

ANTIMICROBIAL PRESCRIPTION PATTERN AMONG OUTPATIENTS IN GOMBE STATE SPECIALIST HOSPITAL, NIGERIA: PRESCRIBING PRACTICES, PRESCRIBER KNOWLEDGE, AND PREDICTORS OF ANTIBIOTIC USE

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ABSTRACT

Background: Antimicrobial resistance (AMR) is a major public health threat, driven in part by inappropriate and excessive use of antibiotics. Surveillance of antibiotic prescribing practices and assessment of prescriber knowledge are important for identifying opportunities for antimicrobial stewardship, particularly in low- and middle-income countries. This study assessed antimicrobial prescription patterns among outpatients in Gombe State Specialist Hospital, Nigeria, and examined factors associated with antibiotic prescribing and prescriber knowledge of rational antibiotic use and AMR. **Methods:** A total of 605 outpatient records were randomly assessed alongside information from 31 available prescribers. Patient demographic characteristics, diagnoses, comorbidities, antibiotic prescribing, number and classes of antibiotics, prescription costs, healthcare-seeking behaviour, and use of leftover medicines were assessed. Prescriber characteristics, formal training, diagnostic approaches, awareness of AMR concepts, knowledge of rational antibiotic use and knowledge of AMR causes were also evaluated. Associations between patient characteristics and antibiotic prescription were assessed using chi-square tests and independent-samples t-tests. Logistic regression was used to identify predictors of antibiotic prescribing while adjusting for age, sex, comorbidity count, and selected diagnoses. **Results:** Antibiotics were prescribed in 49.6% outpatient encounters. Among prescriptions containing antibiotics, the mean number of antibiotics was 1.33 ± 0.55 . Generic names were documented in 70.3% of prescriptions. Cephalosporins constituted the largest antibiotic class (29.7%), followed by penicillin (25.0%) and fluoroquinolones (21.0%). The mean antibiotic cost was ₦1,667.82, while the mean total drug cost was ₦3,323.98. Malaria was the most frequent diagnosis (110 cases), followed by hypertension (72) and urinary tract infection (30). Antibiotic prescribing was significantly associated with age, diagnosis, and number of comorbidities. Patients receiving antibiotics were younger than those who did not receive antibiotics (mean age 28.0 versus 37.2 years; $p < 0.001$). In multivariable analysis, increasing age was associated with lower odds of antibiotic prescription (adjusted OR 0.983; 95% CI 0.973–0.992), while malaria was associated with higher odds of antibiotic prescription (OR 1.94; 95% CI 1.03–3.66). Prescribers had a mean awareness score of 62.5%, rational antibiotic-use score of 75.4% and AMR-cause knowledge score of 64.2%. Only 38.7% had received formal training related to antibiotic use/AMR. **Conclusion:** Antibiotic prescribing occurred in half of the outpatient encounters, with substantial use of cephalosporins, penicillin and fluoroquinolones. Important gaps were identified in prescriber awareness of antimicrobial stewardship and diagnostic tools, while antibiotic prescribing was associated with patient age, diagnosis, and comorbidity profile. Strengthening antimicrobial stewardship, prescriber training, diagnostic capacity, and routine prescription surveillance should be prioritized in outpatient healthcare settings in Gombe State Specialist Hospital.

KEYWORDS: Antimicrobial resistance; antibiotic prescribing; antimicrobial stewardship; outpatient; Nigeria; prescriber knowledge; rational drug use; Gombe State.

INTRODUCTION

Antimicrobial resistance (AMR) is one of the most important threats to effective treatment of infectious diseases and to the sustainability of modern healthcare. Inappropriate and excessive antibiotic use accelerates the emergence and spread of resistant organisms, reducing the effectiveness of medicines essential for prevention and treatment of bacterial infections. The World Health Organization (WHO) Global Action Plan on AMR identifies optimisation of antimicrobial use, surveillance and research, infection prevention, awareness, and sustainable investment as key components of the global response to AMR.^[1]

The global burden of AMR is substantial. A systematic analysis estimated that bacterial AMR was associated with 4.95 million deaths globally in 2019, including 1.27 million deaths directly attributable to bacterial AMR.² Western sub-Saharan Africa had among the highest estimated mortality rates attributable to bacterial AMR, highlighting the importance of strengthening antimicrobial stewardship and surveillance systems in the region.^[2]

Antibiotic use is one of the major modifiable drivers of AMR. WHO therefore recommends routine monitoring of antimicrobial use and prescribing practices as a vital component of antimicrobial stewardship.^[3,4] Point-prevalence and prescription-utilization approaches provide information on the volume and patterns of antibiotic use and help identify priority areas for intervention.^[3,4]

The WHO Access, Watch and Reserve (AWaRe) classification offers a framework for monitoring antibiotic use and guiding antimicrobial stewardship. Access antibiotics are recommended for common infections and have a lower potential for promoting resistance. Watch antibiotics carry a higher risk of driving resistance and should be used more selectively, while Reserve antibiotics are reserved for infections caused by multidrug-resistant organisms when suitable alternatives are unavailable. WHO has also set targets to increase the proportion of total antibiotic consumption accounted for by Access antibiotics.^[5,6]

Nigeria, like many other low- and middle-income countries, faces challenges related to antibiotic prescribing, access to diagnostic services, healthcare financing, and antimicrobial stewardship. Previous Nigerian research has demonstrated substantial antibiotic prescribing and gaps in prescribing practices and knowledge among healthcare professionals.^[7]

Such challenges may be amplified by limited access to microbiological investigations and reliance on empirical treatment.

The outpatient setting is particularly important because a huge proportion of antibiotic use occurs in ambulatory care. Prescribing decisions may be influenced by clinical presentation, diagnostic uncertainty, patient expectations, availability and affordability of medicines, prescriber knowledge, and access to laboratory investigations.

In Gombe State, locally generated evidence describing antibiotic prescribing patterns and prescriber knowledge regarding rational antibiotic use and AMR is limited. Understanding patient characteristics, antibiotic classes, prescribing costs, diagnostic approaches and prescriber knowledge is important for designing context-specific antimicrobial stewardship interventions.

This study therefore assessed antimicrobial prescription patterns among outpatients in Gombe State Specialist Hospital, examined factors associated with antibiotic prescribing, and assessed prescriber awareness and knowledge regarding rational antibiotic use and AMR.

METHODS

Study design and setting

A cross-sectional study was conducted that analyzed outpatient prescription information and prescriber-level data from Gombe State Specialist Hospital, Nigeria. The dataset comprised 605 outpatient records and information from 31 available prescribers.

Study population

The patient-level analysis included 605 outpatient records. The prescriber component included 31 available prescribers. Patient variables included demographic characteristics, diagnoses, comorbidities, antibiotic prescribing, and healthcare-seeking behavior. Prescriber variables included demographic characteristics, professional qualification, years of practice, formal training, diagnostic methods and knowledge of antibiotic use and AMR.

Study variables

The primary outcome was antibiotic prescription, coded as 0 for no antibiotic prescribed and 1 for antibiotic prescribed. Patient-level explanatory variables included age, sex, diagnosis, number of comorbidities and use of leftover medicines. Other variables included sources of healthcare financing, first point of contact when sick, antibiotic cost and total medication cost. Antibiotic prescribing characteristics included number of antibiotics prescribed per encounter, use of generic names and antibiotic classes. Reported classes were cephalosporins, penicillin, macrolides, tetracyclines, aminoglycosides, sulphonamides, fluoroquinolones, quinolones, and broad-spectrum antibiotics.

Assessment of prescriber knowledge

Prescriber knowledge was assessed using three domains: awareness, rational antibiotic use and causes of AMR. Awareness included recognition of rational antibiotic use, antibiotic resistance, antibiotic stewardship, antibiogram, MRSA, VRSA, ESBL and CRE. Rational-use questions addressed appropriate antibiotic use in relation to bacterial infections, common cold, diarrhoea, treatment duration, dose completion, parenteral administration, and prophylactic use. Knowledge of AMR causes included widespread antibiotic use, broad-spectrum antibiotic use, animal husbandry, farming, poor hygiene, parenteral prescribing, lack of guidelines, bacterial mutations, premature treatment interruption, antibiotic use for colds and vaccination.

Statistical analysis

Descriptive statistics summarised patient characteristics, antibiotic prescribing patterns, diagnoses, comorbidities, healthcare access, and prescriber characteristics. Associations between categorical variables and antibiotic prescription were assessed using chi-square tests. Differences in mean age were assessed using an independent samples t-test. The relationship between formal training and knowledge scores was assessed using t-tests. Spearman correlation examined associations between years of practice and knowledge scores, and awareness scores were compared according to diagnostic approach. Binary logistic regression identified predictors of antibiotic prescription using age, sex, comorbidity count, malaria, hypertension, and diabetes. Odds ratios (ORs) and 95% confidence intervals (CIs) were

reported, with statistical significance at $p < 0.05$. The original regression output reported non-convergence; therefore, estimates, particularly for diabetes, require cautious interpretation and model re-estimation before submission.

Ethical considerations

Ethical clearance was obtained from the State Ministry of Health Ethics Committee, and written informed consents were collected from patients.

RESULTS

Patient characteristics

A total of 605 outpatient records were analysed. There were 275 males (45.5%) and 330 females (54.5%). The largest age group was 21–30 years (127 patients), followed by those aged less than 10 years (109), 41–50 years (103), 31–40 years (79), 51–60 years (72), 10–20 years (70), 61–70 years (27), 71–80 years (12), and 85 years and above (6).

Table 1: Patient Demographic Characteristics.

Characteristic	Category	Frequency	Percentage
Total records	Outpatient records analysed	605	100.0%
Sex	Male	275	45.5%
	Female	330	54.5%
Age group	<10 years	109	18.0%
	10–20 years	70	11.6%
	21–30 years	127	21.0%
	31–40 years	79	13.1%
	41–50 years	103	17.0%
	51–60 years	72	11.9%
	61–70 years	27	4.5%
	71–80 years	12	2.0%
	≥85 years	6	1.0%

Antibiotic prescribing pattern

Antibiotics were prescribed in 49.6% outpatient encounters. Among antibiotic-containing encounters, the mean number of antibiotics was 1.33 ± 0.55 . The analysis represented 300 antibiotic prescriptions in the class distribution: 213 encounters involved one antibiotic, 77 involved two, nine involved three, and one involved four antibiotics. Generic names were documented in 70.3% of prescriptions (Table 2).

Table 2: AMR Prescription Pattern.

Indicator	Value
Antibiotic prescribing rate among outpatient encounters	49.6%
Mean number of antibiotics per antibiotic-containing encounter	1.33 ± 0.55
Total antibiotic prescriptions represented in class distribution	300
Encounters involving one antibiotic	213
Encounters involving two antibiotics	77
Encounters involving three antibiotics	9
Encounters involving four antibiotics	1
Prescriptions documented using generic names	70.3%

Table 3: Distribution of antibiotic classes among antibiotic-containing prescriptions.

Antibiotic	Count	Percentage
Cephalosporin	89.0	29.7
enicillin	75.0	25.0
Macrolides	39.0	13.0

Tetracycline	12.0	4.0
Aminoglycoside	4.0	1.3
Sulphonamide	4.0	1.3
Fluoroquinolones	63.0	21.0
Quinolones	8.0	2.7
Broad Spectrum Antibiotics	9.0	2.7

Table 3 shows that cephalosporins were the most prescribed antibiotic class, accounting for 89 prescriptions (29.7%) of all antibiotic-containing prescriptions. This was followed by penicillins, 75 prescriptions (25.0%), and fluoroquinolones, 63 prescriptions (21.0%). Together, these three classes accounted for more than three-quarters of all antibiotics prescribed, indicating that outpatient antibiotic use in the facility was concentrated around a few major antibiotic groups.

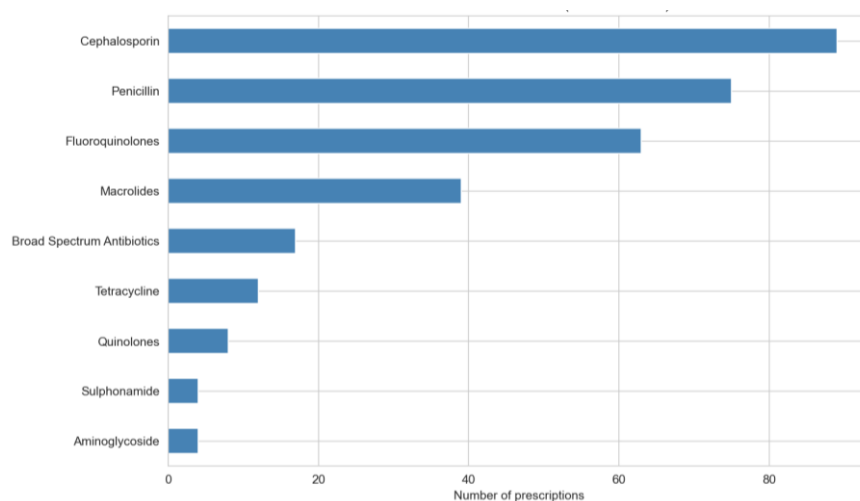


Figure 1: Distribution of antibiotic classes among antibiotic-containing prescriptions.

Prescription costs

The mean cost of antibiotics was ₦1,667.82, with a median of ₦1,500.00. The mean total drug cost was ₦3,323.98, with a median of ₦2,800.00.



Figure 2: Prescription Cost.

Diagnoses and Comorbidities

Malaria was the most frequently recorded diagnosis (110 cases), followed by hypertension (72), urinary tract infection (30), fever (26), peptic ulcer (18), abdominal discomfort (16), PUD (15), dyspepsia (14), cough (14), and upper respiratory tract infection (12).

Table 4. Most frequent diagnoses among outpatient records

Diagnosis	Count
Malaria	110
Hypertension	72
Urinary tract infection	30
Fever	26
Peptic ulcer	18
Abdominal discomfort	16
PUD	15
Dyspepsia	14
Cough	14
Upper respiratory tract infection	12

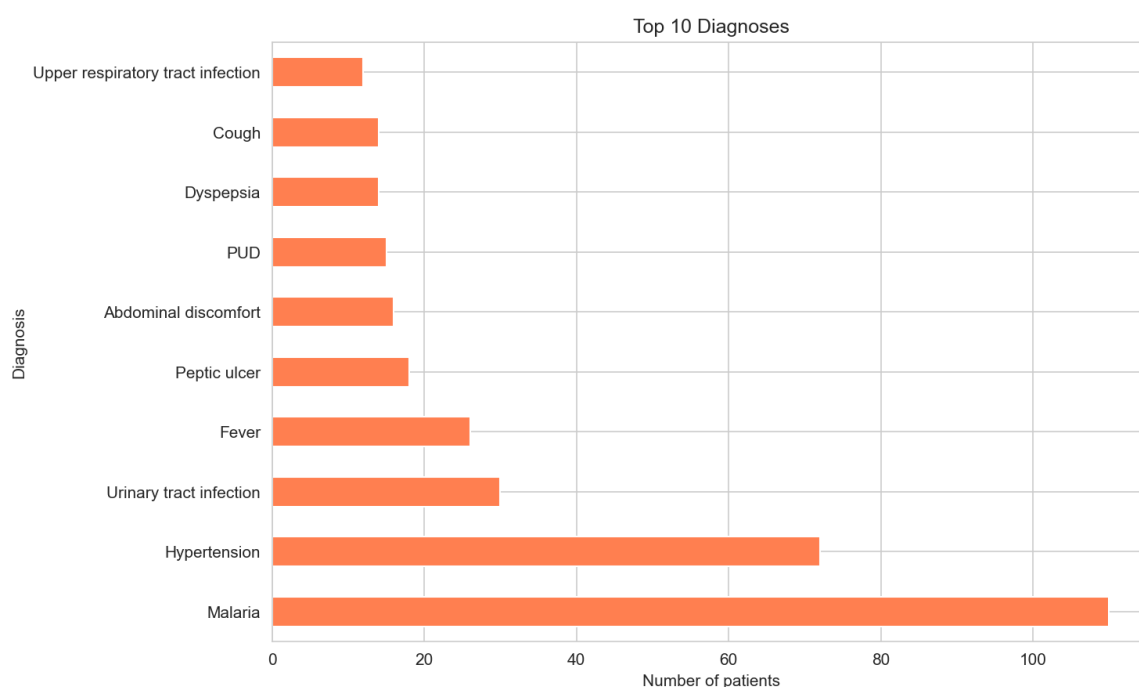


Figure 3: Distribution of the most frequent diagnoses.

Regarding comorbidities, 309 patients had no recorded comorbidity. Malaria was recorded as a comorbidity in 135 patients, peptic ulcer disease in 89, hypertension in 71, diabetes in 13, arthritis in 13 and asthma in six.

Table 5: Recorded comorbidities.

Comorbidity	Count
Hypertension	71
Diabetes	13
Asthma	6
Peptic Ulcer Disease	89
Arthritis	13
Malaria	135
No Comorbidity	309

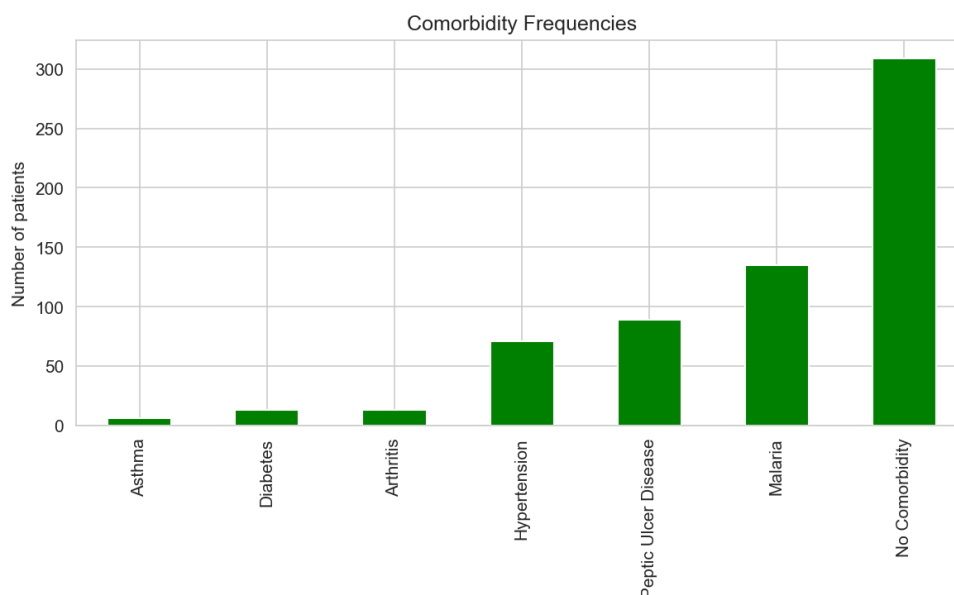


Figure 4: Distribution of recorded comorbidities.

Healthcare financing and healthcare-seeking behaviour

Out-of-pocket expenditure was the most common source of healthcare financing (323 patients), followed by Go-Health (177) and the National Health Insurance Authority (NHIA) (105).

Table 6: Sources of healthcare financing.

Health Financing Source	Count
Out of pocket expenditure	323
Go-Health	177
NHIA	105

Health clinics, primary healthcare centers, and hospitals were the first point of contact when sick for 358 patients; pharmacies or patent medicine vendors were the first point of contact for 203; traditional or spiritual healers for 36; and family and friends for eight.

Table 7: First point of contact when sick.

First Point of Contact	Count
Health clinics, PHCs, Hospitals	358
Pharmacies/Patent Medicine Vendors (PMVs)	203
Traditional/Spiritual Healers	36
Family and Friends	8

More than half of patients (53.2%) reported using leftover medicines during the preceding six months.

Prescriber characteristics and diagnostic approaches

The prescriber component included 31 prescribers, comprising 12 males and 19 females, with a mean age of 30.1 years. Most had MBBS qualifications (28), while three had additional qualifications. The largest practice-duration category was two to three years (10 prescribers). Only 38.7% had received formal training related to antibiotic use or AMR.

Clinical signs and symptoms were the most common diagnostic approach, used by 22 prescribers. Six used culture/microscopy and sensitivity-related investigation (MCS), while three used both culture/MCS and clinical signs and symptoms.

Table 8: Diagnostic methods used by prescribers.

Diagnosis Method Used	Count
Clinical Symptoms and Signs	22
Culture (MCS)	6
Culture (MCS) and Clinical Symptoms and Signs	3

Prescriber awareness and knowledge

The mean overall awareness score was 62.5%, the mean rational antibiotic-use score was 75.4%, and the mean knowledge score concerning causes of AMR was 64.2%. All prescribers were aware of antibiotic resistance. Awareness of rational antibiotic use was 77.4%, antibiotic stewardship 41.9%, and antibiograms 19.4%. Awareness of MRSA, VRSA, ESBL and CRE was 96.8%, 87.1%, 51.6% and 25.8%, respectively.

Table 9: Prescriber awareness of AMR concepts.

Awareness Item	Percent Aware
Awareness: Rational Antibiotic Use	77.419355
Awareness: Antibiotic Resistance	100.000000
Awareness: Antibiotic Stewardship	41.935484
Awareness: Antibiogram	19.354839
Awareness: MRSA	96.774194
Awareness: VRSA	87.096774
Awareness: ESBL	51.612903
Awareness: CRE	25.806452

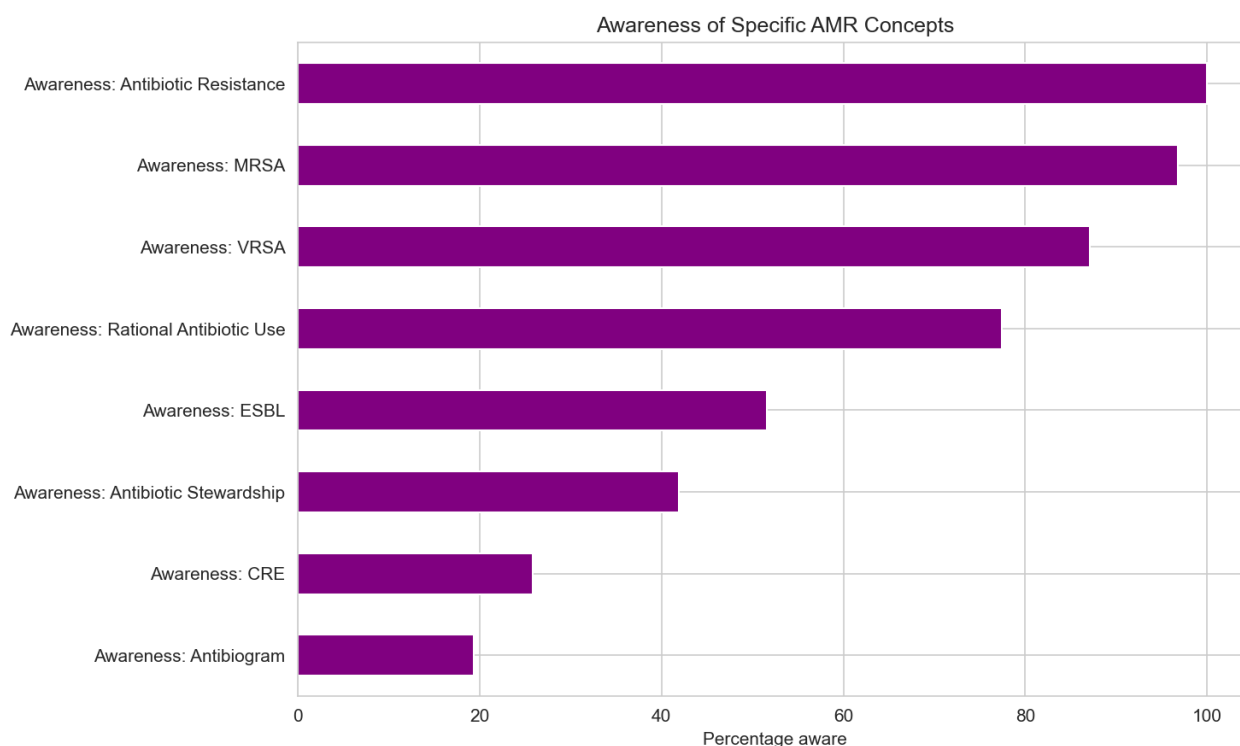


Figure 5: Prescriber awareness of AMR concepts.

Most prescribers correctly recognised that antibiotics are not intended for non-bacterial infections (93.5%) and that prescribed doses should be completed (90.3%). Correct responses were lower for the 24-hour prophylaxis item (58.1%) and three-day prophylaxis item (51.6%).

Table 10: Prescriber knowledge of rational antibiotic use.

Rational Use Item	Percent Correct
Rational: Not for Bacteria	93.548387
Rational: For Cold	67.741935
Rational: Avoid in Diarrhea	80.645161
Rational: Stop Early	80.645161
Rational: Complete Dose	90.322581
Rational: Parenteral Better	80.645161
Rational: Prophylactic 24h	58.064516
Rational: Prophylactic 3d	51.612903

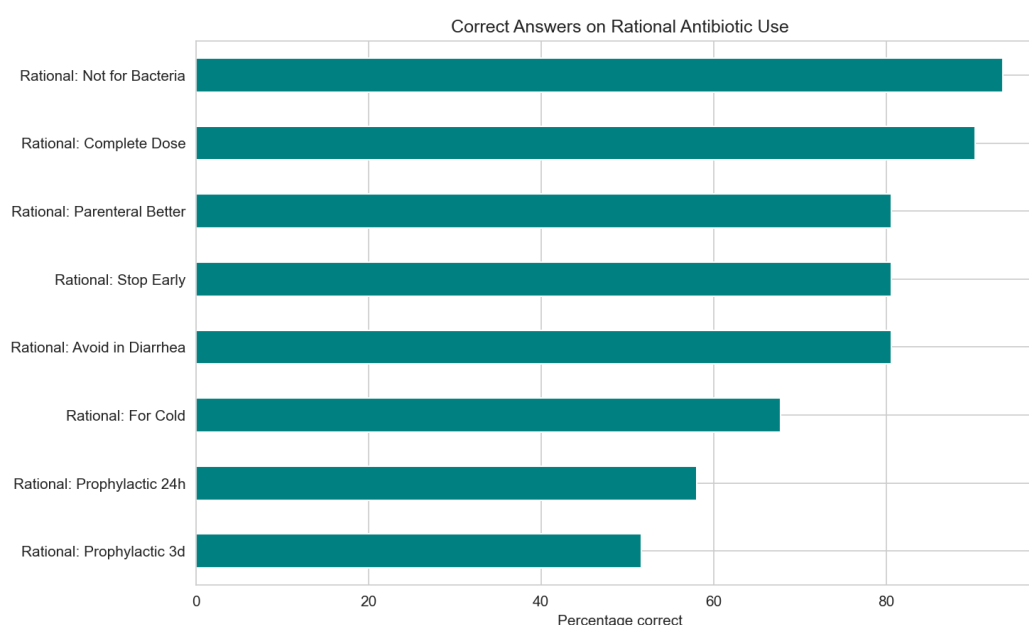


Figure 6: Prescriber knowledge of rational antibiotic use.

All prescribers identified widespread antibiotic use as a cause of AMR. Lack of guidelines and mutations were each identified by 96.8%, and premature interruption of therapy by 90.3%. Knowledge was lower for animal husbandry (22.6%), farming (29.0%), poor hygiene (45.2%), and broad-spectrum antibiotic use (48.4%).

Table 11: Prescriber knowledge of causes of AMR.

Cause Item	Percent Correct
Cause: Widespread Use	100.000000
Cause: Broad Spectrum	48.387097
Cause: Animal Husbandry	22.580645
Cause: Farming	29.032258
Cause: Poor Hygiene	45.161290
Cause: Parenteral Prescribing	64.516129
Cause: Lack of Guidelines	96.774194
Cause: Mutations	96.774194
Cause: Premature Interruption	90.322581
Cause: Antibiotics for Cold	58.064516
Cause: Vaccination	54.838710

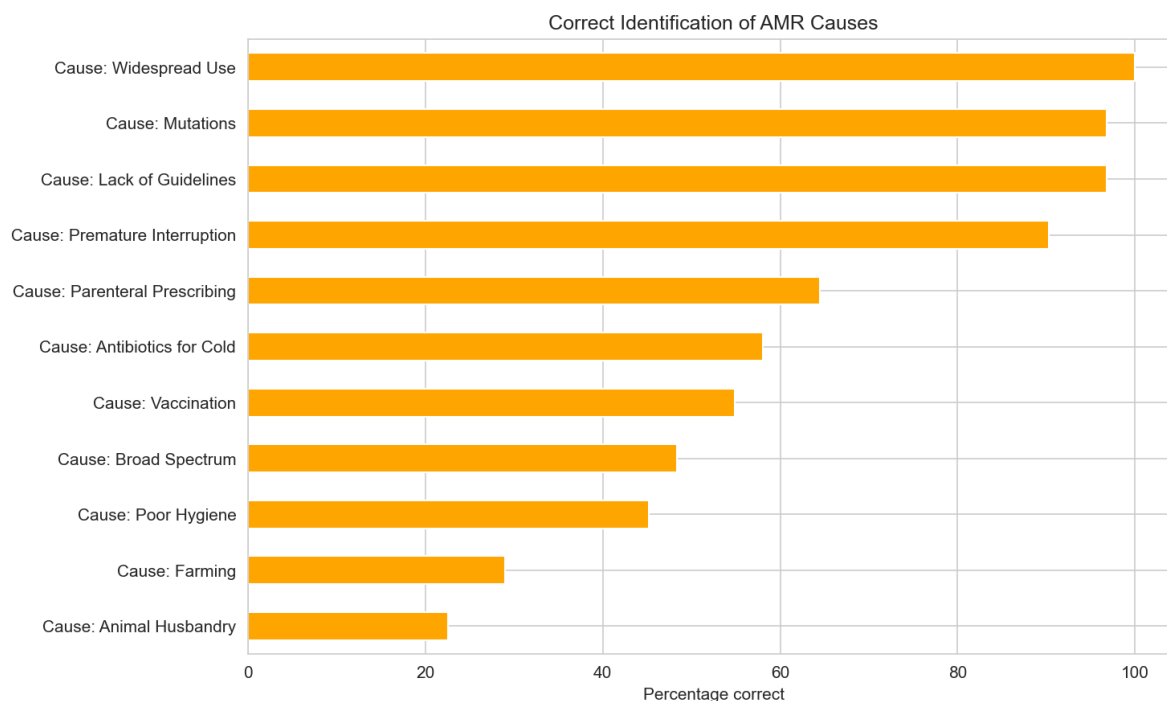


Figure 7: Prescriber knowledge of causes of AMR.

Factors associated with antibiotic prescription

Age group was significantly associated with antibiotic prescription ($\chi^2=50.30$, $p<0.001$), as were diagnosis ($\chi^2=68.27$, $p<0.001$) and number of comorbidities ($\chi^2=13.54$, $p=0.0036$). Sex was not significantly associated ($\chi^2=3.31$, $p=0.069$), nor was leftover medicine use ($\chi^2=0.12$, $p=0.724$). Patients who received antibiotics had a lower mean age than those who did not (28.0 versus 37.2 years; $t=-5.87$, $p<0.001$).

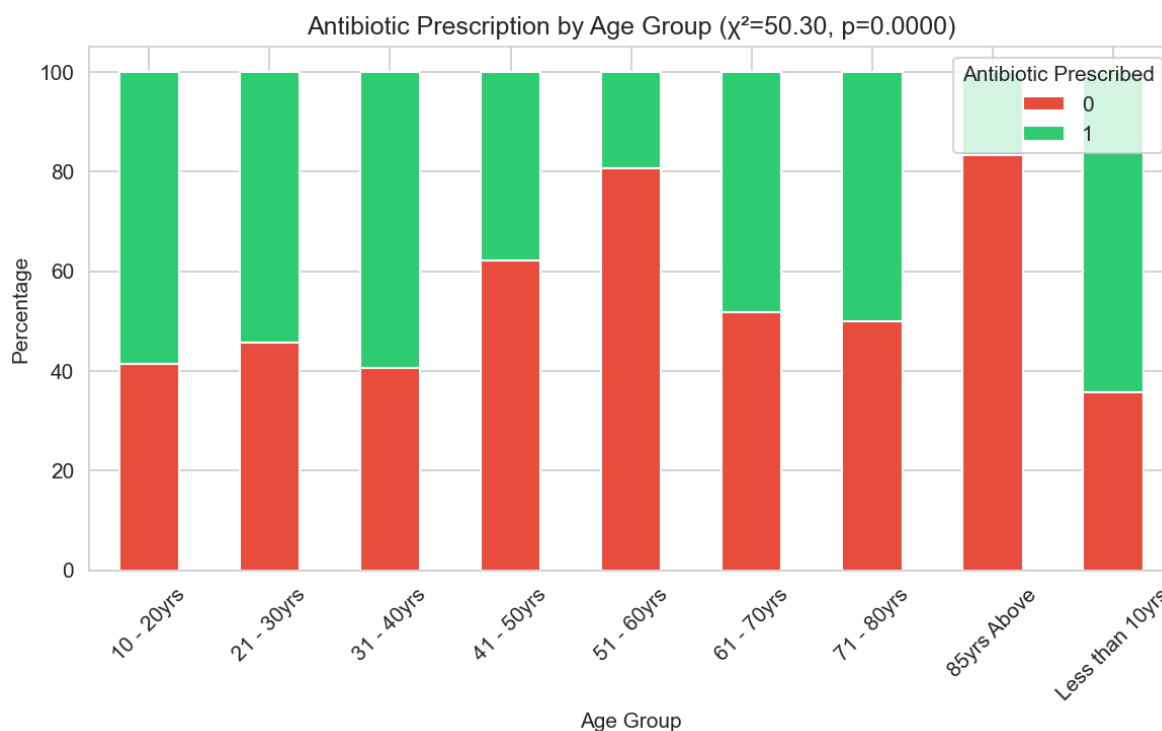


Figure 8: Association between age group and antibiotic prescription.

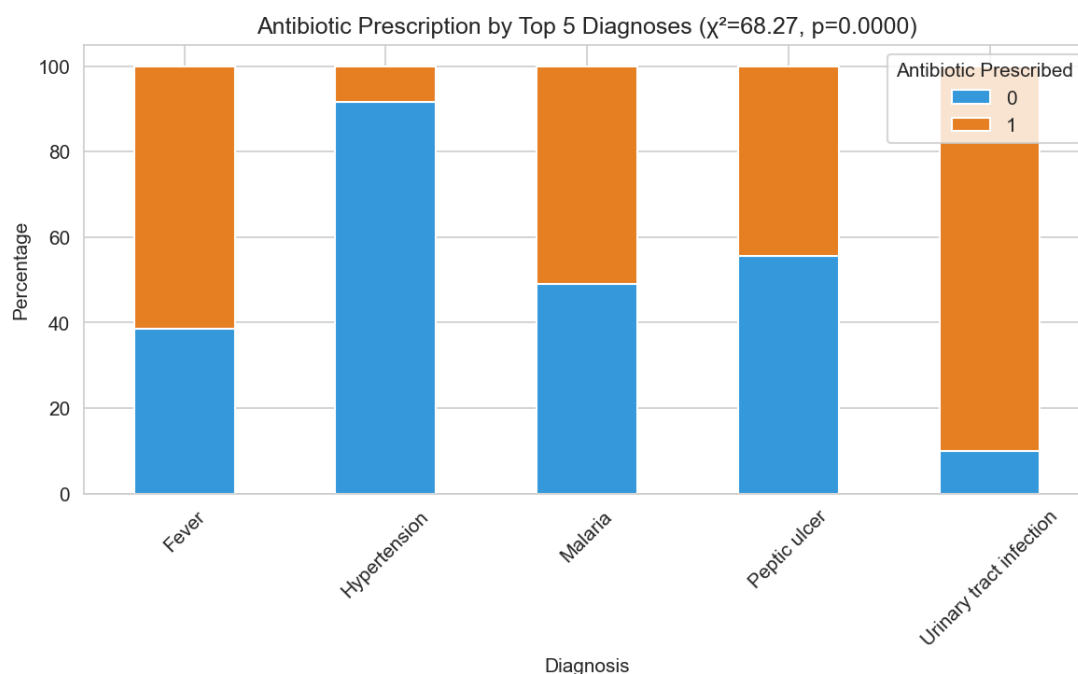


Figure 9: Association between diagnosis and antibiotic prescription.

Association between prescriber training and knowledge

Prescribers who had received formal training had higher mean awareness (70.8% versus 57.2%; $p=0.0553$) and rational-use scores (80.2% versus 72.4%; $p=0.0945$), although neither difference reached conventional statistical significance. AMR-cause knowledge was identical (64.4% versus 64.1%; $p=0.9556$).

Table 12: Prescriber training and knowledge scores.

Score	Trained mean	Untrained mean	t-stat	p-value
Awareness	70.8	57.2	2.00	0.0553
Rational use	80.2	72.4	1.73	0.0945
AMR causes	64.4	64.1	0.06	0.9556

Years of practice were not significantly correlated with awareness (Spearman $r=-0.17$; $p=0.369$), rational-use knowledge ($r=-0.16$; $p=0.390$), or knowledge of AMR causes ($r\approx 0.00$; $p=0.997$). Prescribers using culture-based diagnostic approaches had a higher mean awareness score than those relying on clinical methods (66.7% versus 60.8%), but the difference was not statistically significant ($p=0.453$).

Multivariable analysis

The logistic regression model included age, sex, comorbidity count, malaria, hypertension, and diabetes. The overall model was statistically significant (likelihood-ratio $p<0.001$; pseudo- $R^2=0.07368$). Increasing age was associated with lower odds of antibiotic prescription (OR=0.983; 95% CI 0.973–0.992; $p<0.001$). Sex was not independently associated with antibiotic prescription (OR=0.781; 95% CI 0.556–1.096; $p=0.152$). Comorbidity count was inversely associated with antibiotic prescription (OR=0.560; 95% CI 0.361–0.868; $p=0.009$), while malaria was associated with increased odds (OR=1.944; 95% CI 1.033–3.658; $p=0.039$). Hypertension was not independently associated (OR=1.006; 95% CI 0.478–2.118; $p=0.987$). The diabetes coefficient was extremely unstable, with an exceptionally large standard error and an implausibly small, estimated odds ratio, consistent with sparse-data or separation problems.

Table 13: Logistic regression model summary.

Dep. Variable	Antibiotic Prescribed	No. Observations	605
Model:	Logit	Df Residuals:	598
Method:	MLE	Df Model:	6
Date:	Mon, 17 Aug 2026	Pseudo R-squ.:	0.07368
Time:	12:55:23	Log-Likelihood:	-388.44
converged:	False	LL-Null:	-419.33
Covariance Type:	nonrobust	LLR p-value:	1.941e-11

Table 14: Logistic regression coefficients for predictors of antibiotic prescription.

	coef	std err	z	P> z	[0.025	0.975]
const	0.8756	0.205	4.269	0.000	0.474	1.278
Age	-0.0175	0.005	-3.655	0.000	-0.027	-0.008
Sex	-0.2475	0.173	-1.432	0.152	-0.586	0.091
Comorbidity Count	-0.5801	0.223	-2.596	0.009	-1.018	-0.142
Malaria	0.6645	0.323	2.059	0.039	0.032	1.297
Hypertension	0.0064	0.380	0.017	0.987	-0.738	0.751
Diabetes	-29.8636	1.2e+06	-2.5e-05	1.000	-2.35e+06	2.35e+06

Table 15s: Odds ratios and 95% confidence intervals from the fitted logistic model.

	Odds Ratio	2.5%	97.5%
const	2.400380e+00	1.605723	3.588307
Age	9.826355e-01	0.973449	0.991909
Sex	7.807357e-01	0.556355	1.095609
Comorbidity Count	5.598461e-01	0.361277	0.867556
Malaria	1.943592e+00	1.032574	3.658380
Hypertension	1.006372e+00	0.478134	2.118203
Diabetes	1.072532e-13	0.000000	Inf

Because the original regression output reported that the model did not fully converge, the diabetes estimate should not be interpreted as dependable. The model should be re-estimated using an appropriate approach, such as penalised logistic regression or removal/reclassification of sparse predictors, depending on the underlying data structure.

DISCUSSION

This study found that antibiotics were prescribed in 49.6% outpatient encounters. This represents substantial antibiotic exposure and is important from an antimicrobial stewardship perspective. Antibiotic use is a major driver of AMR, and routine monitoring of prescribing patterns is central to efforts to optimize antimicrobial use.^[3,4]

The antibiotic prescription rate observed is comparable to earlier Nigerian research. A previous survey of drug-use practices at a general hospital in Nigeria reported antibiotics in 50.3% of outpatient encounters.⁷ The similarity suggests that high outpatient antibiotic prescribing may remain a persistent challenge in some Nigerian healthcare settings despite increasing emphasis on antimicrobial stewardship.

The mean number of antibiotics per antibiotic-containing prescription was 1.33. Most antibiotic-containing encounters involved one antibiotic, although approximately one quarter involved two or more. Multiple antibiotic prescribing may sometimes be clinically justified, particularly for severe or polymicrobial infections, but unnecessary combinations can increase medication costs, adverse drug reactions, and selective pressure for resistance.

Cephalosporins were the most frequently represented antibiotic class, followed by penicillins and fluoroquinolones. The substantial use of fluoroquinolones deserves attention because many commonly used agents in this class fall within

the WHO Watch category and therefore warrant careful monitoring.^[5,6] the available dataset did not classify individual antibiotics according to the WHO AWaRe system; consequently, the proportions belonging to Access, Watch and Reserve groups cannot be directly calculated from these results.

Malaria was the most frequent diagnosis and was independently associated with antibiotic prescribing. Malaria is a parasitic disease, and antibiotics should not be used solely for uncomplicated malaria unless a documented or clinically suspected bacterial co-infection requires antibacterial therapy. The observed association may indicate diagnostic uncertainty, co-existing bacterial illness, or empirical prescribing practices. However, the dataset does not provide sufficient information on the clinical rationale for individual prescriptions, malaria test results or documented bacterial co-infections; therefore, the association should not be interpreted as evidence that antibiotics were necessarily inappropriate in individual malaria cases.

The high proportion of diagnoses based on clinical signs and symptoms is also relevant. Only a minority of prescribers reported culture-based diagnostic approaches. Limited access to microbiological testing can encourage empirical prescribing, particularly when clinicians must make rapid treatment decisions. Strengthening diagnostic capacity and surveillance is a vital component of the broader AMR response.^[1,3]

Prescriber knowledge showed a mixed pattern. Awareness of antibiotic resistance was universal, and most prescribers demonstrated good knowledge of several basic rational-use principles. However, awareness of antimicrobial stewardship was only 41.9%, while awareness of antibiograms was 19.4%. These findings suggest that general awareness of AMR does not necessarily translate into familiarity with practical stewardship tools and principles.

Only 38.7% of prescribers had received formal training. Trained prescribers had higher awareness and rational-use scores than untrained prescribers, although differences were not statistically significant. The lack of statistical significance may partly reflect the small prescriber sample. Nevertheless, the direction of the findings supports continuing professional development and structured antimicrobial stewardship education.

Substantial gaps were identified in knowledge of broader determinants of AMR. Although all prescribers identified widespread antibiotic use as a cause of resistance, fewer recognized contributions from animal husbandry, farming, and poor hygiene. This is relevant because AMR is a One Health problem involving human health, animal health, food systems, and the environment.^[1]

The healthcare-seeking findings provide additional context. Most patients first sought care from health clinics, PHCs or hospitals, but a considerable proportion used pharmacies or patent medicine vendors as their first point of contact. More than half reported using leftover medicines in the preceding six months. These behaviours may contribute to inappropriate antibiotic exposure through self-medication, incomplete treatment courses, inappropriate drug selection or delayed professional assessment. However, leftover medicine use was not significantly associated with antibiotic prescription in the present analysis, so the relationship between community medicine practices and facility-based prescribing requires further investigation.

Out-of-pocket expenditure was the most common source of healthcare financing. Mean antibiotic cost was ₦1,667.82, half of mean total drug cost. Although the dataset does not permit assessment of affordability or financial hardship,

antibiotic costs may be relevant to adherence and treatment completion, particularly among patients paying directly for care.

Age was independently associated with antibiotic prescribing, with lower prescribing among older patients. Younger patients may have presented more frequently with acute infectious syndromes or conditions in which antibiotics were more commonly considered. Age itself is unlikely to be a direct indication for antibiotic therapy; the association may reflect differences in diagnoses and clinical presentations across age groups.

The inverse association between comorbidity count and antibiotic prescription in the fitted model should be interpreted cautiously. Although statistically significant, it may reflect the structure of the available data and the clinical characteristics of patients with chronic diseases. The model's modest pseudo- R^2 also suggests that important determinants of prescribing were not captured.

A major limitation of the multivariable analysis is non-convergence in the original regression output. The diabetes variable showed extreme coefficient instability, strongly suggesting sparse data or quasi-complete separation. Consequently, the diabetes estimate should not be interpreted. Before submission, the regression model should be rerun using an appropriate approach, such as penalised logistic regression or removal/reclassification of sparse predictors, depending on the underlying data structure.

Studying has important strengths. It combines patient-level prescribing information with prescriber-level knowledge and practice information, providing a broader picture of antibiotic use than a prescription audit alone. It also examines healthcare-seeking behavior, financing, and leftover medicine use, allowing antibiotic prescribing to be considered within a wider health-system context.

Several limitations should be acknowledged. The available dataset does not specify the study period, number and type of participating facilities, sampling approach, or geographic distribution, limiting assessment of representativeness. The dataset also does not provide sufficient information to determine whether individual prescriptions were clinically appropriate. Microbiological results were limited, preventing assessment of culture-confirmed infections and concordance between susceptibility results and prescribed antibiotics. Individual antibiotics were not mapped to WHO AWaRe categories, limiting international benchmarking. The prescriber sample was small, reducing statistical power for comparisons of knowledge and training. Finally, the logistic regression model did not converge and requires reanalysis before the findings can be considered definitive.

CONCLUSION

Antibiotics were prescribed in half of outpatient encounters assessed in Gombe State Specialist Hospital, Nigeria. Cephalosporins, penicillins and fluoroquinolones were the most frequently represented classes. Antibiotic prescribing was significantly associated with patient age, diagnosis, and comorbidity profile, while malaria was independently associated with increased odds of antibiotic prescription in the fitted model.

Although prescribers demonstrated good knowledge of several basic principles of rational antibiotic use, important gaps were identified in awareness of antimicrobial stewardship, antibiograms, and several broader determinants of AMR. Formal training was associated with higher, although not statistically significant, awareness and rational-use scores.

Implications for antimicrobial stewardship

- Routine outpatient prescription audits and feedback should be strengthened.
- Continuing professional development should emphasise rational antibiotic use, antimicrobial stewardship and WHO AWaRe principles.
- Access to diagnostic and microbiological services should be improved to reduce avoidable empirical prescribing.
- Local antibiotic prescribing guidelines should be developed, implemented, and periodically reviewed.
- Antibiotic-use surveillance should be integrated into routine health-system monitoring.
- Community-level interventions should address self-medication, use of leftover medicines and appropriate first contact with qualified healthcare providers.

Before journal submission, individual antibiotics should be mapped to WHO AWaRe categories; prescription denominators and coding should be verified; the non-convergent regression model should be reanalysed; and the study period, study setting, sampling method, and ethical approval details should be documented more explicitly.

REFERENCES

1. Mendelson M, Matsoso MP. The World Health Organization Global Action Plan for antimicrobial resistance. *S Afr Med J.*, 2015; 105(5): 325. doi:10.7196/samj.9644
2. Murray, C.J., Ikuta, K.S., Sharara, F., Swetschinski, L., Robles Aguilar, G., Gray, A., Han, C., Bisignano, C., Rao, P., Wool, E., et al.; Global Burden of Bacterial Antimicrobial Resistance in 2019: A Systematic Analysis. *The Lancet*, 2022; 399: 629-655
3. World Health Organization. WHO methodology for point prevalence survey on antibiotic use in hospitals, version 1.1. World Health Organization 2018. <https://iris.who.int/handle/10665/280063>. License: CC BY-NC-SA 3.0 IGO
4. GLASS manual on the management of antimicrobial consumption data. Geneva: World Health Organization; 2020. Licence: CC BY-NC-SA 3.0 IGO.
5. World Health Organization. The WHO AWaRe (Access, Watch, Reserve) Antibiotic Book. <https://www.who.int/publications/i/item/WHO-MHP-HPS-EML-2022.02>
6. World Health Organization, WHO access, watch, reserve (AWaRe) classification of antibiotics for evaluation and monitoring of use, 2021. World Health Organization, 2021. <https://iris.who.int/handle/10665/345555>. License: CC BY-NC-SA 3.0 IGO
7. Chukwuani, C M et al. "Survey of drug use practices and antibiotic prescribing pattern at a general hospital in Nigeria." *Pharmacy world & science: PWS*, 2002; 24(5): 188-95. doi:10.1023/a:1020570930844
8. Global Antimicrobial Resistance and Use Surveillance System (GLASS) report. Antibiotic use data for 2022. Geneva: World Health Organization; 2025. Licence: CC BY-NC-SA 3.0 IG
9. World Health Organization, Food and Agriculture Organization of the United Nations & World Organisation for Animal Health, Antimicrobial resistance: a manual for developing national action plans, version 1. World Health Organization, 2016. <https://iris.who.int/handle/10665/204470>
10. WHO implementation handbook for national action plans on antimicrobial resistance: guidance for the human health sector. Geneva: World Health Organization, 2022. Licence: CC BY-NC-SA 3.0 IGO.