

Antimicrobial Stewardship Practice Among Healthcare Professionals, Knowledge, Barriers And Facilitators In Two Public Institutions In Nigeria

Isabel Naomi Aika* and Ehijie Enato

Department of Clinical Pharmacy and Pharmacy Practice, Faculty of Pharmacy, University of Benin, Benin City, Edo State, Nigeria.

*Corresponding Author's E-Mail: isabel.aika@uniben.edu

DOI: <https://njcpt.com.ng/101.1.2.27>

Abstract

Background: Antimicrobial stewardship (AMS) programme is a strategy to combat antimicrobial resistance. The role of healthcare professionals (HCPs) is critical to its success.

Objective: The study aims to investigate the AMS practice among HCPs, knowledge, barriers and facilitators in a secondary and tertiary healthcare facility.

Methods: This was a cross-sectional study conducted among HCPs using a questionnaire. Ethical clearance was obtained, and data analysis was done using SPSS version 22; p values <0.05 were considered significant.

Results: Of the 160 participants, 125(78.7%) admitted that they lacked knowledge of the purpose and scope of AMS. About 50% of healthcare professionals remained neutral on issues on the AMS programme in their institutions. More than half (69%) of the healthcare professionals believed their facility could implement and sustain AMS. Lack of funding and commitment by hospital managers 105(66.4%), non-availability of antibiotic treatment guidelines 98(62.4%), limited knowledge of healthcare professionals 99(61.9) and weak government policy 94(60.7%) were notable limitations to the practice of AMS.

Conclusion: This study revealed that most HCPs had poor knowledge of AMS. Government involvement in implementing policies and the leadership commitment of hospital executives are prominent barriers. On the part of HCPs, training and the availability of uniform antibiotic treatment guidelines are empowering tools to promote AMS.

Keywords: Antimicrobial stewardship, Health Professionals, Perception, Antibiotics, Hospital

Introduction

Misuse of antimicrobial agents significantly contributes to resistance, especially when prescribing and access to antimicrobial agents are not regulated. It has been estimated that about 30-50% of antibiotic consumption in hospitals is inappropriate. One factor contributing to this is the misuse of antibiotics for the treatment of viruses causing upper respiratory tract infections and acute bronchitis in the community, resulting in multidrug-resistant bacteria that are either sensitive to only last-resort antibiotics or those that are pan-resistant ^[1]. Antimicrobial stewardship (AMS) aims to improve the appropriate use of antimicrobials and minimise their adverse effects, including resistance, toxicity and increased healthcare costs ^[2]. A hospital-based antimicrobial stewardship program is regarded as the globally accepted tool to address the challenge of antimicrobial resistance (AMR). The Center for Disease Control developed a framework for implementing AMS, which can be adapted in various healthcare settings. The framework includes establishing a multidisciplinary antibiotic stewardship team with specified and compensated core members; an administratively supported, necessary infrastructure to track antibiotic use; and availability of local guidance, such as local diagnostic and therapeutic antibiotic guidelines or a list of restricted antibiotics ^[3]. These programmes have already been implemented in numerous countries in different hospital settings ^[4].

AMS implementation in hospitals is still a challenging task in resource-limited settings. Effective antimicrobial stewardship delivery in hospitals requires a multidisciplinary team effort that

includes the medical doctors, who mainly prescribe antimicrobials, pharmacists, nurses, microbiology teams and others [3,5]. Healthcare professionals (HCPs) working in hospitals must have adequate knowledge of antimicrobial resistance (AMR), its triggering factors, and how AMS activities are linked to addressing AMR. Physicians are the most influential HCPs in addressing the problem of antimicrobial resistance because they are responsible for prescribing these agents. However, other HCPs, such as pharmacists, are closely involved in assessing that these agents are appropriate and dispensed accurately.

A strategy to successfully implement AMS in hospitals is highly dependent on the joint efforts of these healthcare professionals. Healthcare professionals must be abreast of their antimicrobial stewardship role [5-7].

The study aims to investigate AMS practice among healthcare professionals, including knowledge, barriers and facilitators to implementing AMS programmes in secondary and tertiary healthcare facilities.

Methods

Study design/setting

This cross-sectional study was conducted in Benin City, Edo State, located in Southern Nigeria. The study was done in a secondary hospital and tertiary facility, both owned and managed by the State and Federal Governments, respectively, to assess the perception of healthcare professionals on antimicrobial resistance and aspects of antimicrobial stewardship practice.

Ethical Approval

Ethical clearance was obtained from the Department of Medical Services of Edo State Ministry of Health (Reference No- HA-737/45) and the Health Research Ethics Committee of the University of Benin Teaching Hospital, Benin City, Edo State (Reference Number- ADM/E22A/VOL.VII/14831011). All study participants were orally informed about the objectives and anonymity of the study, and informed consent was sought from participants before the commencement of the interview. All data collected were kept confidential.

Recruitment of participants

Participants included physicians (consultants, medical officers, residents) from the departments of surgery, paediatrics, emergency, gynaecology/obstetrics, and medicine, pharmacists and microbiology laboratory scientists from both study sites who were approached to participate in the study. A self-administered questionnaire was distributed to all study participants who were permanent staff and had worked for six months or more.

Data collection and management

We used a pre-tested semi-structured questionnaire adapted from similar studies [8,9]. This 41-item questionnaire was designed to collect information from respondents regarding antimicrobial resistance, antimicrobial stewardship practice, barriers and facilitators to AMS in their various institutions. The frequency of degree of agreement to statements was classified into "agree" (strongly agree/agree), "disagree" (strongly disagree/disagree) and "neutral".

Data Analysis

Data were entered into Excel and sorted. Data analysis was done using SPSS version 22. Descriptive statistics such as frequencies and percentages were used to characterise the variables of interest. The χ^2 test with a significance level of $p < 0.05$ at 95% Confidence interval was employed to explore differences in proportions of agreement between healthcare facilities and responses.

Results

The demographic characteristics of the 160 participants are shown in Table 1. One hundred and nine (69.4%) of the participants were between 20-49 years and were males. Many of the healthcare professionals are from tertiary institutions (78.5%), while 121(75.7%) of them are doctors. Participants have worked between 6 months and 20 years, with an average length of work in the institution of 3.21 ± 4.27 years.

Table 1: Demographic Characteristics of Participants N=160

Variable	Frequency (N)	Percentage (%)
Age		
20-29	40	25
20-39	58	36.9
40-49	51	32.5
50-59	7	4.5
60-69	0	0
≥ 70	1	0.6
Gender		
Male	91	56.9
Female	49	43.1
Healthcare level		
Secondary	34	21.5
Tertiary	124	78.5
Position		
Doctor	121	75.7
Pharmacist	39	24.3
Area of Specialty		
Medicine	32	20
Surgery	24	15
Paediatric	19	11.9
Gynaecology	25	15.6
Emergency	31	19.4
Pharmacy	29	18.2

Healthcare professionals expressed their opinion on AMR and possible causes in their various facilities; 77 (48.7%) agreed that AMR is a problem in their daily practice. Seventy-seven (48.7%) of the HCPs believed that a patient is likely to develop a drug-resistant infection during their stay in the healthcare facility, while 103(67.4%) agreed that cost considerations for patients influence their choice of antimicrobials.

Seventy-six (47.8%) of participants have heard about antimicrobial stewardship, 34(21.4%) of them claimed they have some knowledge about AMS, while 125(78.7%) of the HCPs admitted that they lacked knowledge regarding the purpose and scope of AMS. Regarding the importance of antimicrobial stewardship activities, 101(65.2%) participants agreed that AMS activities could decrease resistance to antimicrobial agents and reduce the cost of treating patients. More than half (69%) of the participants believed that their facility can implement and sustain AMS, and 40(26.7%) agreed that their institution has a formal AMS programme. At an individual level, 67(42.4%) participants claimed that they performed some antimicrobial stewardship activities, and 64(40.5%) said their department has a guide they follow on antimicrobial prescribing. About 50% of participants remained neutral on antimicrobial stewardship programmes in their institution (items 4-7). [Table 2]

Table 2. Perception on Antimicrobial Stewardship Practice (N=160)

Items	Level of Agreement
-------	--------------------

	Strongly Disagree N(%)	Disagree N(%)	Neutral N(%)	Agree N(%)	Strongly Agree N(%)
AMS improve the quality of patient care and reduces antibiotic use with cost savings	7(4.4)	17(11)	30(19.4)	55(35.5)	46(29.7)
AMS reduces an institution's nosocomial infection rates and antimicrobial resistance	15(3.1)	13(8.1)	35(21.9)	61(38.1)	46(28.7)
This hospital has the capacity to establish, implement and sustain an AMS	9(5.7)	12(7.6)	28(17.7)	63(39.9)	46(29.1)
This hospital has a formal AMS with a dedicated team of healthcare professionals	10(6.3)	24(16)	76(50.7)	21(14)	19(12.7)
The AMS in this hospital is functional with a clear policy statement	11(7.2)	21(13.7)	84(54.9)	19(2.4)	18(1.8)
This hospital has a local antibiotic treatment guideline accessible to staff	9(5.8)	25(15.6)	68(43.6)	37(23.7)	17(10.9)
This hospital has a report of antibiotic resistance and susceptibility pattern (antibiogram) that is accessible to healthcare professionals	12(7.7)	30(19.2)	65(41.7)	36(23.1)	13(8.3)
Infectious disease experts who can guide antibiotic selection and prescription are available in this hospital	8(5)	34(21.5)	28(17.7)	59(37.3)	29(18.4)
Prescribing physicians are the only professionals who need to understand and participate in antimicrobial stewardship	54(34.2)	35(22.2)	43(27.3)	20(12.7)	6(3.8)
Pharmacists and microbiologists with sufficient training can be coopted into the ASP team	7(4.4)	14(8.8)	32(20.1)	58(36.5)	48(30.2)
I perform some antimicrobial stewardship activities at an individual level	15(9.5)	26(16.5)	50(31.6)	51(32.3)	16(10.1)
The department/unit has a guide or format for antimicrobial use on patients	14(8.9)	29(18.4)	51(32.3)	52(32.9)	12(7.6)

Table 3 displays barriers to implementing AMS noted by participants. Lack of funding and commitment by hospital managers were the top list of barriers, with 105(66.4%) responses. Non-availability of standard treatment guidelines for antibiotic use 98(62.4%), cost considerations on patients for carrying out microbial tests 99(60.8), limited knowledge of healthcare professionals in areas of antimicrobial stewardship activities 99(61.9) and weak government policy on AMS 94(60.7%) are other limitations.

Participants suggested enablers to AMS. Most, 128(80%), think that routine training of healthcare professionals will be highly effective, and 121(75.6) believe that active involvement of the hospital infection prevention and control unit in AMS will be effective. Research on antibiotic use at the healthcare level 122(78.6%), government participation 125(78.1%), commitment and good leadership of hospital executives 119(76.8%), and adequate surveillance for drug-resistant organisms and report of resistance/susceptibility pattern 122(76.3%) are other interventions to facilitate AMS programme. Antibiotic restriction intervention by an infectious disease specialist 95(59.4%) was the least suggested facilitator.

Table 3: Barriers to Implementing and Sustaining Antimicrobial Stewardship Programme (N=160)

Items	Level of Agreement				
	Strongly Disagree N(%)	Disagree N(%)	Neutral N(%)	Agree N(%)	Strongly Agree N(%)
Weak government policy on AMS and lack of involvement hinder AMS locally	5(3.2)	20(12.9)	36(23.2)	41(26.5)	53(34.2)
Lack of commitment of healthcare administrators/managers impairs AMS	5(3.2)	15(9.5)	33(20.9)	65(41.1)	40(25.3)
Lack of standard antibiotic treatment guidelines at both national and facility levels	4(2.5)	23(14.6)	32(20.4)	60(38.2)	38(24.2)
Lack of funding to sustain antimicrobial stewardship programs	5(3.2)	12(7.7)	35(22.4)	68(43.6)	36(23.1)
The unwillingness of healthcare professionals to participate in AMS	8(5.1)	30(19)	45(28.5)	47(29.7)	28(17.7)
Lack of laboratory equipment and training of staff	8(5.1)	24(15.1)	41(25.8)	54(34)	32(20.1)
Cost implication on patients for microbial investigation	6(3.8)	17(10.8)	39(24.7)	63(39.9)	33(20.9)
Perverse financial incentives for prescribing antibiotics by healthcare professionals	4(2.5)	21(13.1)	62(38.8)	48(30)	21(13.1)
Poor documentation of antibiotic use at both patient and facility levels	8(5)	25(15.6)	48(30)	50(31.3)	26(16.3)
Limited knowledge/training of healthcare professionals on antimicrobial use	7(4.4)	23(14.4)	27(16.9)	69(43.1)	30(18.8)
Lack of time for antimicrobial stewardship activities due to work overload	6(3.8)	19(11.9)	35(21.9)	64(40)	32(20)

Responses were collapsed into two: disagree (neutral, disagree and strongly disagree) and agree (agree and strongly agree). The relationship between healthcare professionals' responses to antimicrobial resistance and use and the facilities (tertiary and secondary facilities) was assessed. Similar responses were noted in both facilities on participants' thoughts on cost consideration on patient influencing antibiotic prescription (>60%) and no antibiotic hang-out time (time between prescription and administration) [>80%]. Participants in tertiary institutions agreed that patients could develop drug resistance in their hospital compared to those in secondary institutions ($p=0.014$), while those in secondary institutions say that their choice of antibiotic prescribing is influenced by available antibiotics rather than on disease aetiology or laboratory results compared to those in a tertiary institution ($p=0.023$). (Table 4).

Table 4: Relationship Between Antimicrobial Resistance and Use and Healthcare Facility

Items	Level of Agreement		p-value
	Disagree N(%)	Agree N(%)	
Antimicrobial resistance is a problem in the hospital and daily practice			
Secondary	16(47)	17(53)	0.450
Tertiary	63(51.6)	59(48.4)	
A patient is likely to develop a drug-resistant infection during their stay at this hospital.			
Secondary	23(69.7)	10(30.3)	0.014
Tertiary	57(46.3)	66(53.7)	
The antibiotics available in the hospital are suspected to be of poor quality and might not be effective.			
Secondary	27(84.3)	5(15.7)	0.452
Tertiary	106(86.9)	16(13.1)	
Antibiotic hang time (time between prescription and administration) is generally high from my work experience.			
Secondary	28(87.5)	5(12.5)	0.378
Tertiary	98(80.3)	24(19.7)	
The choice of antibiotics is often influenced by the availability of the antibiotics rather than by the etiologic cause of disease (availability of laboratory results)			
Secondary	19(57.7)	14(42.3)	0.023
Tertiary	95(77.2)	28(22.8)	
The sporadic supply of antibiotics in the hospital leads to therapy interruptions, thereby contributing to antimicrobial resistance.			
Secondary	24(72.7)	19(27.3)	0.097
Tertiary	104(84.5)	28(15.5)	
The lack of close clinical follow-up during antibiotic use in the hospital contributes to antimicrobial resistance.			
Secondary	22(66.7)	11(33.3)	0.530
Tertiary	81(65.3)	43(34.7)	
Cost considerations for the patient affect the choice of antibiotics			
Secondary	11(33.3)	21(66.7)	0.511
Tertiary	39(32.8)	80(67.2)	

Responses were merged into two: disagree (neutral, disagree and strongly disagree) and agree (agree and strongly agree). The relationship between healthcare professionals' responses to antimicrobial stewardship practice and the facilities (tertiary and secondary facilities) was determined. There was no statistical significance in the responses on all items from both facilities. Most of the participants, 75.8% and 72.2% from the secondary and tertiary facilities, respectively, disagreed that their hospitals have antimicrobial treatment guidelines, 82.4% and 73.55 from the secondary and tertiary facilities respectively disagreed that their hospitals have an antibiogram, while 79.4% and 65.3% from the secondary and tertiary facilities respectively disagreed that prescribing physicians are the only professionals who need to understand and participate in antimicrobial stewardship. (Table 5).

Table 5: Relationship Between Antimicrobial Stewardship Practice and Healthcare Facility

Items	Level of Agreement		P-value
	Disagree N (%)	Agree N (%)	

This hospital has the capacity to establish, implement and sustain an AMS			
Secondary	14(41.2)	20(58.8)	0.102
Tertiary	34(27.9)	88(72.1)	
This hospital has a formal AMS with a dedicated team of healthcare professionals.	25(75.8)	8(24.2)	0.434
Secondary	83(72.2)	32(27.8)	
Tertiary			
The AMS in this hospital is functional with a clear policy statement	28(82.4)	6(11.6)	0.206
Secondary	86(73.5)	31(26.5)	
Tertiary			
This hospital has a local antibiotic treatment guideline accessible to staff	21(65.6)	11(34.4)	0.585
Secondary	80(65.6)	42(34.4)	
Tertiary			
This hospital has a report of antibiotic resistance and susceptibility pattern (antibiogram) that is accessible to healthcare professionals	27(79.4)	7(20.6)	0.095
Secondary	79(65.3)	41(34.2)	
Tertiary			
I perform some antimicrobial stewardship activities at an individual level	17(50)	17(50)	0.228
Secondary	72(59)	50(41)	
Tertiary			
The department/unit has a guide or format for antimicrobial use on patients	21(63.6)	12(36.4)	0.406
Secondary	73(59.3)	50(40.7)	
Tertiary			

Discussion

This study sought to investigate the AMS practice among HCPs, including their knowledge, barriers and enablers to AMS. More than half of the HCPs in this study had not heard of AMS and admitted that they did not have knowledge of AMS. Poor understanding by HCPs on this subject matter has been reported in many low-middle-income countries (LMICs). In Pakistan, only 15.2% of HCPs were familiar with the term [7,10]. In Sudan, health professionals had fair knowledge regarding the 'Antimicrobial stewardship program' as only 26.4% knew what it meant [11]. A study attributes poor awareness of AMS among HCPs to a lack of such programmes in the hospitals and a lack of exposure to training programs such as conferences, seminars and workshops on AMS [10].

HCPs who lack knowledge of AMS are less likely to practice it, which could lead to inappropriate use of antimicrobials. Many healthcare professionals in this study agreed that AMR is a problem in their daily practice, and half of the participants believe that patients are likely to develop drug-resistant infections during their stay in both secondary and tertiary health facilities. Inappropriate antimicrobial prescribing is a major contributor to this problem at the facility level. More than a third of the HCPs agreed that their choice of antimicrobials prescribed for patients is influenced by the available antibiotics rather than microbiological investigation, while more than 60% from both institutions considered the cost of treatment in choosing an antimicrobial agent.

In Nigeria, most patients visiting healthcare facilities do not have health insurance. Health insurance is an important mechanism to prevent financial hardship in accessing health care. Since the launch of Nigeria's National Health Insurance Scheme (NHIS) in 2005, only 5% of Nigerians have health insurance, and 70% still finance their healthcare through Out-Of-Pocket (OOP) expenditure [12]. The irrational prescribing behaviour observed in this current study was reported in a multistage study across six states in Nigeria, where half of the respondents understood that their prescribing behaviour could promote the development of antimicrobial resistance. More than half of the physicians admitted to prescribing antibiotics to be on the safe side, usually done without diagnostic tools to guide prescription, while others prescribe antimicrobials when demanded by patients [13].

However, most participants agreed that their institution can implement and sustain antimicrobial stewardship programmes. More than 50% agreed that prescribing physicians alone should not be involved in AMS. This implies that they understand that AMS is collaborative. A successful AMS requires a dedicated team of inter-professional members such as a physician, infectious disease specialist, pharmacist, information technologist, and microbiologist. When these are unavailable, as in many hospitals in resource-limited settings, any medical professional, such as a pharmacist or nurse, can take the lead ^[14-16]. Barriers to implementing AMS were noted among respondents. Noteworthy are weak government policy, lack of commitment by hospital managers, lack of antibiotic standard treatment guidelines, limited knowledge of antimicrobial stewardship programs and poorly equipped laboratories. These barriers are associated with the slow pace at which LMICs are embracing AMS ^[4,5].

In a study in Ethiopia, participants expressed the concern that institutional or national policies did not support AMS strategies, so there are no standards to follow. Weak laboratory infrastructure was noted as a significant obstacle to the implementation of AMS. Most physicians acknowledged that they either did not send specimens or did not follow up on results because of delayed result reporting and communication gaps between the laboratory and the treating teams ^[17]. The top on the list of facilitators to mitigating these barriers from this study are routine training of HCPs on antimicrobial stewardship, government involvement, hospital executives showing good leadership and close collaboration with the hospital's infection prevention and control unit.

Leadership commitment at the government and hospital level is the rate-limiting step to implementing and sustaining AMS programs in several ways. Leadership commitment starts with the government and hospital executives because they are involved in developing and implementing policies and guidelines that drive programs and activities in the hospitals and healthcare system at large ^[3]. The Nigerian Action Plan for Antimicrobial Stewardship, with expected implementation by 2022, is suffering some delays, which affects the uptake of this program in various hospitals ^[18]. On the other hand, hospital administrators have a prominent role in implementing and sustaining AMS. It can only be successful by their endorsement. Without adequate support from hospital leadership, programme funding will be inadequate or inconsistent since the programs do not generate direct revenue. Hospital leadership will also ensure that laboratories are present and well-equipped with infrastructure and trained personnel. If hospital leadership is not publicly committed to the programme, the healthcare professionals will show a lax attitude toward it, and its purpose will be defeated ^[2,19].

The availability of uniform treatment guidelines equips HCPs to embark on AMS. The benefit of this initiative is seen in one of China's tertiary-care hospitals. Development of antibiotic treatment guidelines in compliance with the directive of the National Action Plan and availability of the guidelines in pocket-sized formats and through the hospital intranet and restriction of certain antibiotics led to a significant reduction in the proportion of antibiotic prescriptions and expenditure in both out-patient and inpatient settings ^[20].

Training of HCPs on AMS is as important as providing standard antimicrobial treatment guidelines. Training can be a tool in changing physicians' traditional syndromic infectious disease management to actual systematic microbiological testing and appropriate diagnostic tests ^[8]. Some countries have made mandatory continuing medical education courses attended by healthcare professionals and undergraduates to highlight their role in promoting AMS. This training could include clinical scenarios that simulate real clinical settings, objective-centered clinical examinations, awareness campaigns, and interactive learning workshops ^[5,11]. However, education should be sustained in time to change and improve prescription behaviour, which is a challenge in many LMICs. Online free-of-charge training modules are increasingly being developed in Latin America and South Africa ^[21].

In Egypt, a 2-day training curriculum for surgeons and anaesthetic physicians was developed on surgical prophylaxis and on-the-job training for junior surgeons and residents during morning rounds in five tertiary-care emergency surgical hospitals. This resulted in a shorter duration of prophylaxis in some hospitals ^[22]. Antimicrobial stewardship programmes, in conjunction with good infection control and prevention practices, are effective in managing the use of antimicrobial agents, slowing or reversing the development of antimicrobial resistance ^[19]. In South Africa, a public tertiary-care university hospital instituted an antibiotic prescription chart. The AMS team also engaged in ward rounds with the infection prevention and control specialists, giving audits and feedback to individual patients. This

initiative resulted in a substantial decline in total antibiotic consumption and a reduction of US\$ 215,000 over four years in the cost of treatment ^[23].

The strength of this study lies in the fact that participants were recruited from departments where antibiotics are highly used. Hence, some of the responses represent actual practice in the settings where the study was done. However, the results cannot be generalised to other regional settings. The effect of social acceptance could have influenced some participants' reports, as seen in many neutral responses; this is also a limitation of this study.

Conclusion

This study reveals that healthcare professionals are aware of the effect of antimicrobial resistance as it affects many of them in their daily practice. Most participants have poor knowledge of antimicrobial stewardship practice and identified similar limiting factors from both settings towards AMS. Government involvement in ensuring that policies are implemented, and the leadership commitment of hospital executives are prominent barriers. On the part of HCPs, training and education, adequate antimicrobial resistance surveillance, and uniform antibiotic treatment guidelines are empowering tools to promote AMS involvement.

Funding

The authors declare that this research did not receive any specific grant from funding agencies in public, commercial, or not-for-profit sectors.

Conflict of Interest

The authors declared no competing interest.

Authors' Contribution

Conceptualisation, E.E, I.A; Methodology, E.E. and I.A.; Analysis, E.E, I.A; Writing—Original Draft Preparation, I.A; and Writing—Review and Editing, E.E. and I.A

References

1. Debra AG, Ravina K, Ellie JG, Mark G, Dilip N. A global call from five countries to collaborate in antibiotic stewardship: United, we succeed; divided, we might fail. *The Lancet Infection and Disease* 2017;17(2):E56-E63
2. Conan M, Ron EP. Antimicrobial Stewardship Programs in Health Care Systems. *Clinical Microbiology Review* 2005 DOI: 10.1128/CMR.18.4.638-656.2005
3. Core Elements of Hospital Antibiotic Stewardship Program Atlanta (2014): Center for Disease Control and Prevention. <https://www.cdc.gov/getsmart/healthcare/implementation/core-elements>. Accessed December 16, 2021
4. Charani E, Enrique C, Bradley S, Nathwani D, Alison H & Davey P. Implementation of antibiotic stewardship in different settings - results of an international survey. *Antimicrobial Resistance & Infection Control* 2019; 8;34
5. Cox JA, Vlieghe E, Mendelson M, Wertheim H, Ndegwa L, Villegas MV. Antibiotic stewardship in low- and middle-income countries: the same but different? *Clinical Microbiology Infection*. 2017;23(11):812–8. Epub 2017/07/14. 10.1016/j.cmi.2017.07.010
6. Fadare J.O, Ogunleye O, Iliyasu G., Adeoti A., Schellack N., Engler D. Status of antimicrobial stewardship programmes in Nigerian tertiary healthcare facilities: findings and implications. *Journal of Global Antimicrobial Resistance* 2019;17:132–136. 10.1371/journal.pone.0189621
7. [Khezar H](#), [Meagen R](#), [Ali H](#), [Jie C](#), [Wenjing J](#), [Caijun Y](#). Perspective of Key Healthcare Professionals on Antimicrobial Resistance and Stewardship Programs: A Multicenter Cross-Sectional Study From Pakistan. *Frontiers of Pharmacology*. 2019; 10: 1520. doi: [10.3389/fphar.2019.01520](https://doi.org/10.3389/fphar.2019.01520)

8. Gebremedhin BG, Workeabeba A, Damen HM, Wondwossen A, Admasu T, Teferi GF. Opportunities and barriers to implementing antibiotic stewardship in low and middle-income countries: Lessons from a mixed-methods study in a tertiary care hospital in Ethiopia. *PLoS One*. 2018; 13(12): e0208447. doi: [10.1371/journal.pone.0208447](https://doi.org/10.1371/journal.pone.0208447)
9. GNYAHA. Antimicrobial Stewardship toolkit: best practices from the GNYHA/UHF antimicrobial stewardship collaborative 2011. <https://uhfnyc.org/assets/1042>;
10. Muhammad A, Beenish I, Iram M, Nafees A, Zikria S, Azka S et al. Antibiotic stewardship program in Pakistan: a multicenter qualitative study exploring medical doctors' knowledge, perception and practices. *BMC Infectious Disease*. 2021; 21: 374. doi: [10.1186/s12879-021-06043-5](https://doi.org/10.1186/s12879-021-06043-5)
11. Alneima S, Ali A, Salah I. Kheder. Knowledge, Attitudes and Practices of Prescribers towards Antimicrobial Stewardship at Hospitals in Khartoum State - Sudan. *Journal of Medical Informatics and Decision Making* 2020;1(3):12-25.
12. Emelda E.C, David A.O, Christian A.E, Peter L.G, Dennis A., Rosemary A.A & Folasade T.O. Antimicrobial resistance awareness and antibiotic prescribing behaviour among healthcare workers in Nigeria: a national survey. *BMC Infectious Diseases* 2021;22:78-87
13. [Gbadegesin O. Alawode](#) & [David A. Adewole](#). Assessment of the design and implementation challenges of the National Health Insurance Scheme in Nigeria: a qualitative study among sub-national level actors, healthcare and insurance providers. *BMC Public Health* 2021;21:124 <https://doi.org/10.1186/s12889-020-10133-5>
14. Messina A.P, Van den Bergh D, Goff G.A. Antimicrobial stewardship with pharmacist intervention improves the timeliness of antimicrobials across thirty-three hospitals in South Africa. *Infection* 2015; 4 (1):5-14
15. Brink A. J., Messina A. P., Feldman C., Richards G. A., Becker P. J., Goff D. A. Antimicrobial stewardship across 47 South African hospitals: an implementation study. *Lancet Infectious Disease* 2016;6: 1017–1025. [10.1016/j.mcn.2018.05.008](https://doi.org/10.1016/j.mcn.2018.05.008)
16. Jaclyn B, David CMK, Thomas RS, Karin AT, Kirsty LB. Meeting the Challenge for Effective Antimicrobial Stewardship Programs in Regional, Rural and Remote Hospitals-What can we learn from the published literature? *Rural and Remote Health* 2018;18:4442
17. Gebretekle GB, Haile Mariam D, Abebe W, Amogne W, Tenna A, Fenta TG, et al. Opportunities and barriers to implementing antibiotic stewardship in low and middle-income countries: Lessons from a mixed-methods study in a tertiary care hospital in Ethiopia. *PLoS ONE* 2018;13(12): e0208447. <https://doi.org/10.1371/journal.pone.0208447>
18. National Action Plan for Antimicrobial Resistance, 2017-2022 (2017b). <https://www.ncdc.gov.ng/protocols> Accessed December 5, 2021
19. Jerod L. Nagel, James G. Stevenson, Edward H. Eiland, III, Keith S. Kaye. Demonstrating the Value of Antimicrobial Stewardship Programs to Hospital Administrators. *Clinical Infectious Diseases*, Volume 59, Issue suppl_3, October 2014, Pages S146–S153, <https://doi.org/10.1093/cid/ciu566>
20. Medina-Presentado J.C., Margolis A., Teixeira L., Lorier L., Gales A.C., Perez-Sartori G., et al. Online continuing interprofessional education on hospital-acquired infections for Latin America. *Brazilian Journal of Infectious Diseases* 2017;21: 140-147
21. Gong S, Qiu X, Song Y, Sun X, He Chen Y, et al. Effect of financially punished audit and feedback in a pediatric setting in China, within an antimicrobial stewardship program, and as part of an international accreditation process. *Frontiers* 2016: 4: 99
22. Saied T, Hafez S.F, Kandeel A, El-kholy A, Ismail G, Aboushady M, et al. Antimicrobial stewardship to optimise the use of antimicrobials for surgical prophylaxis in Egypt: a multicenter pilot intervention study. *American Journal of Infection Control* 2015;43:e67-71
23. Boyles T.H, Naicker V, Rawoot N, Raubenheimer P.J, Eick B, Mendelson M. Sustained reduction in antibiotic consumption in a South African public sector hospital; Four-year outcomes from the Groote Schuur Hospital antibiotic stewardship program. *South African Medical Journal* 2017; 107:115-118s