Antimicrobial stewardship programmes in the hospital setting

Global policies and practices

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FIP Development Goals

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1 Introduction

1.1 Definition and key principles of antimicrobial stewardship programmes (ASPs) in hospitals

Antimicrobial stewardship programmes (ASPs) in hospitals refers to coordinated, systematic programmes that promote the responsible, evidence-based, and optimised use of antimicrobial agents, encompassing antibiotics, antivirals, antifungals, and antiparasitic drugs, to improve clinical outcomes for patients, minimise adverse effects, slow the emergence of resistance, and ensure cost-effective therapy.[1] Through adherence to widely accepted standards such as those from the Centers for Disease Control and Prevention (CDC, USA), the World Health Organization (WHO), and national health authorities, antimicrobial stewardship (AMS) leverages an ongoing, multidisciplinary effort within a healthcare organisation to optimise antimicrobial use among all patients and minimise consequences of overuse, such as the emergence of resistance across pathogens and occurrence of toxicity in patients.[2]

In hospitals, ASPs operate through structured, key components and coordinated interventions. These primarily include the appropriate selection of the antimicrobial agent along with dosing, route of administration, and duration of therapy tailored to each patient.[3] In addition, central to ASPs is the establishment of a healthcare team, commonly including infectious disease physicians, pharmacists, microbiologists, nurses, and infection control professionals, to design and monitor stewardship activities.[4] This team needs to collaborate in the use of guideline-based prescribing, local resistance data, surveillance, and auditing systems to support clinical decision-making and reduce unnecessary antimicrobial exposure.[5]

1.2 Core strategies in ASP implementation

Two strategies in ASP are consistently identified as core strategies because they change prescribing behaviour and antibiotic exposure at scale: prospective audit with feedback (PAF), and preauthorisation or formulary restriction.[6-8] PAF entails regular, case-level review of active antibiotic therapy with timely, constructive feedback, narrowing spectrum, optimising dose or route (including intravenous to per oral (IV-to-PO)), and setting stop or review dates once microbiology and clinical response is known. Preauthorisation or formulary restriction requires meeting clear criteria or obtaining approval before starting selected agents (for example, carbapenems or anti-MRSA drugs), with rapid reassessment at 24–72 hours to de-escalate or discontinue therapy.

Programmes should implement at least one and ideally both based on local resources, culture, and informatics; PAF is often favoured to build prescriber engagement, while preauthorisation can quickly curb inappropriate use of high-risk or high-cost drugs. These core strategies are amplified by concise, syndrome-based guidelines with duration defaults, pharmacist-led IV-to-PO conversion, pharmacokinetic/pharmacodynamic (PK/PD)-informed dose optimisation and therapeutic drug monitoring, diagnostics stewardship (appropriate cultures, targeted rapid tests), education with audit-and-feedback, and routine measurement/reporting (for example, days of therapy per 1,000 patient-days, guideline concordance, and duration).[6-8]

1.3 Integration of pharmacists in hospital ASPs

Recent international studies have demonstrated the competencies of pharmacists in leading and playing central roles in AMS activities, resulting in decreased mortality, hospital stays, treatment duration, costs, and antibiotic use.[9,10] WHO identifies pharmacists as key members of multidisciplinary AMS teams.[6] Similarly, the CDC in the USA lists pharmacists among the core personnel in its Core Elements for Hospital Antibiotic Stewardship Programmes, recommending them as leaders or co-leaders of stewardship programmes.[7]

In the United Kingdom (UK), the remarkable evolution of AMS over the past 15 years has been strongly driven by the integration of specialist pharmacists, and supported by national funding and infection control mandates.[11] In sub-Saharan African hospitals, pharmacists have successfully led ASPs including protocol

development, ward rounds, audits, and feedback, which have been effective in improving adherence to guidelines, reducing antimicrobial use and lowering healthcare costs. However, implementation remains constrained by limited mentorship, accountability, collaboration, funding, and human resources.[9]

An international cross-sectional survey revealed that the composition of AMS teams often reflects the staffing patterns of the healthcare system. In North America and Oceania, AMS services are primarily delivered by specialist pharmacists and infectious disease (ID) physicians, whereas in Europe, the model is more mixed where pharmacists work alongside medical microbiologists or ID specialists. The skill mix within stewardship teams also determines the AMS strategies implemented; pharmacists typically focus on optimising dosing, implementing IV-to-PO switches, and conducting post-prescription review, while ID specialists contribute to ward rounds and diagnostic input.[12]

According to the CDC in the USA, clinical pharmacists are most effective when they have specific training or experience in AMS.[7] Professional organisations such as the Society of Infectious Diseases Pharmacists (SIDP) and the American Society of Health-System Pharmacists (ASHP), both in the USA, advocate for expanding the number of ID-trained pharmacy specialists to meet increasing demands.[13] The Indian Pharmaceutical Association (IPA) supports ID pharmacists through initiatives like the IPA-Infectious Disease Pharmacists Fellowship, a one-year programme for PharmD graduates to specialise in ID management and combat antimicrobial resistance (AMR).[14]

Clinical pharmacists have been instrumental in effecting changes at both organisational and national levels.[11] The appointment of pharmacists specialised in AMS within hospitals has been viewed positively and contributes to improving prescribing practices.[15] Despite their proven impact, pharmacists' ability to influence antibiotic decision-making is often limited by prescribing hierarchies, interprofessional barriers and resource constraints resulting from insufficient staffing.[15] Establishing the roles of dedicated pharmacists specialised in AMS and fostering collaborative relationships between pharmacists and prescribers remains critical to strengthening hospital stewardship efforts.[11,13,15]

2 National and regional policies on ASPs in hospitals

2.1 Existing policies and regulations governing antimicrobial use in hospitals

2.1.1 Americas region

In the United States of America (USA), a rapid progression in the implementation of ASPs has been accelerated by accreditation and national regulatory requirements for an ASP. Hospital ASPs are required for hospitals to receive payments from the nationally and regionally funded health coverage programmes from the Centres for Medicare and Medicaid Services. Medicare at the federal level and Medicaid at the state level provide payments to hospitals for providing care to older adults, low-income populations, and other vulnerable populations. Thus, the federally regulated mandates supported rapid development of ASPs in the USA. ASPs are also required for accreditation from The Joint Commission.[16] In the 2023 CDC's National Healthcare Safety Network (NHSN) annual survey, 96% of hospitals had implemented all seven of the core elements for ASPs, including pharmacist integration.[17] Hospital ASPs in the USA are often co-led by both a pharmacist and a physician (64%).[18] Yet, even in high resource settings in North America such as the USA, institutional support—specifically financial support—remains a key component for ASP success.

In Canada, hospital ASPs are mandatory for accreditation. In a recent survey, 84% (89/109) of responding hospitals had a formal ASP in place.[19] The programmes reported high rates of key ASP aspects including audit and feedback for antibiotic agents, formal surveillance of quantitative antimicrobial use, and providing education to prescribers and other healthcare staff.

In Mexico, the development of ASPs is progressing but challenges remain. A self-assessment study of public and private hospitals found 68% had an ASP committee and 52% of hospitals had an ASP document, with most interventions being restrictive (68%).[20] Few hospitals (12%) had protected time for ASP professionals or allocated ASP committee funding (14%). The authors concluded that national and institutional policies should prioritise ASP development, monitoring, and dedicated human resources.

2.1.2 African region

In Africa, AMR is considered the leading cause of mortality, ahead of malaria, HIV and tuberculosis, and was responsible for an estimated 1.05 million deaths associated with bacterial AMR in 2019[21] In response to this critical threat, the African Union adopted the AMR Global Action Plan and the African Union Framework for AMR control 2020-2025, both tailored to meet the specific needs of this region. To operationalise these strategies, different taskforces were created to track, progress and assess challenges and barriers, coordinate actions, and draft policies related to AMR across the region.[22] By 2023, 46 of the 47 of African countries responded to the 2023 tracking AMR country self-assessment survey (TrACSS). Results showed an increase in the number of member states adopting a National Action Plan (NAP), yet efforts are needed for better implementation and monitoring.[23]

A systematic literature review investigating the implementation of ASPs across the mother-continent, demonstrated a willingness to implement such programmes at the hospital level. The AMS committee in hospitals included ID specialists, microbiologists, pharmacists, nurses and physicians. Other hospitals had Drugs and Therapeutics Committees (DTCs) or Infection Control Committees (ICCs). The presence of these committees was dominant in the major African countries with presence percentage varying from 83% to 98%.[24] Main activities conducted included surveillance, establishment of antimicrobial guidelines and policies, staff education and training, and weekly antibiotic rounds and reviews. The implementation of ASPs resulted in positive outcomes expressed as a decrease in antimicrobials consumption, cost savings, and a decrease in surgical site-infection rates.[25] Hospitals collate AMR data for common bacterial pathogens under a standardised national AMR surveillance system with a designated national reference laboratory, and a national coordinating centre to generate AMR reports in Africa.[23] Despite this progress, many hospitals require updated guidelines to adopt the WHO Access, Watch, Reserve (AWaRe) categorisation of antimicrobials and more efforts are needed to establish instruments for regular monitoring and measurement of AMS implementation activities.

The much needed area for improvement is the development of educational programmes and training for hospital healthcare workers and providers, covering topics on optimising antimicrobial prescribing and dispensing, and the core principles of ASPs.[24] Ultimately, the key elements for successful AMS implementation in Africa include strong governance, good management and sustainable funding.[26]

2.1.3 Eastern Mediterranean region

In the Eastern Mediterranean Region (EMR), antibiotic consumption rates are the highest among all WHO regions, with Egypt, Iran and Pakistan as the leading countries in the rapid emergence of resistant pathogens.[27-29] Unfortunately, the region also experiencees conflicts, fragile health systems and frequent shortage of medicines.[27] Added to this, there is weak implementation of ASPs, particularly in the areas of infection, prevention and control (IPC) and surveillance. Notably, a clear discrepancy exists between high-income countries such as the Gulf Cooperation Council (GCC) countries of the region and those classified as low- and middle-income countries (LMICs).[27,29] In the GCC, ASPs are primarly adopted in tertiary hospitals with Saudi Arabia at the forefront.

AMS teams in these settings include ID consultants, physicians and, to a certain degree, infection control specialist nurses. Pharmacists are rarely involved and their participation, when it occurs, is restricted to monitoring antimicrobial consumption, reporting, and providing feedback on inappropriate antimicrobial prescribing.[30] The core elements of the ASPs applicable in the GCC countries include adoption of antimicrobial guidelines, accountability and tracking through audit and feedback, and formulary restriction.[30]

In the United Arab Emirates (UAE), AMS teams are more comprehensive, incorporating both clinical pharmacists and AMS specialists. The involvement of clinical pharmacists has been shown to enhance team competence in the regulation of antimicrobial use. Key strategies in UAE hospitals include switching from IV-to-PO antimicrobials as soon as the patient condition allows, the use of real-time surveillance software for monitoring antimicrobials, rapid diagnostic tools, and continuous medical staff educational support.[31] By contrast, LMICs in the EMR face multiple barriers to AMS implementation, including inadequate surveillance systems (especially laboratory infrastructure, diagnostics tools and lack of IPC measures), resource limitations, insufficient workforce teams, and a lack of implementation of information technology.[32] Nevertheless, efforts have been made in different EMR LMICs: in Jordan, the Ministry of Health established the National Antimicrobial Resistance Committee to develop AMS-related policies and guidelines with pharmacists actively contributing as members in this committee.[28] In Lebanon, the integration of electronic medical records, stewardship teams with clinical pharmacists, daily assessment of antimicrobial therapies, and education of healthcare workers are tools helping AMS implementation in a resource-limited environment.[33]

2.1.4 European region

Antibiotic overuse and misuse remain persistent across the European region, despite years of surveillance.[34,35] The European Union (EU) and European Economic Area (EEA) member states are closer to meeting their targets but have shown signs of stagnation, whereas non-EU countries display greater variability, with some achieving strong performance (such as Armenia, Belarus and Switzerland) and others exhibiting persistently high levels of use (such as Montenegro, Serbia and Türkiye).[2,34] The EU faces a concerning rise in last-line "reserve" antibiotic consumption, while many non-EU countries may lack access to this group of antibiotics but overuse broad-spectrum antibiotics.[34,35] Across both regions, primary care is the main driver of antibiotic consumption, reinforcing the need for ASP, diagnostics, and guideline compliance in outpatient settings. Enhancing ASP is one of the most cost-effective strategies to ensure appropriate antimicrobial use, reduce unnecessary consumption, and limit the adverse impacts of AMR. In turn, such programmes can generate significant health and economic benefits across the European region.[36,37]

In this context, The European Association of Hospital Pharmacists (EAHP) has recently investigated the involvement of hospital pharmacists in National Action Plans (NAPs) on AMR, including the implementation of ASPs in European hospitals.[38] This investigation, conducted by the EAHP AMR working group, resulted in a report which found that nineteen EAHP member countries currently have a NAP on AMR.[39] However, only six of these countries (Austria, Germany, Greece, Italy, Luxembourg and Malta) explicitly recognise and include the role of hospital pharmacists within their NAPs. However, there are examples of best practices of hospital pharmacists being an essential part of ASPs.

For example, in France, pharmacists are not involved in antibiotic prescribing, but are involved in evaluating antibiotic prescriptions, training medical and paramedical staff, analysing consumption and bacterial resistance, and providing expert advice. There are models of successful practices in Austria where hospital pharmacists are mentioned in the "Quality standard antiinfectives in hospitals"[40,41] as part of a multidisciplinary ASP team. In addition, Belgium has pharmacists as a mandatory member of the ASP team in hospitals, which is required by law, next to infectious diseases specialists and medical microbiologists.

The study that the EAHP report is based upon, published in 2023 by the European Commission and titled "On the barriers to effective development and implementation of national policies on antimicrobial resistance", mentioned Croatian hospitals as an example of good practice.[41] The study successfully demonstrated that implementing a multidisciplinary approach led by an ASP team—consisting of ID specialist, clinical microbiologist and clinical pharmacist—helped to rationalise the use of last-line "reserve" antibiotics, even with limited human resources. Additionally, in Hungary, although there is no updated national action plan, ASP guidance published in 2018 outlines the role of hospital pharmacists in ASP. It contains recommendations for tackling AMR in hospital and long-term care facilities. Pharmacists are mentioned as key players in stewardship activities and concrete tasks are proposed for professionals working in hospitals. It also states that a multidisciplinary ASP team should be established in each hospital with the participation of a clinical pharmacist alongside other professionals.

Furthemore, Ireland has established AMRIC (Antimicrobial Resistance and Infection Control) which is a national team within the Irish health sector responsible for leading efforts to combat AMR. AMRIC published a guideline in 2022 titled "Antimicrobial Stewardship – Guidance for all healthcare settings".[42] Chapter 1 of this guideline outlines the roles and responsibilities of healthcare workers in ASP, including a section on the role of the pharmacist. This section features a table of practices for pharmacists to support ASP. While the guidance is developed for pharmacists across all settings, many of the recommended practices are directly applicable to the hospital pharmacist, such as directing therapy based on microbiological samples. Finally, an interesting example comes from Sweden, a leader in ASP, where hospital pharmacists are very much involved in AMR in hospitals, but hospital pharmacists and pharmacists in general are not directly mentioned in the national AMR strategy.

Despite the absence of formal recognition of hospital pharmacists' roles in the NAPs or in other legislative and regulatory frameworks of most EAHP member countries in the European region (which includes both EU and non-EU countries), their active involvement in AMR initiatives is regarded as best practice at national and/or local levels.[38] In the European region, hospital pharmacists play a crucial yet often under-recognised role in national AMR strategies, underscoring the need for their formal inclusion in all NAPs.

2.1.5 South East Asian region

AMR imposes substantial clinical and economic burdens across the WHO South East Asian Region (SEAR). Regional policy has therefore elevated hospital ASPs as a core response, with SEAR translating the Global Action Plan into practical hospital-level guidance through webinars, toolkits, and One Health aligned frameworks that emphasise governance, workforce, informatics, and standardised clinical processes.[43] These regional efforts explicitly draw on WHO's practical LMIC stewardship toolkit and the AWaRe framework to orient prescribing toward Access agents where appropriate and to reduce unnecessary exposure to Watch/Reserve antibiotics.[6,44]

Across SEAR, existing hospital policies and regulations governing antimicrobial use have been published or updated, typically including national stewardship guidelines, standard treatment guidelines (STGs), hospital pharmacy policies, and infection-prevention standards. Examples include: Sri Lanka's 2024 National Antimicrobial Stewardship Guideline for Healthcare Institutions, which specifies hospital governance structures, leadership roles, documentation (indication, dose, route, duration, review/stop dates), audit mechanisms, and reporting; Indian Council of Medical Research (ICMR)'s ASP guideline and national treatment guidelines that standardise empiric therapy and align it with antibiograms; Thailand's National Strategic Plan on AMR (2017–2021) that embeds stewardship within a national multi-sector framework; and, Bangladesh's national STG on antibiotic use in hospitals, which frames rational antibiotic use and links to broader AMR policy reforms.[45-49] Collectively, these instruments create a normative baseline for how antibiotics are prescribed, reviewed, and reported in inpatient care.[50]

Government and institutional support, though variable, has become more visible. Ministries of Health and national AMR committees anchor ASPs within NAPs, issue hospital stewardship guidelines/STGs, and in several countries define reporting lines and accountability (e.g., executive sponsors and board-level dashboards). At facility level, policies commonly mandate multidisciplinary ASP committees, designate executive champions, and link stewardship metrics to quality/safety programmes; progressive investments in information systems (antibiograms, prescribing dashboards, decision support) and training (competency-based courses, continuing professional development, cross-disciplinary workshops) are expanding in parallel. These developments provide SEAR with a clearer regulatory scaffold, a pharmacist-centred workforce model, and a governance pathway for hospital ASPs, while highlighting ongoing gaps in financing, digital infrastructure, and capacity outside metropolitan centres.

2.1.6 Western Pacific region

In the Western Pacific Region (WPR), many countries, including Vietnam, China, Indonesia, and Australia, have developed NAPs against AMR, often aligned with the WHO's Global Action Plan.

Vietnam, a middle-income country in the WHO WPR, has one of the highest AMR rates in Asia. Surveillance studies have shown rising resistance among common pathogens such as *Enterobacterales*, *Pseudomonas aeruginosa* and *Streptococcus pneumoniae*. The overuse of antibiotics is largely driven by factors such as easy access to antibiotics without prescriptions in the community, inappropriate prescribing practices in hospitals, unnecessary hospitalisations, patient demands, and limited access to diagnostic microbiology services. In response, Vietnam's Ministry of Health instituted a NAP against AMR extending to 2030.[51]

Indonesia is especially susceptible to AMR due to a number of complicated circumstances, such as inconsistent access to high-quality healthcare, continuously high rates of infectious diseases, and lax enforcement of antibiotic regulations. Since 2017, the NAP for AMR has been developed; however, it is difficult to implement because of a lack of evidence regarding AMR epidemiology, antibiotic use, and sensible prescribing practices.[52]

Australia's response to AMR is detailed in the national AMR strategy, which identifies "appropriate usage and stewardship practices" as a key objective. A national mandate requires all hospitals to implement ASP subject to an accreditation assessment. Hospitals must undergo accreditation every three years against ten National Safety and Quality Health Service (NSQHS) Standards. Currently, there is a transition towards the Short-Notice Survey Accreditation Assessment Process (SNAAP), where hospitals are evaluated annually against three to four standards with at least 48 hours' notice. This approach aims to promote ongoing quality improvement rather than focusing on compliance with a fixed set of standards every three years.[53]

Since the launch of the special rectification campaign on clinical antimicrobial use in 2011, China's Ministry of Health has placed strong emphasis on the rational use of antibiotics and the containment of AMR. A series of policies, regulations, and guidelines have been introduced to support this effort. Health authorities and hospitals at all levels have actively implemented these government directives, achieving remarkable progress in a relatively short time. The average rate of antimicrobial use among inpatients (measured as the percentage of patient encounters involving antibiotic prescriptions) declined from 59.4% to 37.5%. In terms of AMR control, the isolation rates of major resistant organisms such as methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant *Enterococcus faecium* (VREFM) have also decreased.[54]

2.2 Government and institutional support for hospital-based ASPs

Effective ASPs rely heavily on strong government and institutional commitment to ensure sustainable implementation and impact. Leadership dedication and appropriate governance structures are needed to ensure the success of hospital-based ASPs.[6,7,9] In view of this, prioritising AMS at national, local, and institutional levels is needed to achieve optimal antimicrobial use and combat resistance.[9,55]

According to the CDC in the USA, leadership commitment involves allocating the necessary financial, human, and information technology resources to support stewardship activities.[7] The CDC further recommends that

hospital administrators should formally authorise and empower stewardship teams to implement and enforce antibiotic use policies.[2,7] Similarly, a Delphi-based study aimed at developing standardised core elements for implementing ASPs across general hospitals in Korea identified six core elements required for implementing ASPs that also included leadership commitment.[56]

Hospital administrators and public health agencies play a key role in sustaining stewardship efforts, particularly in resource-limited settings.[6,9] In sub-Saharan Africa, one of the major challenges to implementing hospital-based ASPs is the absence of strong institutional and national support for AMS policies. Evidence suggests that dedicated and continuous funding from hospital administrations serves as an independent predictor of successful stewardship interventions, as it facilitates the recruitment and training of pharmacists in ID and AMS.[57] Furthermore, AMS implementation is constrained by heterogeneous and often insufficient legal and policy frameworks, as legislation supporting AMS activities remains weak or non-existent.[58] Supranational action plans and policymaker commitment are essential drivers for AMS development, but these must be adapted to local epidemiological contexts and healthcare systems.[55,58]

At the regional level, evidence from Latin America indicates similar challenges. Studies recommend that hospitals should set ASPs as institutional priorities and strengthen engagement among administrators, clinical leaders, and directors to promote sustainable stewardship practices.[59] While existing data indicate that hospital ASPs offer significant clinical and economic benefits, more robust evidence particularly from LMICs is needed to develop a case for decision-makers in investing in stewardship programmes amidst competing health priorities.[60]

Generally, leadership commitment, resource allocation, and government involvement are foundational to effective hospital-based ASPs. Without these elements, stewardship initiatives risk stagnation, particularly in settings where financial and infrastructural capacities are limited. Long-term success, therefore, depends not only on clinical expertise and guidelines, but also on political will, resource commitment, and institutional culture that values stewardship as a core patient safety priority.[6,9,57] Thus, national health authorities and institutional leaders must prioritise sustained investment and governance frameworks to ensure the long-term success of AMS efforts.

3 FIP Global survey on hospital ASPs

In 2024, FIP conducted a survey to determine what resources are available for AMS across regions, what type of training is needed In relation to AMS, and to measure the establishment of core elements of antibiotic stewardship across regions. This was a FIP-led survey, carried out with support from university colleagues under an MoU, as required by FIP policy.

The survey aimed to identify the current state of pharmacist involvement in antimicrobial stewardship globally in a variety of regions and health systems.

A total of 583 respondents from all six WHO regions participated in the survey, the majority of whom worked in an academic medical centre or teaching hospital (213, 41.8%). The key survey results regarding hospital AMR and AMS programmes based on pharmacists' response are described in Table 1.

Table 1. Key survey results about antimicrobial resistance and stewardship programmes in hospitals based on responses from pharmacists

Regions	African	Americas	European	South East Asian	Eastern Mediterranean	Western Pacific	Total
Pharmacists involved in AMS activities within hospitals	27 (67.5%)	87 (87.0%)	8 (57.1%)	15 (75.0%)	51 (79.7%)	55 (91.7%)	243 (81.5%)
Pharmacists collaborating with or contributing to hospital AMS programmes	22 (55.0%)	85 (85.0%)	10 (76.9%)	14 (70.0%)	53 (82.8%)	52 (86.7%)	236 (79.5%)
AMS responsibilities included as part of pharmacists' official job roles or titles	9 (36.0%)	56 (71.8%)	1 (25.0%)	12 (85.7%)	37 (75.5%)	31 (75.6%)	146 (69.2%)
Pharmacy staff represented in AMS programme leadership	23 (100%)	78 (98.7%)	5 (50.0%)	12 (85.7%)	48 (94.1%)	48 (96.0%)	214 (94.3%)
Availability of funding dedicated to AMS pharmacist positions	0 (0%)	40 (44.4%)	1 (7.7%)	4 (21.1%)	11 (19.3%)	23 (41.1%)	79 (28.8%)
Pharmacists receiving AMS training	26 (66.7%)	73 (83.9%)	4 (28.6%)	11 (61.1%)	34 (57.6%)	40 (71.4%)	188 (68.9%)
Evaluation or measurement of the impact of AMS interventions	9 (47.4%)	52 (82.5%)	3 (60.0%)	7 (63.6%)	24 (77.4%)	28 (75.7%)	123 (74.1%)
Existence of health system–wide antibiograms	11 (24.4%)	72 (69.2%)	8 (50.0%)	14 (63.6%)	33 (56.9%)	34 (69.4%)	172 (58.5%)
Availability of national guidelines for the treatment of infectious diseases	40 (87.0%)	77 (81.1%)	13 (92.9%)	20 (95.2%)	38 (69.1%)	40 (83.3%)	228 (81.7%)
Adherence to local guidelines for the treatment of infectious diseases	19 (73.1%)	49 (80.3%)	9 (81.8%)	8 (80.0%)	21 (72.4%)	33 (86.8%)	139 (79.4%)
Pharmacist participation in One Health initiatives or other AMR-related activities	13 (24.5%)	18 (15.9%)	7 (35.0%)	1 (4.3%)	20 (31.7%)	7 (14.3%)	66 (20.6%)

According to the survey responses, pharmacists' participation in AMS activities is highest in the Western Pacific Region (91.7%) and the Americas Region (87.0%), and lowest in the European Region (57.1%). Pharmacists' collaboration with ASPs is also strong, particularly in the Americas Region (85.0%) and Western Pacific Region (86.7%). Having AMS as part of the job responsibility or title varied widely from 25% in the European Region to 85.7% in the South-East Asian Region.

Pharmacy staff are included in ASP leadership across almost all regions (94.3% overall). However, funding for AMS pharmacists is low globally (28.8%), especially in the African Region (0%). Informal or on-the-job AMS training was reported by 68.9% of pharmacists, with highest rates in the Americas Region (83.9%).

Measuring ASP impact (74.1%) is already well implemented in the Americas and Western Pacific Regions. Overall, health system-wide antibiograms are present in 58.5% of the hospitals that respondents are working in across all regions, with the highest rate in the Americas (69.2%) and Western Pacific (69.4%) Regions. National treatment guidelines exist in 81.7% of countries, and local guidelines are followed in 79.4%. Participation in One Health projects remains limited (20.6%), especially low in South East Asian Region (4.3%).

Common AMS tools (methods, resources, or interventions used to promote the appropriate use of antimicrobials) include documentation of indications for antibiotic orders (67%) and preauthorisation systems (64%), most common in Americas and Western Pacific Regions. Antimicrobial order forms are most common in Eastern Mediterranean and Americas regions (Figure 1).

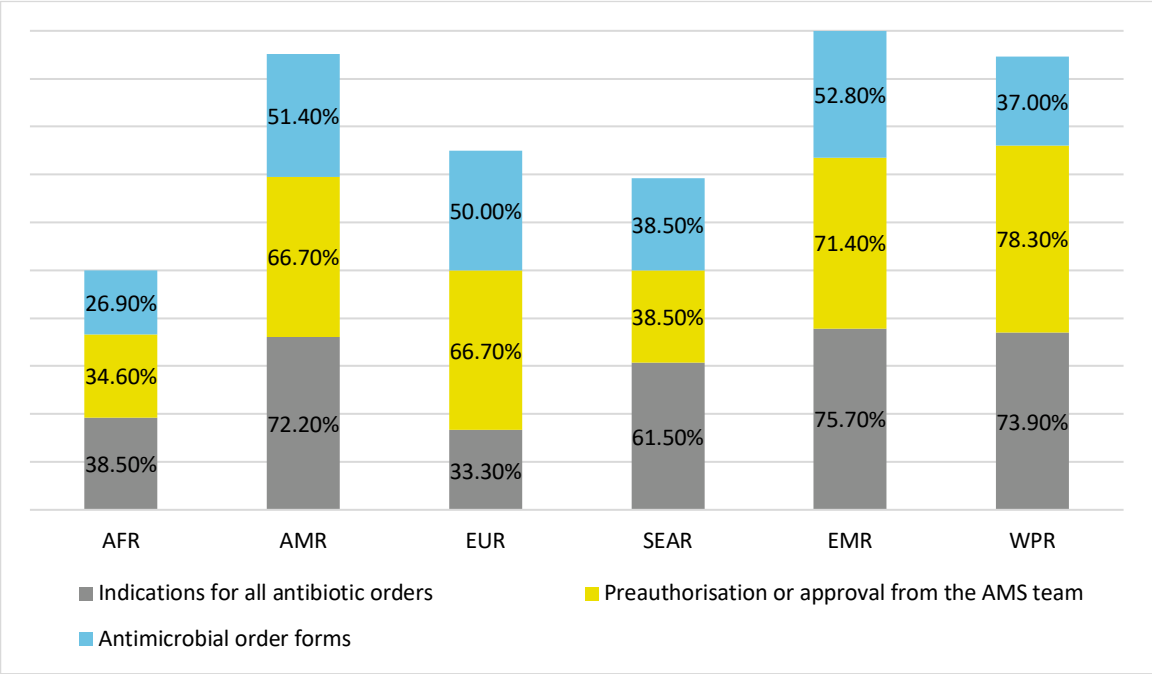

Figure 1: Percentage of pharmacist-reported AMS tools commonly implemented in hospitals

According to the greatest need for developing/improving actions for ASPs in hospitals, the European Region shows the highest need for implementation of diagnostic guidelines (75%), followed by automatic stop orders (60%) and both education categories (50%). The African Region also indicates strong needs across all areas, particularly didactic education or formal courses (71.4%) and implementation of diagnostic guidelines (66.7%). The Eastern Mediterranean Region ranks next, with nearly half of the respondents identifying needs for diagnostic guidelines (50%) and automatic stop orders (48.4%). The South East Asian Region demonstrates moderate needs, especially for formal courses (45.5%) and provider education (36.4%). The Western Pacific Region reports lower overall needs, with automatic stop orders (34.9%) being the most cited. The Americas Region shows the lowest levels of reported need across all categories (ranging from 15.6% to 25.4%) (Figure 2).

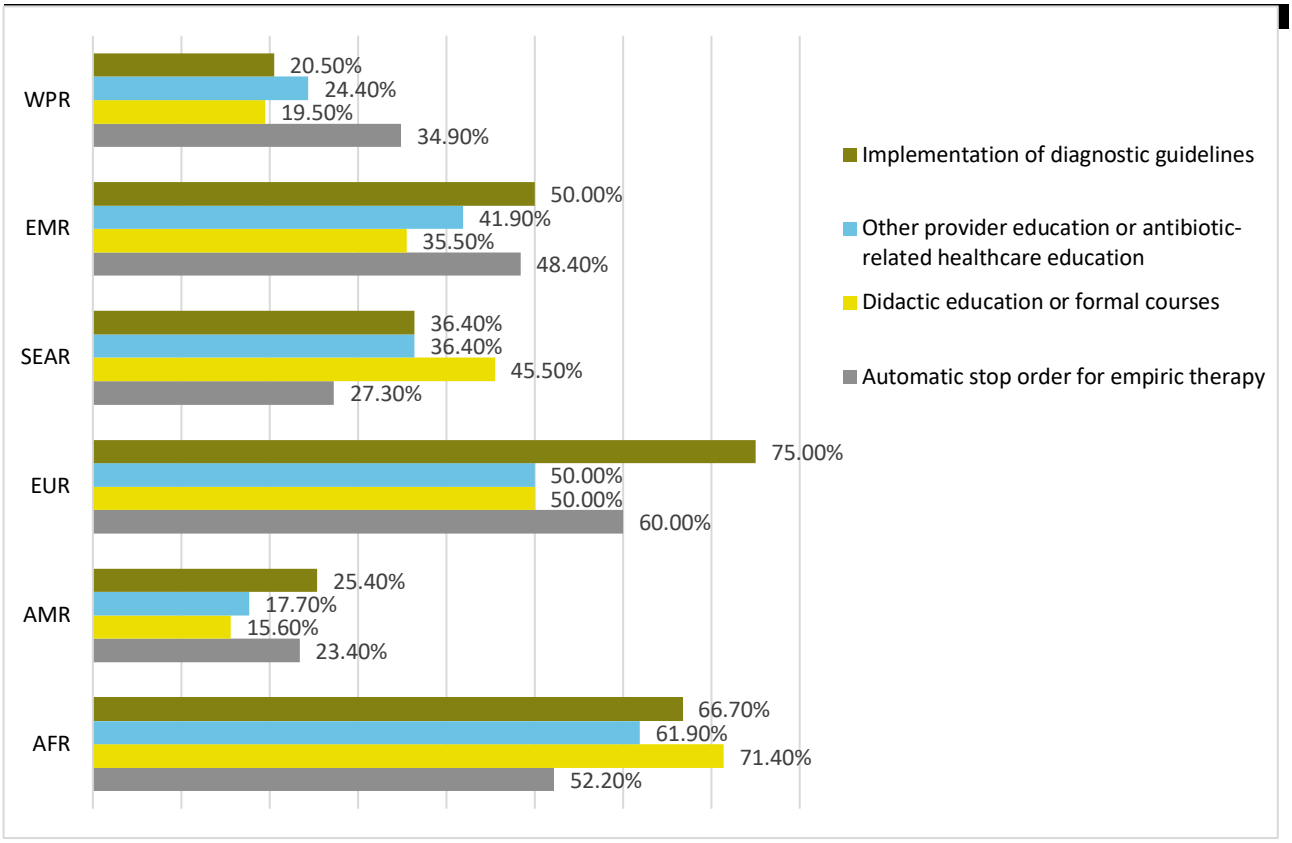

Figure 2: Percentage of pharmacist-reported areas of greatest need to improve or develop actions for ASP in the hospital

The common methods selected to educate healthcare professionals about prescription of antimicrobials were conferences, internal workshop training, and webinars offered by professional societies. These were most frequently used in South East Asian, Western Pacific and Americas Regions (Figure 3).

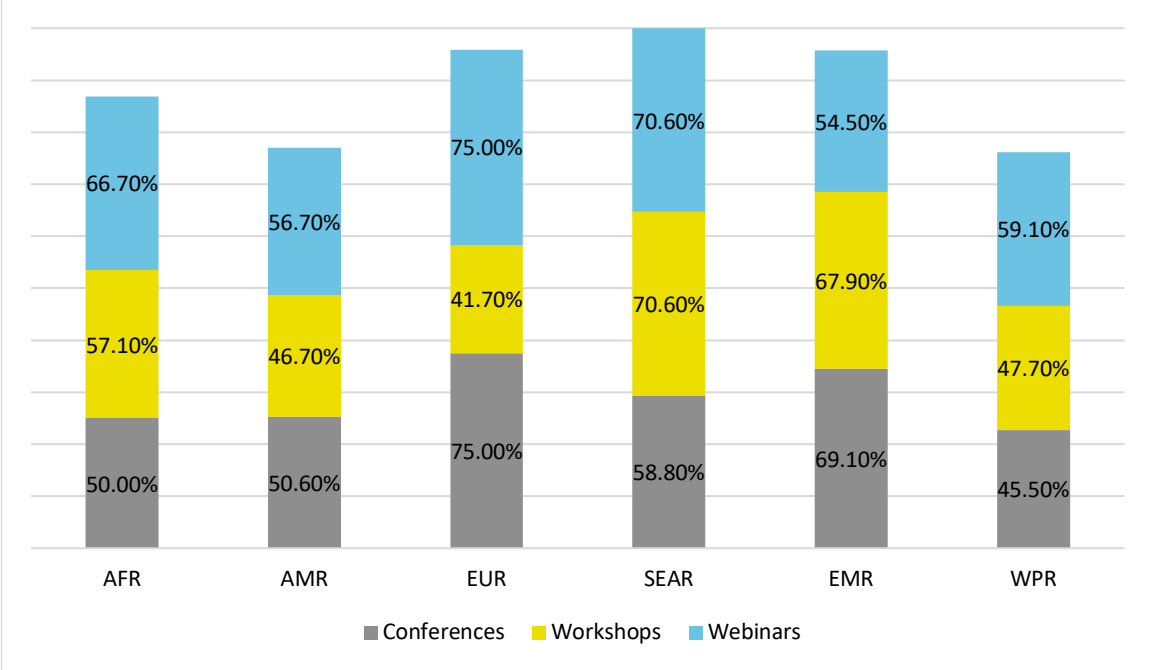

Figure 3: Percentage of pharmacist-reported common methods used to educate on appropriate prescription of antimicrobials

A secondary data analysis was conducted by connecting results from the FIP Global AMS Survey with: 1) published World Bank economic datasets (domestic health expenditure [a percentage of government spending] and Gross Domestic Product [GDP] per capita); and, 2) national-level antibiotic resistance data (the last updated estimated E. coli antibiotic resistance ranges per country/territory for fluoroquinolones and third-generation cephalosporins).[61] Data were aggregated by United Nations regions. This secondary analysis focused on hospital pharmacy responses representing 63 countries (N = 284 participating hospital pharmacists). In most regions, there was no statistically significant relationship between AMS implementation status and antibiotic resistance. However, in Northern Africa and Western Asia regions, increased AMS implementation was associated with lower antibiotic resistance. Results indicate that countries with lower resistance ranges have greater domestic health expenditure, regardless of GDP, and generally more established AMS programmes. Further research is necessary to determine the impact of AMS efforts, but there is a relationship that can be identified between higher health expenditure and lower resistance ranges. Global collaboration to provide more timely resistance data is also necessary to evaluate current AMS programmes. Overall, government economic support appears to improve AMS programme efficacy.[62]

4 Challenges in implementing hospital based ASPs

The implementation of ASPs in hospital settings faces four critical challenges that consistently emerge across diverse healthcare systems: shortage of trained personnel and resources; resistance to ASP policies among healthcare providers; limited availability of real-time surveillance data; and, inconsistent enforcement of antimicrobial prescribing guidelines. These interconnected barriers must be addressed to optimise antimicrobial use and combat the global threat of AMR.[63]

4.1 Lack of trained personnel and resources

A projected shortage of 11 million healthcare workers globally severely affects AMS capacity, with pharmacist vacancy rates in hospitals reaching 11% and even higher in resource-limited countries.[64,65] Systematic reviews reveal that 50% of studies identify human resource shortages as a primary barrier to ASP implementation.[66] The consequences are significant: temporary pharmacist absence results in prolonged therapy duration and a three-fold increase in *Clostridioides difficile* infections.[67]

Resource constraints extend beyond staffing to include financial limitations, infrastructure deficits, and antimicrobial shortages. Drug supply disruptions can trigger inappropriate prescribing, with studies showing 111% increases in broad-spectrum carbapenem use during shortages despite active stewardship interventions.[68] Time constraints in busy clinical settings limit provider participation in stewardship activities, while inadequate funding prevents implementation of monitoring systems and educational programmes.[69]

Evidence-based strategies include task-shifting to expand roles for non-clinical pharmacists and nurses in resource-limited settings,[70] establishing national or regional stewardship networks to pool limited expertise, and implementing e-learning platforms for scalable workforce development.[71] Mobile health applications and digital tools have demonstrated significant improvements in healthcare workers' knowledge and practices regarding AMR.[72] Public-private partnerships and engagement of professional associations can mobilise additional resources for training and guideline development.[73]

Many hospitals, especially in LMICs, lack dedicated infectious disease specialists, clinical pharmacists, or microbiologists to run ASPs. In a recent scoping review of hospital ASP studies from LMICs, 50% of the studies cited a shortage of human resources as a key barrier. Insufficient staff means existing clinicians have limited time to devote to stewardship activities, and it often forces one person to juggle multiple roles. For example, a 2021 international survey of hospitals found that over one-third reported staffing or time constraints as a major obstacle to implementing ASP interventions.[74,75]

4.2 Resistance to ASP policies among healthcare providers

Approximately one-third of physicians view ASPs as impinging on their professional autonomy.[76] This resistance manifests in differential acceptance of interventions: while 73% of prescribers support educational programmes, only 23.4% approve automatic stop orders and 28.8% endorse pre-authorisation requirements.[77] Prescribers often perceive AMR as an external problem rather than a consequence of individual prescribing decisions, creating cognitive dissonance between acknowledging AMR as a global threat and modifying personal practice.[66]

Organisational culture issues compound resistance, including interprofessional tensions, hierarchical structures limiting collaboration, and fragmented education delivered in professional silos.[62] Diagnostic uncertainty, patient expectations, and time constraints in emergency settings create additional pressures that override stewardship recommendations.[78]

4.3 Limited availability of real-time surveillance data

Profound disparities exist in AMR surveillance capacity globally. The number of culture-positive samples with susceptibility testing ranges from 9 per 100,000 people in Sierra Leone to 452 per 100,000 in Eswatini.[79] Only 12% of AMR surveillance records include patient clinical information, severely limiting assessment of treatment outcomes and risk factors. Traditional antimicrobial susceptibility testing requires 24-72 hours, forcing reliance on empiric therapy rather than pathogen-directed treatment.[80]

In resource-limited settings, hospital-level treatment guidelines are frequently absent, forcing providers to rely on international guidelines that may not reflect local resistance patterns.[69]

At the policy level, governments must prioritise investments in health workforce development, laboratory infrastructure, and surveillance systems as essential components of NAPs on AMR.[81] At the institutional level, hospitals should implement evidence-based strategies, optimising available resources, engaging stakeholders collaboratively, and building on existing strengths rather than replicating resource-intensive models from high-income settings.[70,82] At the individual level, healthcare professionals require ongoing education, mentorship, and professional development opportunities, enhancing their stewardship capacity.

International organisations including WHO, FIP, and professional societies play crucial roles in developing standardised approaches, providing technical assistance, and facilitating knowledge exchange.[83] The growing evidence base on effective educational interventions and implementation strategies offers practical guidance for overcoming resistance and building stewardship cultures.

4.4 Inconsistent enforcement of antimicrobial prescribing guidelines

Antimicrobial prescribing in hospitals remains high worldwide with significant regional variations. A recent systematic review and meta-analysis reported an antibiotic inpatient prescribing prevalence of 47.7% with the highest rates observed in South Asia and the lowest in Europe and Central Asia.[84] In LMICs, high antibiotic consumption is observed mainly at the level of tertiary care hospitals and in the intensive care unit; while similar patterns are reported in high-income countries (HICs), an additional concern in LMICs is the frequent prescription of antibiotics at the primary healthcare level, which could be explained by the difficulty in reaching nearby hospitals.[85]

Multiple factors influence the antimicrobial prescription decisions at the hospital level. The patient or care demand notably in critical or deteriorated cases, is a driving factor, as is heavy workload and time pressure, particularly in intensive care units or busy wards, which can also influence consultation and reflection, and the absence of ASPs is leaving prescribers with no internal guidelines or feedback mechanisms. Ultimately, one of the greatest challenges lies when the immediate individual patient risk outweighs the broader population risk of AMR resulting from overprescribing.[86] Successful AMS implementation relies, among other factors, on the establishment of a comprehensive policy on optimal antimicrobial use within the hospital; documentation of antibiotic dose, duration, and indication are necessary procedures to effective performance, as well as the development of facility-specific treatment guidelines to support evidence-based prescribing practices.[87] When clear and well-established clinical guidelines are adhered to within the hospital, both prescribing practice and clinical outcomes improve. For instance, simple recording of antibiotic durations on drug charts can significantly enhance prescribing practices.[88]

Unfortunately, disparities in regulation enforcement varies between HICs and LMICs with weak implementation in the latter.[85] AMS teams or committees created in LMIC hospitals encourage the responsible use of antimicrobials and review antimicrobial prescriptions but these recommendations are not provided by enforcing guidelines.[28] In addition to this, physicians in many LMIC countries do not adopt standard treatment guidelines with respect to the antibiotic choice, length of treatment or the dosage. Other indicators were also investigated and found to be varied in their implementation, such as the existence of a formulary list or essential medicine list, availability of key antimicrobials in the stores, and average number of antibiotic prescribed per hospitalisation.[89] In Lebanon, an expert focus group identified significant barriers to successful AMS implementation which included inadequate awareness and insufficient education and training on AMR

and AMS among healthcare providers, and a lack of collaboration and coordination between all involved teams, including prescribers and dispensers.[90]

The implementation of ASPs varies across hospitals types. For instance, in Uganda (a LMIC), only 47% of private hospitals have adopted formal guidelines and protocols such as restricted antimicrobial formularies and IV-to-PO switch policies, whereas public hospitals generally adhere to national guidelines.[91] In contrast, in Australia, notable differences were observed between public and private hospitals regarding the indications for antibiotic prescriptions. In public hospitals, the majority of prescriptions were for the treatment of infections, while prescriptions for surgical prophylaxis were dominant in private hospitals. Nevertheless, compliance rates with prescribing guidelines were found to be similar across both hospital types.[92]

Successfully addressing workforce shortages, provider resistance, and surveillance limitations requires sustained commitment, innovation, and collaboration across stakeholders.

5 Lessons learned

Enhancing interdisciplinary collaboration

ASPs have been proven to decrease inappropriate antibiotic prescribing, reduce multidrug-resistant infections, and enhance clinical outcomes such as shorter hospital stays and lower mortality rates. Several policy documents and guidelines acknowledge the unique skills that each healthcare professional contributes to the success of ASPs and advocates for strong interprofessional collaboration.[93] For instance, in an escalating intervention model, clinical pharmacists in the wards reviewed patient cases within the intervention group and referred complex cases to ID clinical pharmacists or ID physicians when necessary, while only select cases required direct review by ID physicians. This tiered ASP approach significantly improved multiple clinical and operational outcomes, highlighting the crucial role of clinical pharmacists in promoting appropriate antibiotic use and strengthening AMS practices. Strengthening interprofessional collaboration can therefore be considered a cornerstone of sustainable and impactful ASP.[94]

Expanding training and capacity-building for hospital ASP teams

Stakeholders and policy makers are slowly acknowledging that sustainable ASPs require going beyond individual learning; they depend on institutional engagement, interprofessional teamwork, and leadership-supported integration of stewardship principles into hospital practice.[95] Thus, establishing sustained learning collaboratives or regional ASP networks, integrating online and in-person mentorship, and linking hospitals through shared information and education dashboards, all go a long way in capacity building for ASPs.[96] Further, incorporation of ASP modules into continuing professional development (CPD) programmes for pharmacists, physicians, infection control staff, and administrators is needed.Interprofessional leadership within hospitals through designated ASP champions and inclusion of pharmacists in clinical decision-making, audit, and feedback is another key approach.[97] As research in antimicrobial resistance and stewardship evolves, the development of context-based training curricula would help translate research findings to tailor solutions to local resource and cultural contexts, thus effectively serving different communities and economies.[98]

Improving antimicrobial use tracking and reporting mechanisms

A parallel investment to human capacity building is investment in infrastructure. Hospitals can adopt or align with standardised digital stewardship reporting platforms, linking consumption data to antimicrobial resistance, and resistance and infection outcome metrics.[99] Regular data analysis and feedback cycles would ensure transparency and shared benchmarking for all entities involved in ASPs.[100] Also, the integration of clinical microbiology, pharmacy, and infection control data would allow the streamlining of comprehensive and automated stewardship analysis.[101] Such investments would empower ASPs teams in analysing, interpreting, and acting upon data for targeted improvement cycles and promote accountability in antibiotic use.

Strengthening policy enforcement and accountability in hospitals

Despite global efforts to regulate antibiotic use, antibiotic consumption increased by 16.3% in 67 countries between 2016 and 2023 from 29.5 to 34.3 billion defined daily doses (DDDs).[102] The largest increases were observed in upper-middle- and lower-middle-income countries. Although the COVID-19 pandemic temporarily led to a global decline in consumption, particularly in high-income countries, sustained reductions were limited. Furthermore, the use of Watch antibiotics remains relatively high in many settings, with many countries not meeting the United Nations target calling for 70% of antibiotics coming from the Access category.[103] As Watch antibiotics contribute disproportionately to AMR, stronger measures are needed to prevent their unnecessary use when antibiotics are not required or when Access antibiotics would be sufficient. Moreover, although studies have shown that the WHO AWaRe classification (a system developed to guide the responsible use of antibiotics) has been rapidly adopted as the standard for reporting antibiotic use in LMICs, national policies must now focus on improving the use, availability, and affordability of Access antibiotics to effectively mitigate AMR.[104]

This underscores the need for stronger policy enforcement and accountability mechanisms in hospital settings by giving more responsibility to hospital pharmacists as a part of multidisciplinary ASP teams. This can be achieved through formal integration of hospital pharmacists into NAPs and ensuring clear legislative or regulatory provisions defining their clinical and stewardship responsibilities. Additionally, pharmacists should be recognised as key members of national AMR governance structures (e.g., national stewardship

committees) and actively involved in the development, implementation, and monitoring of hospital antibiotic policies and formularies. Furthermore, all hospitals can be asked to establish ASP committees with hospital pharmacist representation and to take responsibility for regular reporting to health authorities. Chief pharmacists or ID specialists can then be designated to oversee stewardship outcomes and enforce adherence to prescribing guidelines.

In conclusion, strengthening ASP requires more than policy frameworks: it demands rigorous implementation, regular audits, and transparent reporting of antibiotic use in healthcare facilities. Establishing clear lines of accountability, integrating real-time surveillance systems, and linking compliance to institutional performance metrics can help ensure that stewardship policies translate into meaningful, sustained reductions in inappropriate antibiotic use.

Future directions for strengthening hospital-based antimicrobial stewardship efforts

To move from compliance to culture change, hospital ASPs can implement a continuous, multidisciplinary quality-improvement process. These actions showed improved capacity, innovation, and integration across systems through following:

- Expanding pharmacists' roles from dispensing to clinical decision support, participation in antimicrobial rounds, prescription review and feedback, and leading AMS activities.
- Providing advanced training and certification in infectious diseases pharmacotherapy and stewardship.
- Integrating hospital pharmacists into IPC programmes to ensure synergy between IPC and ASP activities.
- Developing AI or digital stewardship tools to support hospital pharmacists and clinicians in optimising empiric therapy.
- Fostering a "shared accountability" model, emphasising that stewardship is a clinical safety priority across all professions, not only infectious disease specialists.
- Embedding ASP principles into medical, pharmacy, and nursing curricula, as well as in post-licensure CPD activities for healthcare providers.
- Incorporating ASP outcomes into hospital quality and safety frameworks and assessment of these outcomes as a part of quality assurance.
- Supporting regional and cross-border collaboration for knowledge sharing in ASP and AMR.
- Securing dedicated funding for ASP infrastructure, including pharmacist positions, surveillance systems, and training.

6 Conclusion

Pharmacists are key members of multidisciplinary Antimicrobial Stewardship Programme (ASP) teams and can act as primary leaders or co-leaders of stewardship initiatives.

This report outlines the core principles of ASPs in hospital settings and highlights the critical competencies pharmacists bring to these programmes. Their leadership and active participation in ASP activities have been shown to reduce mortality rates, shorten hospital stays and treatment durations, lower healthcare costs, and decrease unnecessary antibiotic use.

The report provides an overview of existing policies governing antimicrobial use in hospitals across all six WHO regions. It also presents findings from a 2024 survey, which indicate that many resources for antimicrobial stewardship (AMS) are already available globally, and several countries offer specific training programmes.

Furthermore, while progress has been made in implementing ASPs in hospital settings, widespread adoption remains hindered by four persistent and interrelated challenges that recur across diverse healthcare systems. These are further described in this report in detail: a shortage of adequately trained personnel and financial resources; resistance or lack of adherence to ASP policies among healthcare providers; inconsistent enforcement of antimicrobial prescribing guidelines and, limited availability of timely, real-time surveillance data to guide decision-making. Addressing these systemic barriers is essential to optimise antimicrobial use, strengthen stewardship practices, and mitigate the escalating global threat of antimicrobial resistance (AMR).

In closing, AMR is a global health emergency that demands coordinated, evidence-based action. Hospitals are at the frontline of this battle, and ASPs represent one of the most effective strategies to preserve the efficacy of existing antimicrobials. Pharmacists, with their unique expertise in pharmacotherapy and medication management, are indispensable to the success of these programmes. To achieve sustainable impact, healthcare systems can invest in workforce development, foster a culture of compliance, and leverage real-time data monitoring. By overcoming barriers, ASPs, through hospital pharmacists, can deliver measurable improvements in patient outcomes and play a pivotal role in safeguarding public health for future generations.

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