiotics in the Lebanese community between 2004 and 2016. *Int J Clin Pharm*. 2021;43(4):1065-73. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/33411181/#:~:text=Main%20outcome%20measure%20The%20total,2004%20to%2031.26%20in%202016>.
63. Farah R, Lahoud N, Salameh P et al. Antibiotic dispensation by Lebanese pharmacists: a comparison of higher and lower socio-economic levels. *J Infect Public Health*. 2015;8(1):37-46. [Cited: 2nd October 2023]. Available at: [https://pubmed.ncbi.nlm.nih.gov/25139454/#:~:text=Results%3A%20Over%2Dthe%2Dcounter,areas%20\(p%3D0.003\)](https://pubmed.ncbi.nlm.nih.gov/25139454/#:~:text=Results%3A%20Over%2Dthe%2Dcounter,areas%20(p%3D0.003)).
64. Saleh N, Awada S, Awwad R et al. Evaluation of antibiotic prescription in the Lebanese community: a pilot study. *Infect Ecol Epidemiol*. 2015;5:27094. [Cited: Available at: <https://pubmed.ncbi.nlm.nih.gov/26112266/>.
65. Bajis D, Bajis S, Akel M et al. A grounded theory approach to exploring the experiences of community pharmacists in Lebanon to a triple whammy of crises: The Lebanese financial crisis, COVID-19 pandemic, and the Beirut port explosion. *Explor Res Clin Soc Pharm*. 2023;9:100217. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/36703715/>.
66. Das M. Lebanon faces critical shortage of drugs. *Lancet Oncol*. 2021;22(8):1063. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/34246331/>.
67. Hala Sacre RH, Carole Hassoun, Marie-Louise A. Hanna, Marie Ghossoub, Joumana Jaber, Aline Hajj, Marwan Akel, Rony M. Zeenny, Wadih Mina, Roula Rached, Wael Chourbaji, Samar ElHajj, Bassame Ziade, Rawad Gebrael, Ali Sleiman, Lina Traboulsi, Carol AbiKaram, Omar El Rifai, Pascale Salameh. Towards a national pharmaceutical strategy in Lebanon: Ensuring access to quality and safe medications for all. 2023. [Cited: 28th September 2023]. Available at: <https://pharmacyeducation.fip.org/pharmacyeducation/article/view/2007/1481>.
68. Rizk NA, Zahreddine N, Haddad N et al. The Impact of Antimicrobial Stewardship and Infection Control Interventions on Acinetobacter baumannii Resistance Rates in the ICU of a Tertiary Care Center in Lebanon. *Antibiotics (Basel)*. 2022;11(7). [Cited: 2nd October 2023]. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9311570/>.
69. Katia Iskandar EM, Chadia Haddad, Dalal Hammoudi, Sara EL Khatib, Ismail A. Jomha, Naghham Khanafer Maarten Van Dungen, Pascale Salameh. Using a pharmacist-led educational tool to teach elementary and middle-school students in Lebanon about microbes, antibiotic use and antimicrobial resistance: A pilot study. *Pharmacy education*. 2023;23(1):47-50. [Cited: 2nd October 2023]. Available at: <https://pharmacyeducation.fip.org/pharmacyeducation/article/view/1919>.

70. Hajj A, Zeenny RM, Sacre H et al. Pharmacy education and workforce: strategic recommendations based on expert consensus in Lebanon. *Journal of Pharmaceutical Policy and Practice*. 2023;16(1):1. [Cited: 2nd October 2023]. Available at: <https://doi.org/10.1186/s40545-022-00510-3>.
71. Akel M, Hajj A, Sacre H et al. Developing a national pharmaceutical research strategy in Lebanon: opportunities to bridge the gaps and reach the goals. *Journal of Pharmaceutical Policy and Practice*. 2022;15(1):83. [Cited: 2nd October 2023]. Available at: <https://doi.org/10.1186/s40545-022-00485-1>.
72. Department of health. Ireland's National Action Plan on Antimicrobial Resistance 2017-2020: updated [accessed: 28th September]. Available at: <http://health.gov.ie/national-patient-safety-office/patient-safety-surveillance/antimicrobialresistance-amr/>.
73. Government of Ireland. Ireland's One Health National Action Plan on Antimicrobial Resistance 2021 – 2025 (known as iNAP2): 2021. updated [accessed: 2nd October]. Available at: <https://www.gov.ie/en/publication/d72f1-joint-action-on-antimicrobial-resistance/>.
74. Health Service Executive. Health Service Executive 2022-2025 AMRIC Action Plan: 2021. updated [accessed: 2nd October]. Available at: <https://bit.ly/3nWROS7>
75. Health service executive. HSE antimicrobial stewardship guidance for all healthcare settings: 2022. updated [accessed: 28th September]. Available at: <https://www.hse.ie/eng/services/list/2/gp/antibiotic-prescribing/antibicrobial-stewardship-audit-tools/hse-amric-antimicrobial-stewardship-guidance-for-all-healthcare-settings-v1-published-august-2022.pdf>.
76. Ireland. PSo. S.I. No. 553/2015 - Pharmaceutical Society of Ireland (Continuing Professional Development) Rules 2015.: 2015. updated [accessed: 28th September]. Available at: <https://www.irishstatutebook.ie/eli/2015/si/553/made/en/print>.
77. The Pharmaceutical Society of Ireland. Core competency framework for pharmacists: 2013. updated [accessed: 28th September]. Available at: https://www.thepsi.ie/libraries/publications/psi_core_competency_framework_for_pharmacists.sflb.ashx.
78. Etienne Wenger RM, and William M. Snyder. *Cultivating Communities of Practice: A Guide to Managing Knowledge - Seven Principles for Cultivating Communities of Practice*: Havard Business School; 2002. updated [accessed: Available at: <https://hbswk.hbs.edu/archive/cultivating-communities-of-practice-a-guide-to-managing-knowledge-seven-principles-for-cultivating-communities-of-practice>.
79. Karas M, Sheen NJL, North RV et al. Continuing professional development requirements for UK health professionals: a scoping review. *BMJ Open*. 2020;10(3):e032781. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/32161156/>.
80. European Commission. EU Action on Antimicrobial Resistance: 2023. updated [accessed: 2nd October]. Available at: https://health.ec.europa.eu/antimicrobial-resistance/eu-action-antimicrobial-resistance_en.
81. Organisation for Economic Co-operation and Development. Antimicrobial resistance in the EU/EEA – a one health response briefing note: 2022. updated [accessed: 28th September]. Available at: <https://www.oecd.org/health/Antimicrobial-Resistance-in-the-EU-EEA-A-One-Health-Response-March-2022.pdf>.
82. Pharmacy Group of the European Union. Professional practice – pharmacy education and training: updated [accessed: Available at: <https://www.pgeu.eu/professional-practice/>.
83. Bjerrum A, García-Sangenís A, Modena D et al. Health alliance for prudent prescribing and yield of antibiotics in a patient-centred perspective (HAPPY PATIENT): a before-and-after intervention and implementation study protocol. *BMC Primary Care*. 2022;23(1):102. [Cited: 2nd October 2023]. Available at: <https://doi.org/10.1186/s12875-022-01710-1>.
84. Lambert M, Benkő R, Chalkidou A et al. Developing a Tool for Auditing the Quality of Antibiotic Dispensing in Community Pharmacies: A Pilot Study. *Antibiotics*. 2022;11(11):1529. [Cited: 2nd October 2023]. Available at: <https://www.mdpi.com/2079-6382/11/11/1529>.
85. World Health Organization. National action plan for antimicrobial resistance 2017-2022 Internet: 2017. updated [accessed: 2nd October]. Available at: https://cdn.who.int/media/docs/default-source/a-future-for-children/nigeria-amr-national-action-plan.pdf?sfvrsn=153f003d_1&download=true.
86. Mohammed Y, Ibrahim B, Galalain S et al. Antimicrobial resistance surveillance system in Nigeria: Suggested models. *Sahel Medical Journal*. 2018;21(3):179-80. [Cited: 2nd October 2023]. Available at: <https://www.smjonline.org/article.asp?issn=1118-8561;year=2018;volume=21;issue=3;page=179;epage=180;aulast=Mohammed>.
87. United Arab Emirates Ministry of Health and Prevention. Surveillance of Antimicrobial Resistance Annual Report: 2022. updated [accessed: Available at: <https://mohap.gov.ae/assets/download/c8cb34ff/National%20AMR%20Surveillance%20Report%202022%20MOHAP.pdf.aspx>
88. Mahmood RK, Gillani SW, Alzaabi MJ et al. Evaluation of inappropriate antibiotic prescribing and management through pharmacist-led antimicrobial stewardship programmes: a meta-analysis of evidence.

- Eur J Hosp Pharm. 2022;29(1):2-7. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/34848531/>.
89. Gulf Medical University. Programs offered: College of Pharmacy: 2023. updated [accessed: 2nd October]. Available at: <https://gmu.ac.ae/college-pharmacy/programs-offered/>
 90. El-Lababidi RM, Atallah B, Abdel-Razig S. Design and Implementation of an Antimicrobial Stewardship Certificate Program in the United Arab Emirates. International Medical Education. 2023;2(1):41-8. [Cited: 2nd October 2023]. Available at: <https://www.mdpi.com/2813-141X/2/1/5>.
 91. Commonwealth Pharmacists Association. Who we are. : 2023. updated [accessed: 28th September]. Available at: <https://commonwealthpharmacy.org/who-we-are>.
 92. Iqbal A, Rutter V, Gülpinar G et al. National pharmacy associations in the commonwealth: current scenario and future needs to maximise effective contributions of the pharmacy profession towards universal health coverage. Journal of Pharmaceutical Policy and Practice. 2021;14(1):112. [Cited: 2nd October 2023]. Available at: <https://doi.org/10.1186/s40545-021-00396-7>.
 93. Murray CJL IK, Sharara F, et al. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. The lancet. 2022;399(10325):629-55. [Cited: 2nd October 2023]. Available at: <https://www.jelsciences.com/articles/ibres1343.php#:~:text=Conclusion,use%2C%20resistance%2C%20and%20AMS>.
 94. Commonwealth Pharmacists Association. Our work: 2023. updated [accessed: 28th September]. Available at: <https://commonwealthpharmacy.org/who-we-are>
 95. Commonwealth Pharmacists Association. CwPAMS: Commonwealth Partnerships for Antimicrobial Stewardship: 2023. updated [accessed: 28th September]. Available at: <https://commonwealthpharmacy.org/cwpams>
 96. Ashiru-Oredope D, Langford BJ, Bonaconsa C et al. Global collaborations in antimicrobial stewardship: All hands on deck. Antimicrob Steward Healthc Epidemiol. 2023;3(1):e66. [Cited: 2nd October 2023]. Available at.
 97. Commonwealth Pharmacists Association. CPHOGHF: Chief Pharmaceutical Officer's Global Health Fellows Programme: 2023. updated [accessed: 28th September]. Available at: <https://commonwealthpharmacy.org/cpho-global-health-fellows>.
 98. Commonwealth Pharmacists Association. SPARC: Surveillance and Prescribing support for Antimicrobial Stewardship Resource Capacity Building: 2023. updated [accessed: 28th September]. Available at: <https://commonwealthpharmacy.org/sparc>
 99. Commonwealth Pharmacists Association. Continuing Professional Development for Pharmacists: High quality CPD programmes by Pharmacists for Pharmacists: 2023. updated [accessed: 28th September]. Available at: <https://commonwealthpharmacypcd.org>
 100. Afriyie DK, Sefah IA, Sneddon J et al. Antimicrobial point prevalence surveys in two Ghanaian hospitals: opportunities for antimicrobial stewardship. JAC Antimicrob Resist. 2020;2(1):dlaa001. [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/34222959/>.
 101. Ankrah D, Owusu H, Aggor A et al. Point Prevalence Survey of Antimicrobial Utilization in Ghana's Premier Hospital: Implications for Antimicrobial Stewardship. Antibiotics (Basel). 2021;10(12). [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/34943740/>.
 102. D'Arcy N, Ashiru-Oredope D, Olaoye O et al. Antibiotic Prescribing Patterns in Ghana, Uganda, Zambia and Tanzania Hospitals: Results from the Global Point Prevalence Survey (G-PPS) on Antimicrobial Use and Stewardship Interventions Implemented. Antibiotics (Basel). 2021;10(9). [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/23887006/>.
 103. Brandish C, Garraghan F, Ng BY et al. Assessing the Impact of a Global Health Fellowship on Pharmacists' Leadership Skills and Consideration of Benefits to the National Health Service (NHS) in the United Kingdom. Healthcare (Basel). 2021;9(7). [Cited: 2nd October 2023]. Available at: <https://pubmed.ncbi.nlm.nih.gov/34356268/>.

Appendix A: Survey questionnaire

FIP Antimicrobial Resistance Education Survey

Background: The International Pharmaceutical Federation (FIP) invites you to take part in a global survey on antimicrobial resistance (AMR) education. FIP and partners in AMR recognise the burden of AMR on healthcare and have prioritised the education and training of the pharmaceutical workforce on AMR. This survey uses the World Health Organization (WHO) health workers' education and training on antimicrobial resistance curriculum guide as a framework. It aims to investigate the educational content of the curriculum on AMR for the pharmaceutical workforce worldwide. This is the first FIP global survey that will capture data on AMR education from the perspectives of pharmacy educators, pharmacy practitioners and pharmacy students. From the data, we will develop informed guidelines and provide evidence regarding how education should support worldwide efforts to mitigate AMR. Information for participants: This survey is being conducted by the FIP Antimicrobial Resistance (AMR) Commission. It will take approximately 15–20 minutes to complete and the deadline for participation is 22 September 2022 at 23:55 CEST. Your participation in this study is voluntary and there are no foreseeable risks associated with this survey. However, if you feel uncomfortable answering any questions, you can withdraw from the survey at any point. We hope that you will feel able to share your opinions with us. Your responses will be strictly confidential and data from this research will be reported only in the aggregate. Your information will be coded and will remain confidential; only members of the survey team will have access to this. If you have questions about the survey or the procedures at any time, please contact education@fip.org. Thank you very much for your time and support. Please start the survey by clicking on the start button below.

I agree to participate in the research study. I understand the purpose and nature of this study, and I participate voluntarily.

1. I Agree

What country do you reside in? Please select from the options below.

1. Afghanistan
2. Albania
3. Algeria
4. American Samoa
5. Andorra
6. Angola
7. Anguilla
8. Antigua & Barbuda
9. Argentina
10. Armenia
11. Australia
12. Austria
13. Azerbaijan
14. Bahamas
15. Bahrain
16. Bangladesh
17. Barbados
18. Belarus
19. Belgium
20. Belize
21. Benin
22. Bermuda
23. Bhutan
24. Bolivia
25. Bosnia & Herzegovina
26. Botswana
27. Brazil
28. Brunei Darussalam
29. Bulgaria
30. Burkina Faso
31. Burundi
32. Cabo Verde
33. Cambodia
34. Cameroon
35. Canada
36. Central African Republic
37. Chad
38. Chile

39. China
40. China Taiwan
41. Colombia
42. Comoros
43. Congo, Democratic Republic of
44. Congo, Republic of the
45. Cook Islands
46. Costa Rica
47. Côte D'Ivoire
48. Croatia
49. Cuba
50. Curacao
51. Cyprus
52. Czech Republic
53. Denmark
54. Djibouti
55. Dominica
56. Dominican Republic
57. Egypt
58. El Salvador
59. Equador
60. Equatorial Guinea
61. Eritrea
62. Estonia
63. Ethiopia
64. Faeroe Island
65. Fiji
66. Finland
67. France
68. Gabon
69. Gambia
70. Georgia
71. Germany
72. Ghana
73. Gibraltar
74. Greece
75. Greenland
76. Grenada
77. Guam
78. Guatemala
79. Guinea
80. Guinea Bisau
81. Guyana
82. Haiti
83. Holy See (Vatican City State)
84. Honduras
85. Hong Kong, China
86. Hungary
87. Iceland
88. India
89. Indonesia
90. Iran
91. Iraq
92. Ireland
93. Israel
94. Italy
95. Jamaica
96. Japan
97. Jordan
98. Kazakhstan
99. Kenya
100. Kiribati
101. Korea, Democratic People's Republic of
102. Korea, Republic of

103. Kosovo
104. Kuwait
105. Kyrgyz Republic
106. Lao People's Democratic Republic
107. Latvia
108. Lebanon
109. Lesotho
110. Liberia
111. Libya
112. Liechtenstein
113. Lithuania
114. Luxembourg
115. Macao SAR, China
116. Macedonia (Republic of North Macedonia)
117. Madagascar
118. Malaysia
119. Maldives
120. Mali
121. Malta
122. Marshall Islands
123. Mauritania
124. Mauritius
125. Mexico
126. Micronesia (Federated states)
127. Moldova
128. Monaco
129. Mongolia
130. Montenegro
131. Morocco
132. Mozambique
133. Myanmar
134. Namibia
135. Nauru
136. Nepal
137. Netherlands
138. New Zealand
139. Nicaragua
140. Niger
141. Nigeria
142. Niue
143. North Macedonia
144. Norway
145. Oman
146. Pakistan
147. Palau
148. Palestine (Occupied Palestinian Territory)
149. Panama
150. Papua New Guinea
151. Paraguay
152. Peru
153. Philippines
154. Poland
155. Portugal
156. Qatar
157. Romania
158. Russian Federation
159. Rwanda
160. Samoa
161. San Marino
162. Saudi Arabia
163. Senegal
164. Serbia
165. Sierra Leone
166. Singapore

- 167. Slovak Republic
- 168. Slovenia
- 169. Solomon Islands
- 170. Somalia
- 171. South Africa
- 172. South Sudan
- 173. Spain
- 174. Sri Lanka
- 175. St Kitts & Nevis
- 176. St Lucia
- 177. St Martin
- 178. St Vincent and the Grenadines
- 179. Sudan
- 180. Suriname
- 181. Swaziland
- 182. Sweden
- 183. Switzerland
- 184. Syrian Arab Republic
- 185. Tajikistan
- 186. Tanzania
- 187. Thailand
- 188. Timor Leste
- 189. Togo
- 190. Tonga
- 191. Trinidad & Tobago
- 192. Tunisia
- 193. Turkey
- 194. Turkmenistan
- 195. Tuvalu
- 196. Uganda
- 197. Ukraine
- 198. United Arab Emirates
- 199. United Kingdom
- 200. United States of America
- 201. Uruguay
- 202. Uzbekistan
- 203. Vanuatu
- 204. Venezuela
- 205. Vietnam
- 206. West Bank & Gaza
- 207. Western Sahara
- 208. Yemen
- 209. Zambia
- 210. Zimbabwe
- 211. Other _____

Do you describe yourself as:

1. A faculty member/academic/educator in the area of AMR?
2. A pharmacist/pharmaceutical scientist (who works outside academia)?
3. A pharmacy student (undergraduate student)?

Survey for faculty members/academics/educators in the area of AMR

Information about the survey: The concept of antimicrobial resistance (AMR) is cross-disciplinary, and it may cut across different modules, courses and programmes in your school's curriculum. This survey has five mandatory sections: A. Antimicrobial resistance awareness; B. Appropriate use of antimicrobial agents; C. Infection prevention and control; D. Diagnostic stewardship and surveillance; and E. Ethics, leadership, communication and governance. Each section asks you a list of questions about knowledge, skills, and attitudes to be gained from the pharmacy curriculum in the context of AMR. There is also an optional section F about continuing professional development for AMR education. Please respond to the questions based on your current knowledge. We recommend that the individuals who complete this survey are involved in curriculum development, teaching, and/or research, regarding AMR.

I hereby declare that I am involved in curriculum development in my institution, and/or the teaching, and research of AMR as a stand-



alone or integrated curriculum component.

1. I agree

How long have you been involved in pharmacy education?

1. Less than 5 years
2. 5-10 years
3. 10-15 years
4. More than 15 years

Which of these closely relates to your area of research/teaching as an educator?

1. Pharmaceutical microbiology
2. Pharmacology and toxicology
3. Pharmaceutics and pharmaceutical technology
4. Clinical pharmacy and pharmacy practice
5. Pharmacognosy and herbal/traditional antimicrobial resistance
6. Pharmaceutical and medicinal chemistry
7. Other, please specify _____

What is your highest qualification?

1. BPharm
2. PharmD
3. MPharm
4. MSc
5. PhD
6. Other, please specify _____

Section A: This section explores the extent to which your educational content/curriculum imparts foundational knowledge, skills and attitudes for AMR awareness.

A1. Knowledge for AMR awareness

A1.1. Educational content/curricula should prepare students with the knowledge and awareness of effective approaches to control AMR. Based on this statement, please select “yes”, “no” or “I am not sure” in the following questions below.

| | Yes | No | I am not sure |
|---|--------------------------|--------------------------|--------------------------|
| 1. Does your curriculum equip students with knowledge about antimicrobial agents? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Does your curriculum emphasise on the threats of antimicrobial resistance? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Does your curriculum address how to apply general pharmaceutical skills to the management of infected individuals? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

A1.2. Please rate each of the following statements based on the extent to which you think your curriculum imparts knowledge on awareness of AMR control strategies (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge. Please rate each of the following statements based on the extent to which you think your curriculum imparts knowledge on awareness of AMR control strategies (on a scale of 1-5, where 1 is very low extent and 5 is very high extent). We recognise that all these statements may not be applicable, please respond to the best of your knowledge..

| | 1 | 2 | 3 | 4 | 5 |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Explains the microbial causes of common infections | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Explains the processes involved in the diagnosis, transmission, prevention and control of common infections | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Explains how complex co-morbidities influence the choice of antimicrobial therapy | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Impart the knowledge of current evidence base and relevant best-practice guidelines | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Understand the relevance of pharmacogenomics for proper antimicrobial therapy selection and resistance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

| surveillance | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 6. Outline the common classification of antimicrobial agents, and describe the details of the pharmacokinetics as well as pharmacodynamics of antimicrobial agents | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. Explains the concept of broad- and narrow-spectrum antimicrobial agents, as well as key properties of the classes of antimicrobial agents against bacteria | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. Explains drug-bug combinations in terms of minimum inhibitory concentration (MIC), minimum bactericidal concentration (MBC), time above MIC and area under the curve (AUC) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 9. Explain the mechanisms by which organisms become resistant to antimicrobial agents | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 10. Explain the concept of empirical and culture-based treatment strategies for treating infections | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

A2. Skills for antimicrobial resistance awareness

A2.1. Educational content/curricula should equip students with the skills to improve awareness of AMR. Does your curriculum equip students with these skills?

1. Yes
2. No
3. I am not sure

A2.2. Please rate each of the following statements based on the extent to which you think your curriculum equips students with the skills to improve awareness of AMR (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge. Please rate each of the following statements based on the extent to which you think your curriculum equips students with the skills to improve awareness of antimicrobial resistance (on a scale of 1-5, where 1 is very low extent and 5 is very high extent). We recognise that all these statements may not be applicable, please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Graduates demonstrate the ability to advise on an appropriate antimicrobial drug depending on potential source of infection. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Graduates demonstrate the ability to apply laboratory and imaging test results to the pharmaceutical care of the infected patient, including advising on how laboratory information, including routine haematology, biochemistry and microbiology test results, impact on antimicrobial treatment | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Graduates demonstrate the ability to develop and implement a pharmaceutical care plan for the infected patient | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Graduates demonstrate the ability to source information from current literature and published guidelines | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Graduates demonstrate the ability to modify pharmaceutical care plans in patients with altered physiological states, extremes of age or with complex co-morbidities | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

A3. Attitudes for AMR awareness

A3.1. Educational content/curricula should equip students with the attitudes to improve awareness of AMR. Does your curriculum equip students with these attitudes? Educational content/curriculum should equip the students with the attitudes to improve awareness of AMR. Does your curriculum equip students with these attitudes?

1. Yes
2. No
3. I am not sure

A3.2. Please rate each of the following statements based on the extent to which you think your curriculum promotes attitudes that improve awareness of AMR (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Have a patient-centred focus in managing the medication of individuals with infections | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Be committed to meticulous record-keeping and documentation of antimicrobial use history | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Show willingness to work within a team of care personnel or antimicrobial stewardship teams | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Be vigilant for errors in antimicrobial prescription and escalate/deescalate appropriately | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Keep up to date with recent scientific advances and show enthusiasm for continued professional development on AMR | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Show enthusiasm in performing or contributing to clinical audits and participation in quality improvement programmes relating to rational antimicrobial use | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. Show willingness to teach students, colleagues and other health professionals about antimicrobial agents and the development of resistance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Section B: This section explores the extent to which your educational content/curriculum imparts knowledge, skills and attitudes for appropriate use of antimicrobial agents. Knowledge, skills and attitudes for appropriate use of antimicrobial agents..

B1. Knowledge for appropriate use of antimicrobial agents

B1.1. The curriculum should equip students with the knowledge to facilitate the optimal and safe use of antimicrobial agents for the management of infections. Please select “yes”, “no” or “I am not sure” to the following questions below. The curriculum should equip students with the knowledge to facilitate the optimal and safe use of antimicrobial agents for the management of infections. Please select "yes", "no" or "I am not sure" to the following questions below.

| | Yes | No | I am not sure |
|---|--------------------------|--------------------------|--------------------------|
| 1. Does your curriculum equip students with knowledge on the pharmaceutical management of antimicrobial agents for the infected individual? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Does your curriculum equip students with knowledge on the safe use of antimicrobial agents? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Does your curriculum equip students with knowledge on antimicrobial stewardship and governance? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

B1.2. Please rate each of the following statements based on the extent to which you think your curriculum imparts knowledge for the appropriate use of antimicrobials (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Describe use of AUC/MIC data and the concept of time and concentration-dependent killing and persistent antimicrobial effect and how this affects the choice of antimicrobial agent, the dosing regimen and the method of administration | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Explain the basis of modifying therapy in line with complex co-morbidities, allergies, drug interactions, extremes of age or other physiological states | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Understand the need for therapeutic drug monitoring and when this is required | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Describe the optimal dose, route, dosing interval and duration of antimicrobial therapy for a given clinical condition and when to escalate/deescalate | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Demonstrate knowledge of current evidence-based guidelines for management of the various infectious disease syndromes | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Explain the importance of safe and responsible use of antimicrobial agents and drug allergies, as well as common | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

| | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| signs and symptoms of antimicrobial toxicity | | | | | |
| 7. Describe contraindications to selected antimicrobials in certain clinical conditions | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. Understand the risk of AMR and how it could affect routine patient care and spread within the healthcare environment and the community | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 9. Explain the method of safe disposal of unused antimicrobial agents. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 10. Describe the vital role played by the pharmacist in antimicrobial stewardship | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 11. Explain the importance of antimicrobial formularies, consumption data, principles of antimicrobial pharmacoepidemiology and prescribing policies and processes to monitor use | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 12. Explain how local AMR patterns should be used to direct empirical antimicrobial use | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 13. Explain the pharmacist's role in evaluating evidence from clinical trials and current literature to inform the inclusion of new antimicrobial agents in the formulary | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 14. Explain the importance of restricted reporting of susceptibility data by microbiologists to control antimicrobial use | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 15. Understand the importance of 48- to 72-hour review of all antimicrobial prescriptions to check the optimal duration and prevent overuse | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 16. Understand the WHO strategy for optimising use of antimicrobial agents: Access, Watch and Reserve (AWaRe) categorisation | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 17. Understand the importance of pre-authorisation of certain antimicrobial agents (for settings where policy is applied) and the role of the pharmacist in achieving this safely and without risk to patients | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

B2. Skills for appropriate use of antimicrobial agents

B2.1 Educational content/curricula should equip students with the skills to implement change with regard to appropriate use of antimicrobials. Does your curriculum equip students with these skills?

1. Yes
2. No
3. I am not sure

B2.2. Please rate each of the following statements based on the extent to which you think your curriculum equips students with the skills for appropriate use of antimicrobials (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Demonstrate the ability to carry out a antimicrobial resistance utilisation review (MUR) and create a antimicrobial resistance management plan for antimicrobial agents | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Demonstrate the ability to accurately dispense prescriptions of antimicrobial agents for outpatient and inpatient care | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Demonstrate the ability to counsel patients on the proper use of antimicrobial agents, including the most effective and safe regimen for the patient | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Demonstrate the ability to critically assess all prescriptions for accuracy, safety and adherence to local policies | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Demonstrate the ability to design or contribute to audit processes and quality improvement programmes for antimicrobial prescribing | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Demonstrate the ability to give clear advice on dosage, | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

| | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| preparation and method of administration, dosing intervals, storage, side effects, interactions and contraindications of antimicrobial agents for all patients, and especially for vulnerable patients | | | | | |
| 7. Demonstrate the ability to create a system to investigate, record and report adverse events and substandard and falsified antimicrobial agents to the relevant authorities | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

B3. Attitudes for appropriate use of antimicrobial agents

B3.1. Educational content/curricula should equip students with the attitudes to facilitate optimal and safe use of antimicrobial agents for management of infections according to their field and level of expertise. Does your curriculum promote these attitudes?

1. Yes
2. No
3. I am not sure

B3.2. Please rate each of the following statements based on the extent to which you think your curriculum teaches attitudes that promote the appropriate use of antimicrobials (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Show willingness to communicate in a multidisciplinary team | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Show enthusiasm in performing or contributing to clinical audit and participation in quality improvement programmes relating to antimicrobial use | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Show willingness to educate patients and the public in the safe and appropriate use of antimicrobials, discouraging self-prescription and over-the-counter purchasing of antimicrobial agents wherever possible | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Show willingness to teach students, colleagues and other health professionals about antimicrobial use and resistance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Show a high degree of scrutiny in reviewing prescriptions to ensure accurate and safe prescribing | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Be a role model for good prescribing and dispensing behaviour with regard to antimicrobials | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. Demonstrate willingness to embrace the principles of antimicrobial stewardship | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. Have an enthusiastic approach to the culture of quality improvement | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Section C: This section explores the extent to which your educational content/curriculum imparts the knowledge, skills and attitudes for infection prevention and control.

C1. Knowledge for infection prevention and control

C1.1. Educational content/curricula should equip students with an understanding of the broad principles of infection prevention and control, including the importance of water, sanitation and hygiene (WASH) in healthcare facilities to control and reduce the spread of antimicrobial resistance. Does your curriculum equip students with this knowledge?

1. Yes
2. No
3. I am not sure

C1.2. Please rate each of the following statements based on the extent to which you think your curriculum imparts knowledge for infection prevention and control (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|--|---|---|---|---|---|
| | | | | | |

| | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Understand that health care-associated infection can occur when pharmacological formulations are contaminated with microbes and that it can cause life-threatening infections | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Understand that this may occur during manufacture or when antimicrobial resistance are improperly prepared, handled, dispensed, stored, or outdated | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Have knowledge of the routes of contamination and how to prevent contamination | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Understand the need to follow aseptic/sterile techniques and sterile or single-use equipment when preparing or reconstituting antimicrobial resistance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Have knowledge of infection control practices in a pharmacy | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Understand the risks involved in using multiple-dose vials and the importance of use-by time/date of both single- and multiple-dose vials once opened | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. Understand the need to educate patients on how to use antimicrobials provided at the time of discharge | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. Understand the value of monitoring and identifying contamination and developing a surveillance system | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

C2. Skills for infection prevention and control

C2.1. Educational content/curricula should equip students with the skills to implement change with regard to infection prevention and control. Does your curriculum equip students with these skills?

1. Yes
2. No
3. I am not sure

C2.2. Please rate each of the following statements based on the extent to which you think your curriculum covers skills for infection prevention and control (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Demonstrate the ability to follow standards of aseptic practice within the pharmacy and for the preparation of antimicrobial resistance on wards | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Demonstrate ability to monitor good practice in the pharmacy | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Demonstrate the ability to refer suspected or proven cases of antimicrobial contamination to the appropriate authorities | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Demonstrate adherence to instructions when using single- or multiple-dose vials once they have been opened | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Demonstrate proper labelling, dating and storage of sterile products | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Demonstrate vaccine knowledge, vaccine awareness, and role of vaccines as a general public health measure to prevent infections | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. Be willing to participate in infection control programmes of the healthcare facility | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

C3. Attitudes for infection prevention and control

C3.1. Educational content/curricula should equip students with the attitudes to implement change with regard to infection prevention and control. Does your curriculum equip students with these attitudes?

1. Yes
2. No
3. I am not sure

C3.2. Please rate each of the following statements based on the extent to which you think your curriculum covers attitudes that promote infection prevention and control (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that



all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Maintain meticulous hand hygiene practice | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Have a high standard of compliance with all aspects of infection prevention and control according to agreed policy in the pharmacy and on the wards | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Self-declare and abstain from preparation of medications if suffering from rashes, sunburn, weeping sores, broken skin, conjunctivitis, and respiratory or gastrointestinal infections | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Show compliance with manufacturers' instructions for drugs and equipment and commitment to meticulous record-keeping | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Section D: This section explores the extent to which your educational content/curriculum imparts the knowledge, skills and attitudes for diagnostic stewardship and surveillance.

D1. Knowledge for diagnostic stewardship and surveillance

D1.1. Educational content/curricula should equip students with the knowledge of the principles and processes of diagnostic stewardship, surveillance of AMR and antimicrobial stewardship that underpin prophylaxis and treatment guidelines and AMR control strategies. Does your curriculum equip students with this knowledge?

1. Yes
2. No
3. I am not sure

D1.2. Please rate each of the following statements based on the extent to which you think your curriculum provides knowledge regarding diagnostic stewardship and surveillance (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Describe how to collect and analyse antimicrobial consumption data and antimicrobial costs/expenditure | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Describe the role of molecular/genetic/genomic tests in AMR surveillance and the role of reference labs and observatories in this regard | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Describe the flow of data from receipt of a specimen in a laboratory to performance of identification and susceptibility testing to reporting of the data to a data repository | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Describe basic epidemiology indicators, i.e., incidence and prevalence data, point prevalence studies, use of appropriate denominator data to inform burden of disease | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

D2. Skills for diagnostic stewardship and surveillance

D2.1. Educational content/curricula should equip students with the skills to implement change with regard to diagnostic stewardship and surveillance. Does your curriculum equip students with these skills?

1. Yes
2. No
3. I am not sure

D2.1. Please rate each of the following statements based on the extent to which you think your curriculum provides skills regarding diagnostic stewardship and surveillance (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Demonstrate the ability to collect and analyse antimicrobial consumption data to inform local quality initiatives | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Demonstrate the ability to prepare reports and present data to influence policy | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Demonstrate the ability to contribute to local indicators that measure antimicrobial use from a pharmacist's perspective | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Demonstrate the ability to perform simple analyses linking laboratory, clinical and antimicrobial usage data to improve prescribing | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

D3. Attitudes for diagnostic stewardship and surveillance

D3.1. Educational content/curricula should equip students with the attitudes to implement change with regard to diagnostic stewardship and surveillance. Does your curriculum equip students with these attitudes?

1. Yes
2. No
3. I am not sure

D3.2. Please rate each of the following statements based on the extent to which you think your curriculum promotes attitudes regarding diagnostic stewardship and surveillance (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Show respect for patient confidentiality and data protection regulations | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Show willingness to participate in quality improvement programmes | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Demonstrate a willingness to work in multidisciplinary teams | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Be committed to meticulous record-keeping and documentation | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Be an educator of colleagues, patients and the public and promote good antimicrobial prescribing. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Be an antimicrobial champion and guardian to protect the effectiveness of antimicrobial agents as an ethical imperative for the common good | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Section E: This section explores the extent to which your educational content/curriculum imparts knowledge, skills and attitude for ethics, leadership, communication and governance

E1. Knowledge for ethics, leadership, communication and governance

E1.1. Educational content/curricula should equip students with the knowledge of the concept of ethical practice, effective leadership, the importance of communication and good governance as important strategies that underpin the prevention and control of AMR.

Does your curriculum equip students with this knowledge?

1. Yes
2. No
3. I am not sure

E1.2. Please rate each of the following statements based on the extent to which you think your curriculum imparts knowledge regarding ethics, leadership, communication and governance for the prevention and control of AMR (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Understand the importance of reporting substandard and falsified products and adverse events. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Understand the importance of proper record-keeping of antimicrobial resistance inventories and use of product codes (according to setting) for traceability. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Understand the importance of pharmacovigilance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Understand the importance of leadership, good governance and accountability | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Understand the importance of learning and development as part of personal and team development. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Understand the importance of having and abiding by a local ethics policy | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. Describe strategies for effective communication | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. Describe the main (leadership) role of national medicine regulatory authorities in the regulation of antimicrobial resistance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

E2. Skills for ethics, leadership, communication and governance

E2.1. Educational content/curricula should equip students with the skills to implement change with regard to ethics, leadership, communication and governance for the prevention and control of AMR. Does your curriculum equip students with these skills?

1. Yes
2. No
3. I am not sure

E2.2. Please rate each of the following statements based on the extent to which you think your curriculum provides skills for ethics, leadership, communication and governance for the prevention and control of AMR (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Demonstrate basic skills in patient safety. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Demonstrate good record-keeping and documentation. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Demonstrate compliance with national and local policies. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Participate in quality improvement programmes. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Apply creative thinking in achieving change and improving | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

| | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| patient safety | | | | | |
| Utilise student communication and outreach activities to raise community awareness regarding AMR | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

E3. Attitudes for ethics, leadership, communication and governance Attitude for ethics, leadership, communication and governance

E3.1. Educational content/curricula should equip students with the attitudes to implement change with regard to ethics, leadership, communication and governance for the prevention and control of AMR. Does your curriculum equip students with these skills?

1. Yes
2. No
3. I am not sure

E3.2. Please rate each of the following statements based on the extent to which you think your curriculum promotes attitudes toward ethics, leadership, communication and governance for the prevention and control of antimicrobial resistance (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Believe that every individual has the capacity to lead by example within their peer group. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Be a role model for students, colleagues and peers. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Where necessary, manage ethical dilemmas and challenge poor behaviour. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Show recognition of one's limitations and willingness to ask for advice. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Show enthusiasm for learning and for mentoring/training others. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Where relevant, include the patient in shared decision-making on adherence. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Section F (Optional): This section explores the extent to which continuing education, continuing professional development and innovations are included in AMR education

Does your curriculum provide continuing education or continuing professional development opportunities in antimicrobial resistance?

1. Yes
2. No
3. I am not sure

In which format are these continuing education or continuing professional development opportunities? Tick all that apply.

1. Workshop
2. Courses
3. Continuing education lectures
4. Other, please describe _____

What is the mode of delivery of these continuing education or continuing professional development opportunities? Tick all that apply.

1. Face-to-face

- 2. Virtual synchronous
- 3. Virtual asynchronous at my own pace
- 4. Mixed
- 5. Other _____

Please describe any innovations in AMR education and training applicable to your place of practice (such as antimicrobial stewardship training).

Please let us know any additional thoughts you have about the AMR education for the pharmaceutical workforce which have not addressed in this survey

Would you like to showcase your activities and innovations in antimicrobial resistance education at a FIP event?

- 1. Yes
- 2. No

First Name

Last Name

Email Address

Survey for pharmacists and pharmaceutical scientists

Information about the survey: The concept of antimicrobial resistance (AMR) is cross-disciplinary and it may cut across different

modules, courses and programmes and must fulfil the needs in practice. This survey has five mandatory sections: A. Antimicrobial resistance awareness; B. Appropriate use of antimicrobial agents; C. Infection prevention and control; D. Diagnostic stewardship and surveillance; and E. Ethics, leadership, communication and governance. Each section ask you a list of questions about knowledge, skills, and attitudes gained from education in the context of AMR. There is also an optional section F about continuing professional development for AMR education. Please respond to the questions based on your current knowledge. Please click next to start the survey.

Which of these closely relates to your area of practice?

1. Hospital pharmacy
2. Community pharmacy
3. Industrial Pharmacy
4. Military and emergency pharmacy
5. Social and administrative pharmacy
6. Regulatory Pharmacy
7. Medical representative
8. Other, please specify _____

How long have you been practicing as a pharmacist?

1. Less than 5 years
2. 5-10 years
3. 10-15 years
4. More than 15 years

What is your highest qualification?

1. BPharm
2. PharmD
3. MPharm
4. MSc
5. PhD
6. Other, please specify _____

Section A: This section explores the extent to which your university or continuing education has been relevant/supportive of your practice with regard to the knowledge, skills and attitudes towards AMR awareness.

A1. Knowledge for antimicrobial resistance awareness

A1.1. University or continuing education should equip pharmacy practitioners with the knowledge and awareness of effective approaches to control AMR. Based on this statement, please select “yes”, “no” or “I am not sure” to the following questions.

| | Yes | No | I am not sure |
|--|--------------------------|--------------------------|--------------------------|
| 1. Did your university or continuing education equip you with knowledge about antimicrobial agents? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Did your university or continuing education emphasise the threats of antimicrobial resistance? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Did your university or continuing education address how to apply general pharmaceutical skills to the management of infected individuals? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

A1.2. To what extent are the following statements useful to your practice with regards to having knowledge on awareness of antimicrobial resistance (on a scale of 1-5, where 1 is very low extent and 5 is very high extent). We recognise that all these

statements may not be relevant, please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Explains the microbial causes of common infections | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Explains the processes involved in the diagnosis, transmission, prevention and control of common infections | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Explains how complex co-morbidities influence the choice of antimicrobial therapy | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Impart the knowledge of current evidence base and relevant best-practice guidelines | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Understand the relevance of pharmacogenomics for proper antimicrobial therapy selection and resistance surveillance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Outline the common classification of antimicrobial agents, and describe the details of the pharmacokinetics as well as pharmacodynamics of antimicrobial agents | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. Explains the concept of broad- and narrow-spectrum antimicrobial agents, as well as key properties of the classes of antimicrobial agents against bacteria | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. Explains drug-bug combinations in terms of minimum inhibitory concentration (MIC), minimum bactericidal concentration (MBC), time above MIC and area under the curve (AUC) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 9. Explain the mechanisms by which organisms become resistant to antimicrobial agents | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 10. Explain the concept of empirical and culture-based treatment strategies for treating infections | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

A2. Skills for antimicrobial resistance awareness

A2.1. University or continuing education should equip pharmacy practitioners with the skills to implement change in awareness of AMR according to role and level of training. Did your past or recent education equip you with these skills?

1. Yes
2. No
3. I am not sure

A2.2. To what extent are the following statements useful to your practise with regards to having skills for raising awareness of antimicrobial resistance. (On a scale of 1-5, where 1 is very low extent and 5 is very high extent). We recognise that all these statements may not be relevant, please respond to the best of your knowledge).

| | 1 | 2 | 3 | 4 | 5 |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. The ability to advise on an appropriate antimicrobial drug depending on potential source of infection. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. The ability to apply laboratory and imaging test results to the pharmaceutical care of the infected patient, including advising on how laboratory information, including routine haematology, biochemistry and microbiology test results, impact on antimicrobial treatment | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. The ability to develop and implement a pharmaceutical care plan for the infected patient | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. The ability to source information from current literature and published guidelines | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. The ability to modify pharmaceutical care plans in patients with altered physiological states, extremes of age | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

| | | | | | |
|--------------------------------|--|--|--|--|--|
| | | | | | |
| or with complex co-morbidities | | | | | |

A3. Attitude for antimicrobial resistance awareness

A3.1. University or continuing education should equip pharmacy practitioners with the attitudes to implement change with regard to AMR awareness according to role and level of training. Did your past or recent education equip you with these attitudes?

1. Yes
2. No
3. I am not sure

A3.2. To what extent are the following statements useful to your practice with regard to promoting attitudes for raising awareness of AMR (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Having a patient-centred focus in managing the medication of individuals with infections | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Being committed to meticulous record-keeping and documentation of antimicrobial use history | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Showing willingness to work within a team of care personnel or antimicrobial stewardship teams. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Being vigilant for errors in antimicrobial prescription and escalate/deescalate appropriately | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Keeping up to date with recent scientific advances and show enthusiasm for continued professional development on AMR | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Showing enthusiasm in performing or contributing to clinical audits and participation in quality improvement programmes relating to rational antimicrobial use | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. Showing willingness to teach students, colleagues and other health professionals about antimicrobial agents and the development of resistance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Section B: This section explores the extent to which your university or continuing education has been relevant/supportive of your practice with regard to the knowledge, skills and attitudes for appropriate use of antimicrobial agents.

B1. Knowledge for appropriate use of antimicrobial agents

B1.1. University or continuing education should equip pharmacy practitioners with knowledge and understanding to facilitate the optimal and safe use of antimicrobial agents for the management of infections. Based on this statement, please select “yes”, “no” or “I am not sure” to the following questions.

| | Yes | No | I am not sure |
|---|--------------------------|--------------------------|--------------------------|
| 1. Did your university or continuing education equip you with knowledge on the pharmaceutical management of antimicrobial agents for the infected individual? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Did your university or continuing education equip you with knowledge on the safe use of antimicrobial agents? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Did your university or continuing education equip you with knowledge on | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

| | | | |
|---|--|--|--|
| | | | |
| antimicrobial stewardship and governance? | | | |

B1.2. To what extent are the following statements useful to your practice with regard to having knowledge of the appropriate use of antimicrobials (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Describing the use of AUC/MIC data and the concept of time and concentration-dependent killing and persistent antimicrobial effect and how this affects the choice of antimicrobial agent, the dosing regimen and the method of administration | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Explaining the basis of modifying therapy in line with complex co-morbidities, allergies, drug interactions, extremes of age or other physiological states | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Understanding the need for therapeutic drug monitoring and when this is required | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Describing the optimal dose, route, dosing interval and duration of antimicrobial therapy for a given clinical condition and when to escalate/deescalate | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Demonstrating knowledge of current evidence-based guidelines for management of the various infectious disease syndromes | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Explaining the importance of safe and responsible use of antimicrobial agents and drug allergies, as well as common signs and symptoms of antimicrobial toxicity | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. Describing contraindications to selected antimicrobials in certain clinical conditions | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. Understanding the risk of AMR and how it could affect routine patient care and spread within the healthcare environment and the community | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 9. Explaining the method of safe disposal of unused antimicrobial agents. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 10. Describing the vital role played by the pharmacist in antimicrobial stewardship | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 11. Explaining the importance of antimicrobial formularies, consumption data, principles of antimicrobial pharmacoepidemiology and prescribing policies and processes to monitor use | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 12. Explaining how local AMR patterns should be used to direct empirical antimicrobial use | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 13. Explaining the pharmacist's role in evaluating evidence from clinical trials and current literature to inform the inclusion of new antimicrobial agents in the formulary | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 14. Explaining the importance of restricted reporting of susceptibility data by microbiologists to control antimicrobial use | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 15. Understanding the importance of 48- to 72-hour review of all antimicrobial prescriptions to check the optimal duration and prevent overuse | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 16. Understanding the WHO strategy for optimising use of antimicrobial agents: Access, Watch and Reserve (AWaRe) categorisation | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 17. Understanding the importance of pre-authorisation of certain antimicrobial agents (for settings where policy is applied) and the role of the pharmacist in achieving this safely and without risk to patients | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

B2. Skills for appropriate use of antimicrobial agents

B2.1. University or continuing education should equip pharmacy practitioners with the skills to implement change with regard to the appropriate use of antimicrobials, according to their field and level of training/expertise. Did your past or recent education equip you with these skills?

1. Yes
2. No
3. I am not sure

B2.2. To what extent are the following statements useful to your practice with regard to having skills for the appropriate use of antimicrobials (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Demonstrating the ability to carry out an antimicrobial resistance utilisation review (MUR) and create an antimicrobial resistance management plan for antimicrobial agents | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Demonstrating the ability to accurately dispense prescriptions of antimicrobial agents for outpatient and inpatient care | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Demonstrating the ability to counsel patients on the proper use of antimicrobial agents, including the most effective and safe regimen for the patient | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Demonstrating the ability to critically assess all prescriptions for accuracy, safety and adherence to local policies | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Demonstrating the ability to design or contribute to audit processes and quality improvement programmes for antimicrobial prescribing | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Demonstrating the ability to give clear advice on dosage, preparation and method of administration, dosing intervals, storage, side effects, interactions and contraindications of antimicrobial agents for all patients, and especially for vulnerable patients | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. Demonstrating the ability to create a system to investigate, record and report adverse events and substandard and falsified antimicrobial agents to the relevant authorities | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

B3. Attitude for appropriate use of antimicrobials

B3.1. University or continuing education should equip pharmacy practitioners with the attitudes to facilitate optimal and safe use of antimicrobial agents for management of infections according to their field and level of expertise. Did your past or recent education promote these attitudes?

1. Yes
2. No
3. I am not sure

B3.2. To what extent are the following statements useful to your practice with regard to promoting attitudes for the appropriate use of antimicrobials (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements



may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Showing willingness to communicate in a multidisciplinary team | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Showing enthusiasm in performing or contributing to clinical audit and participation in quality improvement programmes relating to antimicrobial use | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Showing willingness to educate patients and the public in the safe and appropriate use of antimicrobials, discouraging self-prescription and over-the-counter purchasing of antimicrobial agents wherever possible | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Showing willingness to teach students, colleagues and other health professionals about antimicrobial use and resistance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Showing a high degree of scrutiny in reviewing prescriptions to ensure accurate and safe prescribing | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Being a role model for good prescribing and dispensing behaviour with regard to antimicrobials | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. Demonstrating willingness to embrace the principles of antimicrobial stewardship | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. Having an enthusiastic approach to the culture of quality improvement | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Section C: This section explores the extent to which your university or continuing education has been relevant/supportive of your practice with regards the knowledge, skills and attitudes for infection prevention and control.

C1. Knowledge for infection prevention and control

C1.1. University or continuing education should equip practitioners with an understanding of the broad principles of infection prevention and control, including the importance of water, sanitation, and hygiene (WASH) in healthcare facilities to control and reduce the spread of AMR. Did your university or continuing education equip you with this knowledge?

1. Yes
2. No
3. I am not sure

C1.2. To what extent are the following statements useful to your practice with regard to having knowledge of infection prevention and control (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge).

| | 1 | 2 | 3 | 4 | 5 |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Understanding that health care-associated infection can occur when pharmacological formulations are contaminated with microbes and that it can cause life-threatening infections | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Understanding that this may occur during manufacture or when antimicrobial resistance are improperly prepared, handled, dispensed, stored or become outdated. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Having knowledge of the routes of contamination and how to prevent contamination | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Understanding the need to follow aseptic/sterile techniques and sterile or single-use equipment when preparing or reconstituting antimicrobial resistance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Having knowledge of infection control practices in a | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

| pharmacy | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 6. Understanding the risks involved in using multiple-dose vials and the importance of use-by time/date of both single- and multiple-dose vials once opened | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. Understanding the need to educate patients on how to use antimicrobials provided at the time of discharge | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. Understanding the value of monitoring and identifying contamination and developing a surveillance system | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

C2. Skills for infection prevention and control

C2.1. University or continuing education should equip pharmacy practitioners with the skills to implement change with regard to infection prevention and control. Did your education equip you with these skills?

1. Yes
2. No
3. I am not sure

C2.2. To what extent are the following statements useful to your practice with regards to having skills for infection prevention and control (on a scale of 1-5, where 1 is very low extent and 5 is very high extent). We recognise that all these statements may not be relevant, please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Demonstrating the ability to follow standards of aseptic practice within the pharmacy and for the preparation of antimicrobial resistance on wards | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Demonstrating ability to monitor good practice in the pharmacy | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Demonstrating the ability to refer suspected or proven cases of antimicrobial contamination to the appropriate authorities | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Demonstrating adherence to instructions when using single- or multiple-dose vials once they have been opened | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Demonstrating proper labelling, dating and storage of sterile products | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Demonstrating vaccine knowledge, vaccine awareness, and role of vaccines as a general public health measure to prevent infections | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. Being willing to participate in infection control programmes of the healthcare facility | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

C3. Attitude for infection control and prevention

C3.1. University or continuing education should equip pharmacy practitioners with the attitude to implement change with regard to infection prevention and control. Did your education equip you with these attitudes?

1. Yes
2. No
3. I am not sure

C3.2. To what extent are the following statements useful to your practice with regard to promoting attitudes for infection prevention



and control (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Maintaining a meticulous hand hygiene practice | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Having a high standard of compliance with all aspects of infection prevention and control according to agreed policy in the pharmacy and on wards | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Self-declaring and abstaining from the preparation of antimicrobial resistance if suffering from rashes, sunburn, weeping sores, broken skin, conjunctivitis, or respiratory or gastrointestinal infections | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Showing compliance with manufacturers’ instructions for drugs and equipment and commitment to meticulous record-keeping | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Section D: This section explores the extent to which your university or continuing education has been relevant/supportive of your practice with regard to the knowledge, skills and attitudes for diagnostic stewardship and surveillance.

D1. Knowledge for diagnostic stewardship and surveillance

D1.1. University or continuing education should equip practitioners with the knowledge and understanding, relevant to their field and level of expertise, of the principles and processes of diagnostic stewardship, surveillance of AMR and antimicrobial stewardship that underpin prophylaxis and treatment guidelines and AMR control strategies. Did your education equip you with this knowledge?

1. Yes
2. No
3. I am not sure

D1.2. To what extent are the following statements useful to your practice with regard to having knowledge for diagnostic stewardship and surveillance (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Describing how to collect and analyse antimicrobial consumption data and antimicrobial costs/expenditure | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Describing the role of molecular/genetic/genomic tests in AMR surveillance and the role of reference labs and observatories in this regard | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Describing the flow of data from receipt of a specimen in a laboratory to performance of identification and susceptibility testing to reporting of the data to a data repository | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Describing the basic epidemiology indicators, i.e., incidence and prevalence data, point prevalence studies, use of appropriate denominator data to inform burden of disease | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

D2. Skills for diagnostic stewardship and surveillance

D2.1. University or continuing education should equip practitioners with the skills to implement change with regard to diagnostic stewardship and surveillance. Did your education equip you with these skills?

1. Yes
2. No
3. I am not sure

D2.2. To what extent are the following statements useful to your practice with regards to having skills for diagnostic stewardship and surveillance (on a scale of 1-5, where 1 is very low extent and 5 is very high extent). We recognise that all these statements may not be relevant, please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Demonstrating the ability to collect and analyse antimicrobial consumption data to inform local quality initiatives | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Demonstrating the ability to prepare reports and present data to influence policy | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Demonstrating the ability to contribute to local indicators that measure antimicrobial use from a pharmacist's perspective | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Demonstrating the ability to perform simple analyses linking laboratory, clinical and antimicrobial usage data to improve prescribing | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

D3. Attitudes for diagnostic stewardship and surveillance

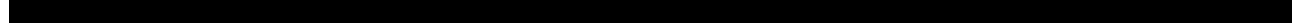
D3.1. University or continuing education should equip practitioners with the attitudes to implement change with regard to diagnostic stewardship and surveillance. Did your education equip you with these attitudes?

1. Yes
2. No
3. I am not sure

D3.2. To what extent are the following statements useful to your practice with regard to promoting attitudes towards diagnostic stewardship and surveillance (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Showing respect for patient confidentiality and data protection regulations | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Showing willingness to participate in quality improvement programmes | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Demonstrating a willingness to work in multidisciplinary teams | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Being committed to meticulous record-keeping and documentation | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Being an educator of colleagues, patients, and the public and promoting good antimicrobial prescribing | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Being an antimicrobial champion and guardian to protect the effectiveness of antimicrobial agents as an ethical imperative for the common good | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Section E: This section explores the extent to which your university or continuing education has been relevant/ supportive of your



practice with regards to knowledge, skills and attitudes for ethics, leadership, communication and governance.

E1. Knowledge for ethics, leadership, communication and governance

E1.1. University or continuing education should equip practitioners with the knowledge of the concept of ethical practice, effective leadership, the importance of communication, and good governance as important strategies that underpin the prevention and control of AMR. Did your education equip you with this knowledge?

- 1. Yes
- 2. No
- 3. I am not sure

E1.2. To what extent are the following statements useful to your practice with regard to knowledge of ethics, leadership, communication and governance for the prevention and control of AMR (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Understanding the importance of reporting substandard and falsified products and adverse events | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Understanding the importance of proper record-keeping of medicine inventories and use of product codes (according to setting) for traceability | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Understanding the importance of pharmacovigilance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Understanding the importance of leadership, good governance, and accountability | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Understanding the importance of learning and development as part of personal and team development | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Understanding the importance of having and abiding by a local ethics policy | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. Understanding the importance of strategies for effective communication | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. Understanding the importance of the main (leadership) role of national antimicrobial resistance regulatory authorities | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

E2. Skills for ethics, leadership, communication and governance

E2.1. University or continuing education should equip pharmacy practitioners with the skills to implement change with regard to ethics, leadership, communication, and governance for the prevention and control of AMR. Did your education equip you with these skills?

- 1. Yes
- 2. No
- 3. I am not sure

E2.2. To what extent are the following statements useful to your practice with regard to having skills for ethics, leadership, communication and governance for the prevention and control of AMR (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Demonstrating basic skills in patient safety | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Demonstrating good record-keeping and | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

| documentation | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 3. Demonstrating compliance with national and local policies | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Participating in quality improvement programmes | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Applying creative thinking in achieving change and improving patient safety | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Utilising student communication and outreach activities to raise community awareness of AMR | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

E3. Attitudes for ethics, leadership, communication and governance

E3.1. University or continuing education should equip pharmacy practitioners with the attitudes to implement change with regard to ethics, leadership, communication and governance for the prevention and control of AMR. Did your education equip you with these attitudes?

1. Yes
2. No
3. I am not sure

E3.2. To what extent are the following statements useful to your practice with regard to promoting attitudes for ethics, leadership, communication and governance for the prevention and control of AMR (on a scale of 1–5, where 1 is very low extent and 5 is very high extent)? We recognise that all these statements may not be applicable. Please respond to the best of your knowledge.

| | 1 | 2 | 3 | 4 | 5 |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Believing that every individual has the capacity to lead by example within their peer group | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Being a role model for students, colleagues and peers | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Where necessary, managing ethical dilemmas and challenging poor behaviour | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. Showing recognition of one's limitations and willingness to ask for advice | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. Showing enthusiasm for learning and for mentoring/training others | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. Where relevant, including the patient in shared decision-making on adherence | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Section F (Optional): This section explores continuing education, continuing professional development and innovations in relation to education in AMR.

F1. Please rate the following statement (1 strongly disagree and 5 strongly agree).

| | 1 | 2 | 3 | 4 | 5 |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. In general, my undergraduate education on antimicrobial resistance is relevant to my practice | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. In general, other education opportunities for antimicrobial resistance excluding my undergraduate education has relevant to my practice | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Participation in workshops on laws and regulations on prescription and sale of antimicrobials, for human use will improve my knowledge, attitude and behaviour regarding antimicrobial resistance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

F2. Are you willing to attend workshops on national antimicrobial resistance action plan?

1. Yes
2. No
3. I am not sure

F3. Would you consider an advanced course on antimicrobial resistance and therapeutic impact important?

1. Yes
2. No
3. I am not sure

F4. Which format of antimicrobial resistance continuing education would you prefer?

1. Course, being a set of classes on AMR leading to an exam or qualification
2. Workshop, having hands-on and practical training experience
3. Other, please describe _____

F5. Which mode of delivery of antimicrobial resistance continuing education would you prefer?

1. Face-to-face
2. Virtual synchronous, having to virtually attend a class session at the same time as your instructor and classmates
3. Virtual asynchronous, not having to virtually attend a class session at the same time as your instructor and classmates
4. Mixed
5. Other _____

F6. Please let us know any additional thoughts you have about the antimicrobial resistance education which have not been addressed in this survey

F7. Would you like to showcase your activities and innovations in antimicrobial resistance education at a FIP event?

1. Yes
2. No

First Name

Last Name

Email Address

Survey for undergraduate students

Information about the survey: This survey includes eight questions and an optional question on additional thoughts about education in antimicrobial resistance. Please answer the questions based on your knowledge and preferences.

1. What academic degree are you currently studying for?

1. B.Pharm
2. M.Pharm
3. Pharm.D

2. Have you studied antimicrobials and antimicrobial resistance in your undergraduate degree?

1. Yes
2. No
3. I am not sure

3. How was the AMR course delivered?

1. As a stand alone course
2. As a part of other courses
3. Other, please describe _____

4. Please select from the list below the areas related to AMR education that you have taken courses on.

1. Foundations that build knowledge and awareness of antimicrobial resistance
2. General pharmaceutical skills applied to the infected individual
3. Antimicrobial agents and the threat of antimicrobial resistance
4. Appropriate use of antimicrobial agents
5. Pharmaceutical management of antimicrobial agents for the infected individual
6. Safe use of antimicrobial agents
7. Antimicrobial stewardship and governance
8. Infection prevention and control
9. Health care-associated infection, antimicrobial resistance and infection prevention and control
10. Diagnostic stewardship and surveillance
11. Surveillance of antimicrobial consumption, antimicrobial resistance and links to diagnostic stewardship
12. Ethics, leadership, communication and governance.
13. Other _____

5. Have you taken any additional courses related to antimicrobials and AMR outside your undergraduate programme?

1. Yes
2. No
3. I am not sure

6. How often have you learnt about concepts related to AMR in your pharmacy school education?

1. 1–2 lectures over an academic year as part of other courses
2. 3 or more lectures over an academic year as part of other courses
3. An entire module or course within the curriculum
4. Other, please describe _____

7. How do you rate your knowledge of antimicrobials and AMR?

1. None
2. Some
3. Reasonable
4. Good
5. Very good

8. How confident do you feel about your skills to deliver antimicrobials related services after graduation?

1. Not confident
2. Slightly confident
3. Neutral
4. Confident
5. Very confident

9. Please let us know any additional thoughts you have about your education on antimicrobial resistance.

Appendix B. Countries that responded to the survey

| Country | Number of respondents |
|--------------|-----------------------|
| Afghanistan | 3 |
| Algeria | 3 |
| Argentina | 2 |
| Australia | 10 |
| Bulgaria | 2 |
| Burkina Faso | 1 |
| Cameroon | 3 |
| Canada | 4 |
| Chile | 1 |
| Costa Rica | 1 |
| Croatia | 1 |
| Egypt | 2 |
| Ethiopia | 1 |
| France | 4 |
| Germany | 1 |
| India | 24 |
| Ireland | 1 |
| Israel | 1 |
| Italy | 2 |
| Japan | 1 |
| Jordan | 3 |
| Kenya | 3 |
| Latvia | 1 |
| Lebanon | 4 |
| Malaysia | 12 |
| Mali | 1 |
| Mongolia | 1 |
| Nepal | 2 |
| Netherlands | 4 |
| New Zealand | 1 |
| Niger | 1 |
| Nigeria | 21 |
| Norway | 2 |
| Oman | 9 |
| Pakistan | 5 |
| Peru | 1 |
| Philippines | 6 |
| Portugal | 33 |
| Romania | 2 |
| Rwanda | 1 |

| | |
|----------------|------------|
| Senegal | 1 |
| Serbia | 1 |
| Slovakia | 2 |
| South Africa | 15 |
| Spain | 9 |
| Sri Lanka | 2 |
| Sweden | 1 |
| Switzerland | 2 |
| Tanzania | 16 |
| Thailand | 2 |
| Türkiye | 4 |
| Uganda | 3 |
| Ukraine | 1 |
| United Kingdom | 5 |
| United States | 8 |
| Uruguay | 3 |
| Yemen | 4 |
| Zambia | 11 |
| Zimbabwe | 1 |
| Total | 272 |

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