THE ARABIAN PENINSULA ANTIMICROBIAL STEWARDSHIP PROGRAM: SUCCESSES, CHALLENGES AND PERSPECTIVES

Maha Mahmoud Alawi

Infection Control and Enviromental Heath Unit, Department of Clinical Microbiology and Immunology, Faculty of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia

Abstract. The Arabian Peninsula has recently witnessed an increase in antimicrobial resistance, mainly due to the misuse of broad-spectrum antibiotics. The countries that make up the region have collectively adopted the Antibiotic Stewardship Program (ASP) as a component of the healthcare delivery system with the intention of scaling it up to combat the growing issue of antibiotic resistance in the region. Therefore, this study evaluated the current situation of ASPs in the Arabian Peninsula and provided recommendations for bolstering the defense against antimicrobial resistance. The available literature demonstrated that countries in the Arabian Peninsula had effectively adopted ASPs to a reasonable degree using practical tactics. In the region, Saudi Arabia has set a positive example. Since the Arabian Peninsula has implemented ASP, overall expenses have decreased, drug-resistant *Pseudomonas aeruginosa* has become less common, and broad-spectrum antibiotics such as ceftriaxone have been used less frequently. However, the Arabian Peninsula has found it challenging to adopt ASPs due to several issues. Therefore, it is recommended that strategies be put into place for continuous training and education of healthcare professionals and the public, for improved surveillance and monitoring of antibiotic use, and for enforcement of local guidelines and regulations in order to expand the adoption of ASP in the Arabian Peninsula.

Keywords: antimicrobial resistance, antimicrobial stewardship program, Arabian Peninsula, implementation

Correspondence: Maha Mahmoud Alawi, Faculty of Medicine, King Abdulaziz University, University Street, Jeddah 21589, Saudi Arabia
Tel: +96 6126408222 Ext 14308
E-mail: malalawi@kau.edu.sa

INTRODUCTION

Globally, the ever-rising emergence of antimicrobial resistance constitutes a significant public health problem (Prestinaci *et al*, 2015). By 2050, antimicrobial resistance is projected to be the leading cause of death worldwide, closely followed by cancer, diabetes mellitus, diarrhea, and automobile accidents (Dadgostar, 2019). Globally, antimicrobial resistance is projected to cost a tremendous amount of USD 100 trillion and a decline in gross domestic products by 2.0-3.5% (Taneja and Sharma, 2019)

Antimicrobial resistance adversely affects health outcomes in patients' care, thus, leading to a higher disease prevalence, an increased number of deaths and an elevated healthcare cost (Nathan and Cars, 2014). The inappropriate use of antibiotics has been identified as one of the primary factors that promote antimicrobial resistance (Peterson, 2006). Antimicrobial stewardship programs (ASP) have been generally accepted worldwide as an effective way to combat the rising prevalence of antibiotic resistance. ASP constitutes strategies implemented to improve the appropriate use of antibiotics to optimize patients' outcomes while minimizing antimicrobial resistance. According to the World Health Organization (WHO), ASP provides an organized approach to the overall healthcare delivery system by promoting an appropriate utilization of antimicrobial agents using evidence-based interventions generally accepted locally and internationally (WHO, 2019). ASP has been designed to preserve the effectiveness of antimicrobial agents while delaying the emergence of resistance to these drugs. It is a patient-focused program involving the collaboration of multiple healthcare professionals, including physicians, hospital pharmacists, microbiologists, and nurses (Kapadia *et al*, 2018). The program ensures that each patient receives appropriate antibiotics at the proper dosage and for the shortest effective duration to improve clinical outcomes and reduce the chances of unintended consequences. Also, it has been established that implementation of an ASP is associated with reduced length of hospital stays, lower cost of antibiotics consumption and decreased hospital readmission rates (Hamilton *et al*, 2015).

The Arabian Peninsula is a region of the Middle East that encompasses Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates. This conglomerate of independent States, tied by political and economic interests, is also known as the Gulf Cooperation Council (GCC). The Arabian Peninsula has witnessed

significant economic and healthcare developments in the past few decades, which has led to an increase in antimicrobial prescriptions and, consequently, an increase in the prevalence of antimicrobial resistance (Zowawi, 2016; Borgio *et al*, 2021; Somily *et al*, 2021). The increase in antimicrobial resistance in the region has been primarily attributed to frequent prescribing of broad-spectrum antimicrobials, lack of well-coordinated infection control programs, shortage of trained personnel, obsolete architectural designs of many healthcare facilities, and lack of integration of computerized systems and information technology (Aly and Balkhy, 2012; Balkhy *et al*, 2016; Jamsheer *et al*, 2016).

It is against this backdrop of the high burden of antimicrobial resistance in the Arabian Peninsula that the GCC Centre for Infection Control was established in 2005 (Balkhy *et al*, 2016), and charged with the responsibility of curbing the growing threat of antimicrobial resistance bedeviling the Arabian Peninsula. Within a decade of its inception, the GCC Centre for Infection Control has developed the first GCC strategic plan, and published and distributed the content addressing antimicrobial resistance issues (Balkhy *et al*, 2016). The GCC strategic plan provided general recommendations for the implementation of ASPs among the Arabian Peninsula countries and served to augment the 2015 global action plan launched by the WHO (WHO, 2015). Implementing the GCC strategic plan was the responsibility of individual member nations.

The progress of the Arabian Peninsula in its implementation of ASPs has been vastly under-reported. Although several primary and secondary research studies have assessed the degree to which ASP has been implemented at the hospital level in a number of the Arabian Peninsula and Middle East countries (Wagner *et al*, 2014; Schuts *et al*, 2016; Nasr *et al*, 2017; Alghamdi *et al*, 2021a), nevertheless information remains scarce regarding the implementation and success of ASPs in the Arabian Peninsula.

There is an urgent need to address the rise of antimicrobial resistance in the Arabian Peninsula (Zowawi, 2016). The region's diverse population has various cultural beliefs, practices, and healthcare systems. This diversity presents unique challenges in implementing ASP tailored to each country's needs and context. An understanding of the triumphs and challenges of ASPs in the region is crucial to developing effective strategies that can be adapted and implemented in each country.

Thus, this study evaluated the current status of APSs in the Arabian Peninsula, identified the successes and challenges associated with APS implementation and explored perspectives for improving APS practices in the region. The study identified and discussed critical factors, which facilitate or hinder the successful implementation of APSs in the Arabian Peninsula and provided recommendations for improving programs to combat the development and spread of antimicrobial resistance in the region. The findings should be of potential use to policymakers, healthcare providers and other stakeholders in the Arabian Peninsula in optimizing the application of antimicrobial agents without engendering further occurrence of drug resistance.

METHODOLOGY

A literature search was conducted in electronic databases, such as Google, Google Scholar, MEDLINE, PubMed, ScienceDirect, and Scopus for studies conducted on ASPs in the Arabian Peninsula. Important keywords used to explore the studies were the following: "Antibiotics", "Antimicrobial Resistance", "Antimicrobial Stewardship Program", "Antimicrobials", "Arab Countries", "Arabian Peninsula", "ASP Challenges", "ASP Implementation", "ASPs", "Drugs", "Infection", "Infectious Diseases", "Kuwait", "Medications", "Middle East Region", "Oman", "Patients", "Qatar", "Rational Drug Prescribing", "Saudi Arabia", "United Arab Emirates", and "Yemen". The search was conducted from January to May 2023. Relevant titles were manually identified and irrelevant studies were screened out. Twenty-two articles were included for review regarding the ASPs in the Arabian Peninsula, which were evaluated under the following topics: ASP Implementation, Challenges of ASP Adoption and Perspectives

REVIEW

ASP implementation

In the Arabian Peninsula, ASPs have been implemented to varying degrees of success in many hospitals across all GCC countries. This success of ASP adoption was achieved despite numerous obstacles along the way. Based on the available reports, specific ASP strategies frequently applied in the region include prospective audits with intervention and feedback, formulary restrictions and pre-authorization, and guidelines and clinical applications (Aly *et al*, 2012; Abdallah *et al*, 2017; Nasr *et al*, 2019). Other less reported ASP strategies were the conversion from parenteral to oral intake,

timely de-escalation of antibiotic therapy and education of healthcare professionals (Table 1). Moreover, locally designed ASP guidelines based on antimicrobial culture and sensitivity as recommended by the Centers for Disease Control and Prevention (CDC, 2019) were often used in most of the hospitals in the region. In many hospitals where ASPs have been established, the ASP team comprises only infectious disease specialists and consultants, while in other health facilities, the ASP team includes infection control nurses and other specialists.

As ASP team members, clinical pharmacists were responsible for monitoring antibiotic use and providing necessary feedback in a few hospitals in the region. Some hospitals in Saudi Arabia have microbiologists as members of the ASP team. They are responsible for providing data on antimicrobial resistance (antibiograms) to hospital committees to assist in adjusting appropriate ASP interventions. Overall, the published literature indicates that Saudi Arabia is the country in the Arabian Peninsula most advanced in ASP implementation. The ASP successes recorded in Saudi Arabia in recent years have been largely attributed to the crucial roles of clinical pharmacists as key hospital ASP team members (Alomi, 2017; Haseeb *et al*, 2020).

In addition, clinical pharmacists, particularly those specializing in infectious diseases, play essential roles within the hospital ASP. In Saudi Arabia, the roles clinical pharmacists play in ASPs are well documented in previous studies (Al-Somai *et al*, 2014; Alghamdi *et al*, 2021b). For example, clinical pharmacists are actively involved in managing antibiotics by regulating the use of antibiotics and optimizing prescribing practices based on available local guidelines and policies (Haseeb *et al*, 2020). This is accomplished by educating patients, healthcare professionals and the general public on the ASP (Al-Somai *et al*, 2014). Clinical pharmacists also help to prevent the spread of infectious diseases within healthcare institutions by monitoring patterns in antimicrobials' prescribing and formulary including guideline adherence, and providing information on these trends (Haseeb *et al*, 2020). They are involved in keeping watch on the length of antibiotic therapy and offering advice to patients on the proper intake of antimicrobial medicines (Al-Somai *et al*, 2014; Alomi, 2017).

Many beneficial outcomes have been documented due to implementing various ASP strategies in the Arabian Peninsula. These benefits range from the reduction of antimicrobial consumption to the optimization of antibiotic use. A study conducted in Saudi Arabia

Table 1

Evidence of ASP implementation in the Arabian Peninsula

No.	Country	Setting	Intervention	Outcome	Reference
1.	Kuwait	Nine public hospitals	Prospective audit, clinical guidelines for antibiotic consumption	Compliance of antibiotic prescriptions with local clinical guidelines	Aly *et al*, 2012
2.	Bahrain	Military hospital	Strategies to reduce HCAIs and patient length of stay	Antibiotic consumption, cost savings	Al Ansari *et al*, 2013
3.	Oman	Tertiary hospital	Restriction of vancomycin usage	Appropriate vancomycin prescriptions	Al Za'abi *et al*, 2013
4.	Saudi Arabia	Tertiary care ICU hospitals, 894 beds	Prospective audit and feedback	Proper antimicrobial consumption	Amer *et al*, 2013
5.	Saudi Arabia	General hospital, 380 beds	Restrictive reporting and general ASP practices	Consumption of antibiotics measured as DDD per 1,000 patient days, susceptibility rates of Enterobacter aerogenes and Pseudomonas aeruginosa, and antibiotic prescribing for gram-negative bacteria	Al-Tawfiq *et al*, 2015
6.	Qatar	Hospitals, primary care center	Staff education and identification of ASP activities in Qatar and pharmacists' involvement in the program	Level of implementation of ASP	Pawluk *et al*, 2015
7.	Qatar	A community hospital, 75 beds	Tracking of antibiotic usage	Antibiotic consumption by DDD	Garcell *et al*, 2016
8.	Saudi Arabia	Tertiary hospital, 1002 beds	Restrictions of antibiotic usage, pre-authorization and dispensing rules	Antibiotic consumption, death rate, multi-drug resistance, and cost	Alawi and Darwesh, 2016

Table 1 (cont)

No.	Country	Setting	Intervention	Outcome	Reference
9.	Saudi Arabia	Public hospitals, 1,350 beds	Restrictions of carbapenem consumption	The susceptibility of Pseudomonas aeruginosa to carbapenem and DDD per 1,000 patient days	Abdallah *et al*, 2017
10.	Qatar	Community Hospital	Staff education and monitoring the consumption of antibiotic prophylaxis in patients who undergo appendectomies.	Compliance in timely administration, dose selection, proper discontinuation of prophylactic antibiotics, and overall reduction of antibiotic consumption	Garcell *et al*, 2017
11.	Saudi Arabia	Ministry of Health hospitals	General ASP practices	Level of implementation of ASP	Alghamdi *et al*, 2021a
12.	United Arab Emirates	Quaternary hospital, 360 beds	Dose optimization of antibiotics and IV to oral conversion	Antibiotic consumption is measured as days of therapy per 1,000 patients and antibiotic cost-saving	El-Lababidi *et al*, 2019
13.	Saudi Arabia	4 public hospitals and 2 private hospitals, 500 beds	ASP practices	The extent of implementation of ASP and clinicians' perceptions of the program	Baraka *et al*, 2019
14.	Saudi Arabia	General hospital, 380 beds	Tracking of antimicrobial consumption	DDD per 100 bed days, adjusted DDD and day of therapy	Momattin *et al*, 2018
15.	Qatar	Teaching hospital, 65 beds	Prospective audit and feedback with the aid of educational intervention and tracking of changes	Compliance of antimicrobial prescriptions to national guidelines and evaluation of the outcome of educational interventions	Nasr *et al*, 2019
16.	Saudi Arabia	Tertiary hospital, 1,500 beds	De-escalation of antibiotic usage	Rate of de-escalation of antibiotic usage and average hospital length of stay.	Alshareef *et al*, 2020

Table 1 (cont)

No.	Country	Setting	Intervention	Outcome	Reference
17.	Saudi Arabia	19 hospitals	Formulary restrictions, prospective feedback, clinical guidelines, and 18.use of automated stopping ord19.ers.	Evaluation of ASP practices and level of success.	Haseeb *et al*, 2020
18.	Qatar	Hospital, 603 beds	Pre-au20.thorization, prospective audit and feedback	Prevalence of multi-drug resistant Pseudomonas aeruginosa and antibiotic consumption by measuring DDD per 1,000 patient days	Sid Ahmed *et al*, 2020
19.	Saudi Arabia	Four private tertiary hospitals	Staff education, pre-authorization, prospective audit, and feedback	Consumption of antibiotics measured as DDD per 1,000 patient days, the acquisition cost of IV and oral antibiotics, healthcare-associated infections	Al-Omari *et al*, 2020
20.	Qatar	Teaching hospital, 320 beds	Formulary restrictions, pre-authorization and staff education	Antibiotic consumption is measured as DDD per 1,000 patient days and the rate of de-escalation and discontinuation of restricted antibiotics	Shaukat *et al*, 2020
21.	Saudi Arabia	Nursing home: 100 beds and ICU: 6 beds	The ASP was designed and led by a multidisciplinary team including an infectious disease consultant, two clinical pharmacists, a clinical microbiologist, and an infection control preventionist	Five key performance indicators were monitored: (1) IV-to-oral switch rate, (2) consumption of restricted IV antimicrobials (raw consumption and DDD index), (3) cost of restricted IV antimicrobials, (4) antimicrobial sensitivity profiles, and (5) MDR-HAI.	Alawi *et al*, 2022

ASP: Antibiotic stewardship program; DDD: Defined daily dose; HCAI: Healthcare-associated infections; ICU: Intensive care unit; IV: Intravenous; MDR-HAI: Multidrug resistance rate among hospital-acquired infections

found that restriction in carbapenem consumption reduces the prevalence of *Pseudomonas aeruginosa* to imipenem and meropenem from 76.0 to 38.5% (p-value = 0.019) and 74.1 to 30.0% (p-value = 0.012), respectively; however, the susceptibility of *P. aeruginosa* to other antibiotics is unrelated to restriction to carbapenem access (Abdallah *et al*, 2017). Al-Omari *et al* (2020) demonstrated that ASP implementation in four private hospitals in Saudi Arabia resulted in a cost reduction of antimicrobial consumption by 28.45% in the first year of the program and remained moderately the same in the next five years, with an aggregate cost savings of SAR 6,286,929 (USD 1,676,412.45). Another study in Qatar reported that ASP implementation led to a decrease in the prevalence of multi-drug resistant *P. aeruginosa* from 9.00% in 2014 (before the launch of the program) to 5.46% in 2017 (p-value = 0.019); specifically, the prevalence of *P. aeruginosa* resistance to ciprofloxacin is reduced from 91.0 to 88.5%, to piperacillin/tazobactam from 90.4 to 80.3%, to meropenem from 89.2 to 86.9%, and to amikacin from 58.4 to 47.5% (Sid Ahmed *et al*, 2020). Similarly, a study in Qatar demonstrated that ASP implementation in a hospital reduced ceftriaxone consumption by an early switch from an intravenous to an oral route of drug administration; additionally, this switch is associated with a shorter hospital stay and decreased incidence of side effects linked to the intravenous infusion (Shaukat *et al*, 2020).

Nevertheless, several factors significantly contributed to the successful implementation of ASP, namely, leadership support, effective communication, education and training, availability of guidelines and policies, and use of data and surveillance. Other factors impacting ASP implementation in the Arabian Peninsula are poor adherence to related policies and guidelines, lack of enforcement of such measures from the Ministries of Health and hospital administrations, shortage of ASP professionals, fears and concerns of physicians concerning liability, and lack of health information technology infrastructure.

Challenges of ASP adoption

The Arabian Peninsula still faces several obstacles that prevent the ASP expansion and continuous implementation, despite the benefits associated with its implementation. Cultural and social variables, lack of infrastructure and resources, lack of senior administrative support, disregard for local hospital policies, and lack of understanding among healthcare professionals are some of the significant problems that have been identified (Hashad *et al*, 2020). Cultural beliefs and customs also hamper the adoption of ASPs in the

Arabian Peninsula. For example, antibiotics may be overused in situations where people expect to be prescribed regardless of the underlying conditions (Alghamdi *et al*, 2019). It may be difficult for pharmacists or infectious disease specialists to interfere on antibiotic prescribing practices in cultures where it is less acceptable to disagree with medical professionals' judgments (Alghamdi *et al*, 2019). In such situations, practitioners would prefer not to disclose antibiotics prescribing patterns to avoid a possible exposure of mistakes with possible subsequent consequences, such as loss of professional and social reputation, cost of litigation, the emotional impact of malpractice, damage to doctor-patient trust, erosion of patients' confidence in physicians, and negative patient/family reaction. Moreover, public knowledge of the principles of safe utilization of antibiotics and the negative impacts of irrational prescribing and misuse of these drugs have been increasing recently, which might be the factor behind the current phenomenon of disagreements with professionals concerning their judgments in the practice of prescribing drugs.

Ample infrastructure and resources are needed to successfully implement an ASP, such as suitable laboratory facilities, information technology systems, and staff with the necessary skills. Additionally, many healthcare professionals need to be made aware of the fundamentals of ASPs and how to use them successfully. Due to this lack of knowledge, inappropriate prescribing techniques are used, promoting the development of bacteria resistant to antibiotics (Aly *et al*, 2012; Baraka *et al*, 2019). This problem is compounded by the fact that many areas of the Arabian Peninsula lack or have ineffective antibiotic resistance surveillance programs, essential for tracking the development of antibiotic resistance and regulating antibiotic use. Additionally, the identification of antibiotic-resistant bacteria is hindered by a dearth of laboratories with adequate facilities to conduct antibiogram assays (Al-Tawfiq *et al*, 2015; Alghamdi *et al*, 2019).

The Arabian Peninsula's lack of infrastructure and resources appears to be one of the main obstacles to adopting ASPs. The infrastructure, dedicated ASP personnel and funding are all under constraints (Alghamdi *et al*, 2019; Baraka *et al*, 2019). The resources needed to implement an effective ASP, which calls for a multidisciplinary team approach involving doctors, pharmacists and infectious disease specialists, are only available in certain healthcare settings (Amer *et al*, 2013). With sufficient funding, healthcare facilities in the Arabian

Peninsula would find it easier to implement ASPs, resulting in efficient and successful implementation of the programs.

Other documented challenges to ASP implementation in the Arabian Peninsula include lack of funding and expertise, being major obstacles to program implementation in the Arabian area (Enani, 2016). Also, the insufficient policies and guidelines that govern, encourage, and oblige the commencement of the program is a considerable barrier. Furthermore, even with the limited availability of the related measures and regulations, applying them in practice is another challenge (Table 2).

Perspectives

Using antibiotics responsibly and preventing the emergence and spread of microorganisms resistant to antibiotics are among the primary goals of ASP. The stewardship of antibiotics has advanced significantly in recent years, but there is still much to be done to guarantee their continued efficacy. Antibiotic-resistant microbes are becoming increasingly common, being one of the significant problems in the Arabian Peninsula that will likely confront ASPs in the future. When bacteria evolve resistance genes to antibiotics or when they gain these genes through horizontal transfer, infections recalcitrant or completely resistant to drug treatment causing a rise in morbidity, mortality and healthcare expenditures. Future efforts of antibiotic stewardship will have to continue to concentrate on avoiding and limiting the spread of antibiotic-resistant bacteria, using such strategies as infection control, prudent antibiotic usage, and surveillance and monitoring of patterns of antibiotic resistance.

New antibiotics discovery and development have declined currently, with few new medications receiving regulatory agency approval. The drop in new antibiotics coming into the market is caused in part by the high cost and lengthy drug development processes, as well as the difficulties in identifying novel chemicals that can successfully treat infections already resistant to antibiotics in daily use. Future discovery of novel antibiotics will need to be supported and encouraged through programs including funding for research and development, regulatory incentives for pharmaceutical companies to produce these types of drugs and establishment of public-private partnerships. Judicious use of antibiotics will also require future ASPs in the Arabian Peninsula to adopt new technology and methods. These strategies will involve the use of point-of-care diagnostics to target antibiotic therapy more precisely, telemedicine to increase

Table 2

Challenges to ASP implementation in the Arabian Peninsula

No.	Country	Challenge to ASP implementation	Reference
1.	Kuwait	Lack of higher managerial support, lack of education and training on local hospital guidelines, lack of adherence to guidelines, physicians' resistance to changing their prescribing habits, fear of liability risk	Aly *et al*, 2012
2.	Saudi Arabia	Lack of education and training on local hospital guidelines, diagnostic challenges	Al-Tawfiq, 2013
3.	Saudi Arabia	Lack of higher managerial support	Amer *et al*, 2013
4.	Qatar	Lack of dedicated ASP personnel, physicians' high turnover, physicians' high workload and limited time, diagnostic challenges	Garcell *et al*, 2016
5.	Saudi Arabia	Lack of higher managerial support	Momattin *et al*, 2018
6.	United Arab Emirates	Lack of dedicated ASP personnel, shortage of infectious disease physicians, shortage of microbiologists, lack of education and training on local hospital guidelines, lack of health information technology	El-Lababidi *et al*, 2019
7.	Saudi Arabia	Lack of enforcement, lack of antimicrobial resistance and antibiotic consumption national surveillance system, of higher managerial support, of dedicated ASP personnel, of internal policy and guidelines, of education and training on local hospital guidelines, of ASP resources, and of confidence; limited funding	Alghamdi *et al*, 2019
8.	Saudi Arabia	Lack of higher managerial support, of confidence and of adherence to guidelines	Baraka *et al*, 2019

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patient access to care, and large data analysis employing artificial intelligence to forecast and monitor antibiotic resistance patterns. Antibiotic stewardship can only advance by adapting to changing patient and healthcare demands through embracing new technologies and methods.

RECOMMENDATIONS

This study has highlighted the necessity for ongoing training and education of medical professionals and the general public, improved antibiotic use surveillance and monitoring, and enforcement of local guidelines and regulations to improve the implementation of ASPs across various levels of healthcare in. Educational initiatives should be developed and implemented to encourage the prudent use of antibiotics and draw attention to the risks of antibiotic resistance. The general public in the Arabian Peninsula should be the primary target of these programs, emphasizing that antibiotics are not a panacea and should only be used when necessary. Patients should also be made aware of the significance of completing their prescribed antibiotic course because premature cessation of antibiotic medication can result in the emergence of pathogens resistant to antibiotics. Additionally, medical professionals should regularly receive training on the basic principles of antibiotic stewardship, such as proper prescribing techniques and the significance of antibiotic resistance monitoring. All healthcare professionals including doctors, nurses and pharmacists should receive this regular training. Furthermore, continuing education sessions on antibiotic stewardship should be made mandatory to ensure that healthcare professionals stay up-to-date with the most recent recommendations and best practices.

Improved surveillance and monitoring of antibiotic use would make it easier to tackle the occurrences of resistance to antibiotics. A detailed surveillance program for antibiotic resistance should be implemented to monitor the occurrence and trends of antibiotic-resistant bacteria in the region. In the surveillance programs, hospitals and other health facilities should be required to report on a regular basis data on trends in antibiotic consumption and resistance. All healthcare facilities should have access to the appropriate technologies, and diagnostic laboratories responsible for determining antibiotic susceptibility need to be kept up-to-date regarding new emerging technologies. These surveillance initiatives will help in the identification of bacterial outbreaks that are resistant to antibiotics, in addition to providing information to

guide optimal antibiotic prescribing practices. All medical facilities should also develop and adhere to national standards for appropriate antibiotic prescribing procedures.

These recommendations must be evidence-based and constantly revised to reflect recent developments. Antibiotics should not be openly available to the general public, and regulations should be implemented to restrict the accessibility of antibiotics without a prescription.

CONCLUSIONS

The issue of antimicrobial resistance was the driving force, to some extent, behind the implementation of ASPs in the Arabian Peninsula. Commonly reported ASP strategies were prospective audit, formulary restrictions and staff education. ASP implementation in the Arabian Peninsula has reduced cost, decreased the prevalence of multi-drug resistant *P. aeruginosa*, and reduced ceftriaxone consumption. Nevertheless, adopting ASPs in the Arabian Peninsula is hindered by cultural and social variables, lack of infrastructure and resources, lack of senior administrative support, disregard of local hospital policies, and a lack of understanding among healthcare professionals. Implementation of ASPs in the Arabian Peninsula is fraught with difficulty, but raising awareness and increasing surveillance, as well as enforcing rules and regulations, will help to improve the adoption of ASPs. A comprehensive strategy for encouraging responsible antibiotic usage is required to prevent the spread of antibiotic-resistant microbes and to enhance public health in the area. The Arabian Peninsula can safeguard its population's health by adopting ASP and implementing its recommendations. It is the hope of this study to contribute to the global efforts of combating antimicrobial resistance and improve patients' treatment outcomes.

CONFLICT OF INTEREST DISCLOSURE

The author declares no conflict of interest.

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