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Antimicrobial Stewardship in Saudi Arabia: A Narrative Review of Insights from Physicians, Pharmacists, and Nurses

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Abstract

Antimicrobial resistance (AMR) is a serious public health challenge fueled by the misuse and overuse of antibiotics. Antimicrobial stewardship (AMS) programs are central to the proper use of antimicrobials, patient outcomes improvement, and resistance reduction. Over the years, AMS has taken top place in Saudi Arabia as part of its healthcare reform. Therefore, the present narrative review aims to summarize the opinions of physicians, pharmacists, and nurses regarding the current practices of AMS in Saudi Arabia. It discusses the successes, challenges, and importance of interprofessional collaboration in Saudi Arabia. Significant barriers include insufficient infrastructure and training, cultural factors influencing prescription practices, and relatively low penetration into decision-making roles. Successes include adopting explicit AMS policies, increasing awareness among healthcare professionals regarding AMS issues, and several ongoing training programs. Recommendations for AMS improvement consist of furthering interprofessional collaboration, building educational efforts, implementing advanced diagnostics, raising the level of authority of pharmacists and nurses, and investing in health infrastructure for better real-time surveillance and support for evidence-based prescribing.

Keywords: *Antimicrobial Resistance (AMR), Antimicrobial Stewardship (AMS), Healthcare Professionals, Saudi Arabia, Physicians, Pharmacists, Nurses, Interprofessional Collaboration.*

Introduction

Overuse and misuse of antibiotics are major drivers of antimicrobial resistance (AMR). Antimicrobial stewardship (AMS) programs represent critical interventions through which appropriate prescribing practices, dosing, and duration of therapy can significantly influence the overgrowing crisis of AMR. In

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countries such as Saudi Arabia, where AMR rates are on the rise, there is a pressing need for a coordinated AMS response that goes well beyond the physician and includes the pharmacist and nurse, each with a clearly defined yet interconnected role [1,2].

Physicians' roles are diagnosis and prescription process, which involve an assessment of the general state of health of the patient and evaluation of symptoms. This process generally involves diagnostic laboratory tests and pharmacological treatment [3–5]. Pharmacists check for the appropriateness of diagnoses, provide their expert knowledge in pharmacology, and observe the patient's behavior regarding their compliance with prescribed medicines so that doses are correctly applied, and potential interactions are avoided. Pharmacists also advise patients and healthcare providers regarding the safe use of antimicrobial drugs [6]. Nurses also play a pivotal role in patient education. As immediate caregivers of the patient, the nurses handled all contact with antibiotics [4,7]. They observed the signs and symptoms of adverse drug reactions in their patients, tried to ensure regular timing of doses, and usually implemented infection control measures [3,7].

Moreover, a nurse's advocacy role is essential, including reinforcing principles and expressing concerns about inappropriate antibiotic use by physicians and pharmacists [4,8]. The current review aims to summarize the roles of physicians, pharmacists, and nurses regarding the current practices of AMS and point out different problems that the hospital and non-hospital sectors face to improve them.

Role of Physicians

Physicians are primarily involved in the antimicrobial prescription process. Physicians in Saudi Arabia have acknowledged AMS's benefits in reducing AMR. However, patients with high expectations for antibiotics and diagnostic uncertainty often overuse them. Many physicians feel enormous pressure regarding patients' demand for antibiotics, particularly against viral infections where antibiotics do not work [5,9,10].

Another key barrier is the lack of rapid diagnostic tools at other healthcare facilities, which results in empirical treatment and, to some extent, rational antimicrobial use. Rational use of antimicrobials is a critical step in the containment of AMR, designed to reduce people's overreliance on microbes. Although empirical treatment is necessary in some cases, it should be minimized because it fosters inappropriate antibiotic use and contributes to AMR. Healthcare professionals have also indicated the need for rapid and accurate diagnostic tools to distinguish between bacterial and viral infections to facilitate targeted therapies. The provision of point-of-care testing and molecular diagnostics would significantly increase the use of antimicrobials [6,11].

To address these challenges, the Ministry of Health has incorporated training programs to develop diagnostic capabilities and evidence-based prescriptions. These programs underline the need for more knowledge of antimicrobial guidelines, enhance the education of physicians on patient communication strategies to reduce patient pressure for antibiotics, and foster a culture in which diagnostic stewardship is achieved. Improved electronic prescribing systems incorporated into clinical decision support are encouraged to help physicians make the right choices regarding the use of antibiotics. Such systems can also provide real-time suggestions and warnings regarding potentially inappropriate prescriptions to support evidence-based decisions [9–12].

Table 1. Key Physician Challenges and Solutions

Challenge	Description	Proposed Solution
High Patient Expectations	Patients often demand antibiotics, even for viral infections where they are ineffective.	Training physicians in patient communication to manage expectations.
Lack of Rapid Diagnostic Tools	Limited access to point-of-care diagnostics leads to empirical treatment and overuse of antibiotics.	Investment in rapid diagnostic and molecular tools.

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Pressure to Prescribe	Physicians feel pressure to satisfy patient demands, leading to overprescribing.	Education campaigns to inform the public about AMR risks.
Diagnostic Uncertainty	Difficulties in differentiating bacteria from viral infections contribute to inappropriate use.	Training programs to enhance diagnostic skills and precision.

Insights from Pharmacists

Pharmacists play an essential role in AMS by reviewing prescriptions and educating patients on healthcare. In Saudi hospitals, pharmacists actively participate in AMS programs through prospective audits, feedback, and actual contributions to developing antibiotic guidelines. However, this is still hindered by low authority to change prescriptions, low interprofessional collaboration, and inadequate incorporation into clinical decision-making processes [13–15].

There is an opportunity for pharmacists to drive AMS through an extra checkpoint for inappropriate prescriptions. However, most pharmacists in Saudi Arabia are restricted by barriers that negate their impact on prescribing decisions. These include a lack of autonomy to individually adjust a prescription and obstacles due to a hierarchy restricting any active intervention [13,16,17].

With more liberalization and stronger integration into patient care teams, fostering pharmacists' role might significantly improve AMS outcomes in the USA. Describing the actual positions of pharmacists within the multidisciplinary AMS team would ensure the beneficial use of their skills. This may also instigate proactive AMR measures. Investment in specifically oriented programs further improves pharmacists' proficiency in making sound decisions and implementing evidence-based practices [6,14,17].

Furthermore, the pharmacy staff can educate other healthcare staff and patients about the appropriate use of antimicrobials. This can be achieved through workshops initiated by pharmacy staff that develop and update materials and involve other healthcare professionals in the community. Such community outreach programs could help influence harmony in behavior concerning antimicrobial usage, thus preventing AMR. More importantly, such a teaching function can decrease self-medication and heal many misconceptions about treatment in the general population. Advocating for a more active role for pharmacists in public health campaigns, especially campaigns that aim to reduce antibiotic usage, could greatly benefit AMS efforts [12,16].

Table 2. Pharmacist Challenges and Solutions

Challenge	Description	Proposed Solution
Limited Authority	Pharmacists often cannot modify inappropriate prescriptions directly.	Greater authority and clear protocols for AMS.
Inadequate Collaboration	Poor interprofessional collaboration limits AMS's effectiveness.	Structured collaboration channels and teamwork.
Education and Audits	Inadequate opportunities for pharmacists to lead AMS initiatives.	Increased involvement in audits and patient care.

Nurses and Their Contribution to AMS

In Saudi Arabia, nurses provide AMS services through patient education, infection control, and adverse drug reaction surveillance. As they directly handle patient care activities, involving them in explaining proper antimicrobial use, the correct regime for treatment, and misbeliefs related to antibiotics are easy for nurses. They were comfortable teaching patients about antibiotics, and the nurses expressed the need for more AMS knowledge [8,18,19].

Nurses support AMS by monitoring and surveillance of antimicrobial use and drug reactions. They act as frontline observers who ensure the prompt reporting of any signs of misuse or complications related to antibiotic therapy. By recording and reporting patients' responses to antibiotic treatment, nurses can ensure

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that therapeutic adjustments are made promptly to maximize patient benefits. Therefore, this optimizes the outcome for a patient who may present with signs or an established infection. They also ensure the active implementation of infection control practices, including hand hygiene and isolation protocols, both of which are imperative in containing the spread of resistant infections in any healthcare setting [18,20].

However, one of the significant challenges is that nurses often do not have structured AMS training. They expressed the need for comprehensive in-service education on AMS-related topics, which would cover knowledge of various classes of antibiotics, how to identify inappropriate prescribing, and patient education strategies. This can be achieved by designing programs for the continuous professional education of nurses, thus filling the gap in improving the input of efforts on AMS by nurses. Such programs should involve hands-on workshops, simulations, and multidisciplinary real-case deliberations to enhance knowledge and confidence regarding active involvement in AMS [18,19,21].

Moreover, empowering nurses by formally recognizing their contributions to the AMS team would enhance AMS practices. When the nurse is in the loop of decision-making regarding antimicrobials, this will ensure much input, as they relate most to patients. They would be better positioned to note signs of adverse reactions early and to push for a change in the treatment plan. Structured communication routes for nurses, physicians, and pharmacists could enhance collaboration and effectiveness in ensuring appropriate AMS [8,20,21].

Table 3. Nurse Challenges and Solutions

Challenge	Description	Proposed Solution
Lack of AMS-Specific Training	Nurses need more structured AMS training to improve their role.	Continuous AMS-focused education programs.
Monitoring and Adverse Reactions	Surveillance of antibiotic use and managing adverse reactions.	Developing protocols for better surveillance.
Patient Education	Inconsistent knowledge in providing AMS education to patients.	Training in effective communication techniques.

Challenges and Barriers

Insufficient infrastructure, training, and collaboration among healthcare professionals are the primary barriers to successfully implementing AMS in Saudi Arabia. Most significantly, inadequate laboratory facilities and diagnostic tools contribute to the inability to diagnose infections promptly and rely on empirical treatments. The major impediment to successful AMS in Saudi Arabia is interprofessional disconnection between physicians and pharmacists. Good reporting hierarchies that are too rigid tend to inhibit effective collaboration due to a lack of adequate communication channels, leading to fragmented care and missed opportunities for optimization of antimicrobial use [22–24].

Moreover, cultural factors, such as patients wanting antibiotics and the obligation to fulfill such demands, lead to overprescription. Saudi Arabia presents a cultural idea about antibiotics as a fast solution that often pressures the medical staff to respect the patient's expectations even if antibiotics are not clinically needed. Yet another point is that the public's unawareness of the threats of AMR leads to these demands. In the present perception, public campaigns on education, mass media, community programs, and changing school attitudes could work as effective strategies [21,25,26].

Another significant barrier is the inadequacy of AMS training among healthcare practitioners, especially those working in rural and underserved areas. As these areas do not usually have access to formalized education on AMS, this contributes to the variation in antimicrobial prescription practices. Online modules, workshops, and telemedicine initiatives could help fill this gap in AMS training across different regions in Saudi Arabia. In addition, the lack of contextualized national AMS guidelines has led to disparities in how AMS is implemented in various healthcare settings, further complicating efforts to achieve best practice standardization [23,27].

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Insufficient availability of electronic health records (EHR) and integrated clinical decision support systems limit AMS effectiveness. Such systems can offer alerts and advice on time, help evidence-based prescriptions, and ensure adherence to AMS protocols. Investment in health information technology, specifically in integrating EHRs with AMS tools, may improve real-time monitoring and intervention [24,27].

Emergency Preparedness and Pandemic Considerations

The COVID-19 pandemic has underscored the need for strong AMS programs in emergency public health situations. The pandemic served as a real litmus test for the AMS frameworks that needed to be resilient and adaptive to unprecedented challenges facing healthcare systems in Saudi Arabia. Such experience views from the preparedness angle emerge as an imperative for flexibility in protocols that stand well in crises [28–30].

During a health crisis, sustainably effective AMS becomes exceedingly arduous because of the rise in the number of patients stretched into health resources and the urgency in decisions related to treatment. Hospitals in Saudi Arabia have evidenced increased use of broad-spectrum antibiotics during the COVID-19 pandemic because of primarily such fears relating to secondary bacterial infections. This underscores the balance that crisis-specific AMS protocols must strike between immediate patient needs and long-term resistance concerns. Different forms of healthcare facility-specific emergency response planning need to be developed. These include but are not limited to rapid response teams with expertise in AMS, modification of approval processes for restricted antimicrobials, streamlined communication between prescribers, emergency inventory management systems for critical antimicrobials, and accelerated diagnostic testing protocols [29–32].

The COVID-19 pandemic has taught AMS programs in Saudi Arabia several essential lessons. Telemedicine was implemented successfully during the pandemic, revealing the opportunity for remote AMS consultants because specialists would guide several facilities simultaneously. The experience also included visibility on the importance of holding strategic reserves for critical antimicrobials and developing a supply chain management system considering global supply disruptions. Also revealed to be an imperative need was establishing precise and rapid communication channels between healthcare professionals and their facilities for coordination response and sharing best practices. In addition, it also became evident during the crisis period the value these systems could add to real-time surveillance and EHR in monitoring trends in patterns of use of antimicrobials and resistance trends [31,33,34].

Effective emergency protocols for AMS should be inculcated with the following aspects. A tiered response system that begins with enhanced monitoring and reporting at Level 1, proceeds to modified prescription protocols at Level 2, and strikes Level 3 with a complete emergency response and centralized control should be initiated. The communication framework must include clear chain-of-command designation communication channels, status update regularity, and cross-departmental coordination protocol. Resource allocation systems should have priority-based distribution systems, alternative medication protocols, emergency staffing plans, equipment, and supply management. Documentation requirements must maintain simplification but adequacy in documentation processes, emergency override procedures, audit trail maintenance, and quality assurance measures [28,34,35].

Effective AMS under any emergency is significantly reliant upon contingency planning. Risk assessment and mitigation should regularly analyze potential threats (probability), the scenarios possible during an emergency, how to mitigate them, and a proper update of the risk management plan. Alternative care protocols include backup systems for critical functions, modified treatment guidelines for the crisis, alternative diagnostic approaches, and emergency staffing patterns. The recovery plan should detail the steps involved in returning to normal operations, evaluating emergency response actions, implementing lessons learned, and updating experience-based revised protocols. Training and preparation shall comprise regular drills for emergency response measures, staff members applying for their respective roles in an emergency, cross-training of key personnel, and exercises in simulation [32,33,36].

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Healthcare facilities should review emergency protocols and update preparedness assessments periodically to ensure effectiveness. Readiness should be regularly assessed, the emergency response team maintained, relationships with external support networks fostered, information systems invested in, and comprehensive training programs developed [28,35,36].

Economic Impact

Implementing AMS in Saudi Arabia requires a significant investment in healthcare infrastructure, carefully considering the economic factors and resources involved. The initial implementation costs for the AMS program in the Saudi healthcare setup include infrastructure development, staff training, technology implantation, and the day-to-day operational cost. Studies from tertiary care hospitals in Saudi Arabia show that the average initial setup cost ranges between SAR 500,000 and SAR 2 million, depending on the facility's size and the program's scope. These include setting up dedicated AMS teams, developing information systems, and creating monitoring protocols [37–40].

The cost savings resulting from lowered AMR strengthen the economic case for AMS implementation [39,41]. A detailed analysis of healthcare data in Saudi Arabia found that institutions implementing AMS programs experienced a 15-25% reduction in annual antimicrobial expenditure within the first two years of implementation. It also uncovered additional financial benefits from reduced hospital stays, readmission rates, and reduced incidence of resistant infections. For example, it found that well-structured AMS programs cut the average inpatient stay for patients with resistant infections by 3.5 days, leading to savings of about SAR 7,000 per patient. Proper stewardship practices can further reduce the economic burden of resistant infections, now claimed to cost between SAR 35,000 and 50,000 per case [40,42–44].

Resource allocation considerations have proven to be a significant determinant of the success of implementing and sustaining AMS programs. Regarding personnel, technologies, and operational costs, the healthcare facility needs to prepare its strategic workforce across these components. Most personnel spending focuses on allocating resources to be set aside for the program's implementation, including specialized infectious disease physicians, clinical pharmacists, and support personnel. The investment in technology infrastructure will account for 20-30% of resource allocation. Other components will include training programs, quality improvement initiatives, and educational materials. A unique strategic planning emphasis on immediate and long-term sustainability objectives must be implemented to ensure proper resource distribution across all program components [37,38,41].

The cost-effectiveness of different AMS interventions is very disparate, so a careful valuation of various approaches is needed. Prospective audit and feedback systems have consistently achieved the highest return on investment in Saudi healthcare settings, typically 1:3 to 1:5 cost-benefit ratio. Although requiring a large initial outlay, electronic prescription monitoring systems show cost-effectiveness within 18-24 months due to reduced medication errors and improved prescribing practices. Educational programs, less capital-intensive, bring about moderate yet relatively consistent returns by influencing physicians' prescribing behavior and decreasing inappropriate antibiotic use. The cost-effectiveness of formulary restriction and preauthorization schemes is variable, although the actual implementation costs are recouped by decreased antimicrobial expenditure within a year to 18 months [40,42–44].

International Comparisons

A comparative analysis of AMS practices from Saudi Arabia to other Gulf Cooperation Council countries would show similarities and differences. In this region, one country has already implemented its national AMS framework and mandates stewardship programs in all healthcare facilities. This country is among the Gulf Cooperation Council (GCC) regions, the United Arab Emirates, which has noticed a 23% reduction in broad-spectrum antibiotic use over three years. Kuwait has also recorded significant success in reducing AMR rates through its centralized approach to AMS implementation, with all government hospitals having standardized protocols. Oman can also provide several valuable technological insights due to its integration of clinical decision support systems within the national healthcare infrastructure [22,45–50].

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Saudi Arabia could better utilize its AMS implementation through even more standardized protocols and technological integration based on these regional benchmarks. This could perhaps be regarded as the most valuable lesson for the Saudi healthcare system, which can be learned from the AMS programs of developed nations. AMS in the Netherlands has restricted antimicrobial use stringently through prescribing guidelines and the compulsory presence of stewardship teams; thus, it has achieved some of the lowest levels of AMR worldwide [46,51,52]. The national survey of antimicrobial prescribing in Australia is a prototype for such surveillance and feedback systems across all settings. The tiered approach to implementation taken by the UK reflects national requirements of varying facility size and complexity and, in turn, holds lessons for managing diverse healthcare settings. Long-term low antibiotic use in Sweden due to sustained public education campaigns and healthcare provider training highlights the overriding importance of comprehensive stakeholder involvement [51,53–56].

Regional networking opportunities would significantly escalate the promotion of AMS practices in the Middle East. What the Gulf Health Council is doing through its many initiatives on harmonizing guidelines on antimicrobial usage creates a good platform for improved collaboration. Though early, cross-border surveillance networks on resistance monitoring would envisage more effective regional responses to emerging threats. Joint training programs and knowledge-sharing platforms for healthcare professionals in the region would ensure much easier sharing of best practices and expertise. Regional research networks would also provide the development of interventions and guidelines that are more pertinent to the needs of various countries. All these efforts will be raising the bar concerning the individual country programs while helping to push a more organized way to tackle this issue in the region [22,45,46,51,53].

Recommendations

Several measures are recommended to improve AMS in Saudi Arabia further. Improved interprofessional collaboration is essential because doctors, pharmacists, and nurses can fill different knowledge gaps. The knowledge of other professionals can be shared through well-established communication channels such as multidisciplinary team (MDT) meetings. Further developing these relationships will allow the implementation of a highly coordinated AMS approach that optimally uses individual professionals' experiences to ensure the best possible patient outcomes [22,57].

Another equally important step is stepping up healthcare provider training and education. Persistent AMS education with diagnostic tools, antimicrobial guidelines, and effective patient communication can work wonders in augmenting adherence to AMS protocols. Education should consider the difference in roles among healthcare providers and be readily available to experts from all regions, even rural and underserved areas. Workshops, simulation exercises, and online resources will fill this knowledge gap and ensure a uniform understanding of AMS principles [5,9].

Public education campaigns will contribute to driving patients toward health workers and requesting unjustified antibiotics. More importantly, information about AMR risks and the proper use of antibiotics could change cultural attitudes and reduce the perceived need for antibiotics as the first treatment option. The effort would include mass media campaigns, in-school programs for all ages, and outreach to induce common basic knowledge of AMR and its implications. The participation of health workers also boosts credibility and guarantees a homogeneous message [9,57].

Moreover, investment in health information technologies, such as EHRs integrated with computerized clinical decision support systems (CDSS), constitutes an infrastructure-support investment that can enhance evidence-based prescribing and AMS compliance. Such systems can provide real-time alerts for inappropriate use and offer recommendations based on the most up-to-date AMS protocols. Upgrading technological infrastructure, especially among hospitals and clinics lacking such systems, is instrumental in effectively implementing AMS [3,12].

Empowering pharmacists and nurses in AMS teams through more rights and acknowledging their valuable work can multiply AMS outputs. If pharmacists are formally included in deciding upon the use of antimicrobials and nurses are granted roles in AMS practices, the approach will be steered from a

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comprehensive multidisciplinary viewpoint. Further specific education for pharmacists and nurses, including expanding their positions within AMS teams, will promote a culture that proactively deals with AMR [21,26,57].

Conclusion

AMR in Saudi Arabia has shown some marked achievements; however, several challenges remain and require much attention for its long-term success. Integrating insights from the interprofessional collaboration of physicians, pharmacists, and nurses called for enhanced interprofessional collaboration-targeted training and public awareness campaigns. Bridging the gaps between healthcare professionals through structured communication channels and empowering pharmacists and nurses with more defined roles in AMS is a significant step that would help strengthen AMS practices. Investments in improved diagnostics, health information technology, and public education could help address systemic barriers and misconceptions about antibiotic use. In turn, this would go a long way toward propelling a unified, multidisciplinary approach toward curbing the burden of AMR with the effective engagement of all stakeholders. Saudi Arabia ensures yet another heavy lift to ascertain the sustainability of AMS efforts.

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