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Current status and future direction of antimicrobial stewardship programs and antibiotic prescribing in primary care hospitals in Zambia

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Background: Antimicrobial Stewardship Programs (ASPs) intended to optimize antibiotic use will be more effective if informed by the current status and patterns of antibiotic utilisation. In Zambia's primary healthcare (PHC) settings, data on ASPs and antibiotic utilisation were inadequate to guide improvements. As a first step, this study assessed antibiotic prescribing and ASP core elements among PHC first-level hospitals (FLHs) in Zambia.

Methods: A point prevalence survey was conducted at the five FLHs in Lusaka using the Global-PPS® protocol. Hospital ASP core elements evaluated included hospital leadership commitment, accountability, pharmacy expertise, action, tracking, reporting, and education.

Results: Antibiotic use prevalence was 79.8% (146/183). A total of 220 antibiotic prescription encounters were recorded among inpatients, with ceftriaxone (J01DD04, Watch) being the most (50.0%) prescribed. Over 90.0% (202) of the antibiotic prescriptions targeted suspected community-acquired infections, but only 36.8% (81) were compliant with national treatment guidelines. ASP core element implementation was 36.0% (16.2/45), with only two hospitals achieving over 50.0%. The most deficient core elements were accountability, action, tracking, and reporting.

Conclusions: ASP implementation in Zambia's FLHs providing PHC was sub-optimal, with high antibiotic prescribing rates, frequent use of broad-spectrum Watch group antibiotics, and low compliance with national treatment guidelines. As key ways forward, ASPs in Zambia's PHC require strengthening by adapting the WHO AWaRe recommendations and improving accountability, actions, tracking, and reporting antibiotic use to improve stewardship practice and reduce AMR.

Introduction

Antimicrobial resistance (AMR) is a global concern[1,2] that is disproportionately higher in low- and middle-income countries (LMICs).[3,4] Globally, sub-Saharan Africa has the highest burden of AMR, resulting in increased morbidity, mortality, prolonged hospitalisation, poor health outcomes, and increased healthcare costs.[5] Overuse and misuse of antibiotics, for instance, inappropriate prescribing,[6,7] over-the-counter dispensing of antibiotics without a prescription,[8–10] self-medication,[11,12] and growth promotion use in agriculture[13–15] are among the main drivers of AMR in both humans and animals, rendering these antimicrobials ineffective.[2,16] Both in terms of incorrect regimens and prescription without clinical indication, inappropriate use of antibiotics remains a major driver of AMR.[17]

Concerns are increasing regarding the relatively high antibiotic use reported in Zambia,[18–23] including evidence of multidrug-resistant pathogens,[24–28] and a drug resistance index above 60%.[28,29] In response to the local burden of AMR, the Government of Zambia launched a one-health multisectoral national action plan (NAP) in 2017,[30,31] with five strategic objectives, including optimising antimicrobial use through Antimicrobial Stewardship Programs (ASPs). An ASP is a coordinated effort to promote the appropriate and judicious use of antimicrobials, improve patient outcomes, and reduce AMR.[5,32–34] Despite this initiative, hospital ASP implementation gaps persist in Zambia.[20,35,36] Recent efforts to address this have employed hub-and-spoke initiatives to establish ASPs where they were nonexistent, mostly in the secondary and tertiary-level hospitals across the country,[37] similar to other places.[38] Global recommendations suggest hospital-based ASPs have hospital leadership commitment, accountability, pharmacy expertise, action, tracking, reporting, and education as core elements for effective antimicrobial stewardship (AMS) implementation.[34] This is in addition to utilising the WHO AWaRe (Access, Watch, Reserve) framework and the 2019 model Essential Medicines List (EML) as stewardship tools, with their increasing use across countries to assess current utilisation patterns.[39,40] Adherence to treatment guidelines is increasingly seen as important to improve future antibiotic use, with quality indicators increasingly focusing on antibiotic utilisation by AWaRe classification.[41,42] According to the WHO AWaRe framework and guidance in the newly launched WHO AWaRe book guidance giving treatment recommendations for 35 infectious diseases, Access antibiotics should be the preferred first choice, where appropriate, with a narrow spectrum of activity and less potential for resistance.[39,43,44] Recently, the United Nations General Assembly (UNGA) suggested a new target of achieving at least 70% of overall antibiotics used in human health from the WHO Access group by 2030, expanding from the 2023 global target.[45] The Watch group are those antibiotics with a broader spectrum of activity but with a high potential for resistance, requiring ASPs to preserve their effectiveness. The increasing overuse of WHO Watch antibiotics is a growing concern among LMICs,[46,47] with implications on AMR. The Reserve antibiotics are the last resort agents for multidrug-resistant organisms, with their inappropriate use an urgent focus for ASPs.[43,44]

As hospital ASPs continue to evolve worldwide, particularly in developing countries, they remain an effective strategy to optimize antibiotic use, reduce costs, and prevent AMR.[5,33,48] There were previously concerns that ASPs would be difficult to undertake in LMICs, particularly in African countries, due to funding and personnel constraints.[49] However, this is now changing with multiple ASPs being successfully implemented across Africa and other LMICs in recent years.[50–54] The US Centres for Disease Control and Prevention (CDC) recently updated the hospital ASP core elements toolkit to reflect both lessons learnt from five years of experience as well as new evidence from the field of AMS.[34] The CDC hospital ASP toolkit is similar to the WHO toolkit for healthcare facility core elements of ASPs in LMICs[48] as both guide the building of the requisite frameworks needed to implement sustainable ASPs.

Primary healthcare (PHC) accounts for more than 80% of all antibiotic use across LMICs, including Africa, primarily relying on indications based on signs and symptoms with empiric prescribing.[55,56] Similar to other sub-Saharan African countries, public PHC in Zambia is delivered through sub-national health system structures at the district level.[18,20,35] Often the first point of access to healthcare for patients in local communities, PHC facilities are important targets of ASPs given the high rates of AMR,[25,27,57,58] antibiotic use,[18,20,37] and AMS knowledge gaps reported previously across Zambia, which is similar to other African countries.[14,36,59–62] Public PHC facilities and services in Zambia are classified into four levels from the lowest to the highest as follows: Health Post, Health Centre, Zonal Health Centre, and First-Level Hospital (FLH), respectively.[63] With inpatient capacities between 50 and 250 beds, FLHs servicing 80 000–200 000 catchment population are often characterized by few specialist physicians, general physicians or non-physician clinicians, including limited laboratory services for general analysis but not for specialized pathological analysis.[63,64] Although ASPs are beginning to take place mostly in the secondary and tertiary-level hospitals in Zambia, using educational initiatives[37,65] building on earlier concerns,[19,20,35,36,66] there is an information gap regarding the current state of ASPs alongside recent concerns with high prescribing rates of WHO Watch antibiotics in PHC hospitals.[23,67] Moreover, accurate quantification of antibiotic prescribing in PHC across LMICs is typically limited, thereby necessitating studies to address these gaps and to potentially suggest interventions that can be scalable across PHC levels.

Our study aimed to assess current antibiotic prescribing and ASPs in hospitals providing PHC in Zambia, building on earlier studies. Specifically, the study determined antibiotic use patterns, including prescribing quality concerning compliance with the WHO AWaRe framework and national standard treatment guidelines (STG) among the FLHs. Additionally, the study evaluated the ASP core elements to identify areas requiring improvement in these key hospitals. The overarching goal was to generate findings that could guide future interventions to optimize antibiotic utilisation practices through ASPs as an initial step towards achieving the UNGA targets in Zambia and elsewhere.

Materials and methods

Study design, population, and setting

A point prevalence survey (PPS) was conducted in the FLHs providing PHC services in Lusaka, Zambia.[63] Lusaka is the capital and most densely populated city, with ∼2.2 million people[68] where 5 out of the 7 Type (A) category FLHs are located in Zambia.[63] Type (A) FLHs provide PHC services to a population coverage above or between 80 000 and 200 000.[63]

Sample size and sampling

All five FLHs situated in Lusaka were purposively selected for this study. Since all FLHs had <500 inpatient bed capacity, we used a complete enumeration as per the Global-PPS protocol.[69]

Inclusion and exclusion criteria

Only the public-owned FLHs providing PHC were included. Only the medical records of patients admitted before 08:00 AM on the survey day were surveyed as per the standard Global-PPS protocol.[66,69,70] Medical records of outpatients, including inpatients admitted to chronic care wards (e.g. TB, HIV, cancer wards), emergency departments, daycare (for observation, endoscopy, dialysis), and labour wards were excluded. Only prescriptions of antibiotics for systemic use administered by either the oral or parenteral routes were considered.

Data collection tools and procedures

The standard Global-PPS data collection forms[66,69,71] were used for data abstraction from inpatient medical records. The Global-PPS is a widely employed methodology across Africa.[53,66,71,72] At each FLH, three pharmacy staff were oriented using a standard module (available at URL: https://www.global-pps.com/wp-content/uploads/2021/02/Global-PPS_2019_optional-HAI-module.pptx) to assist in collecting data from the medical records, thereby ensuring consistency in data collection. A 45-item self-assessment checklist questionnaire adapted from the CDC core elements of hospital ASP toolkit[34,73,74] was completed by the respective Head of Clinical Care or Pharmacist-in-charge at each FLH surveyed. These officers were key members of the Medicines and Therapeutics Committee (MTC) and gatekeepers of program information at the respective hospital. Data were collected from July to September 2023.

Study variables and measurements

For PPS data, the demographic characteristics, antibiotic regimen, indication, and prescription quality in terms of documenting the reason for prescribing antibiotics in the patient's medical record, the stop or review date, and compliance with the Zambian STG.[75] Compliance with guidelines was measured as per the protocol, similar to other Global-PPS studies and Pan-African country studies.[66,69,71,76] However, we were aware that a growing number of prescribing quality indicators have been derived and are being used across hospitals.[5,42,53] The total number of antibiotic encounters was also recorded. Antibiotics were described by their International Non-proprietary Name (INN),[77] Anatomical Therapeutic Classification (ATC) code,[78] as well as the WHO AWaRe classification.[39,42,44] A composite performance score from 0 to 45 was used to measure hospital ASP core elements across the 45-item checklist consisting of seven domains i.e. Hospital leadership commitment (7 items), Accountability (2 items), Pharmacy expertise (3 items), Action (14 items), Tracking (12 items), Reporting (4 items), and Education (3 items). The indicative scores 'Yes' = 1 and 'No' = 0 quantified whether or not a core element item was implemented at each hospital.[37,74]

Data analysis

Antibiotic use prevalence was measured as a proportion of the total number of patients prescribed an active or ongoing systemic antibiotic (numerator) divided by the total number of patients admitted to the wards of interest (denominator) across the hospitals. Pearson's chi-square and Fisher's exact test were used to detect associations between antibiotic prescribing and patients' demographic characteristics. Performance scores in each of the seven ASP core elements were summed, and the

Table 1. Inpatient bed capacity and antibiotic use among patients in the FLHs surveyed

Variable & level	Frequency			*p* value[a]
Hospital ID	**Inpatient bed capacity (*n*, %)**	**Inpatients surveyed (*n*, %)**		-
• FLH01	85 (15.3)	31 (36.4)		
• FLH02	153 (27.5)	54 (35.3)		
• FLH03	60 (10.8)	28 (46.7)		
• FLH04	163 (29.3)	45 (27.6)		
• FLH05	95 (17.1)	25 (26.3)		
Number of inpatients admitted by 08:00 AM on survey day	On antibiotics (*n*, %)	Not on antibiotics (*n*, %)	Total (*n*, %)	
• FLH01	27 (87.1)	4 (12.9)	31 (100.0)	0.1238
• FLH02	40 (74.1)	14 (25.9)	54 (100.0)	
• FLH03	26 (92.9)	2 (7.1)	28 (100.0)	
• FLH04	36 (80.0)	9 (20.0)	45 (100.0)	
• FLH05	17 (68.0)	8 (32.0)	25 (100.0)	
Sex of the admitted patient				0.0001
• Male	77 (67.5)	37 (32.5)	114 (100.0)	
• Female	69 (100.0)	0 (0.0)	69 (100.0)	
Patient Case Type				0.4585
• Medical	122 (80.0)	29 (19.2)	151 (100.0)	
• Surgical	24 (75.0)	8 (25.0)	32 (100.0)	

This table displays the FLHs stratified by bed capacity and reveals the proportions of inpatient medical records surveyed who were prescribed antibiotics as a proportion of the total number of eligible patients surveyed per hospital.
[a]Pearson's chi-square test for association.

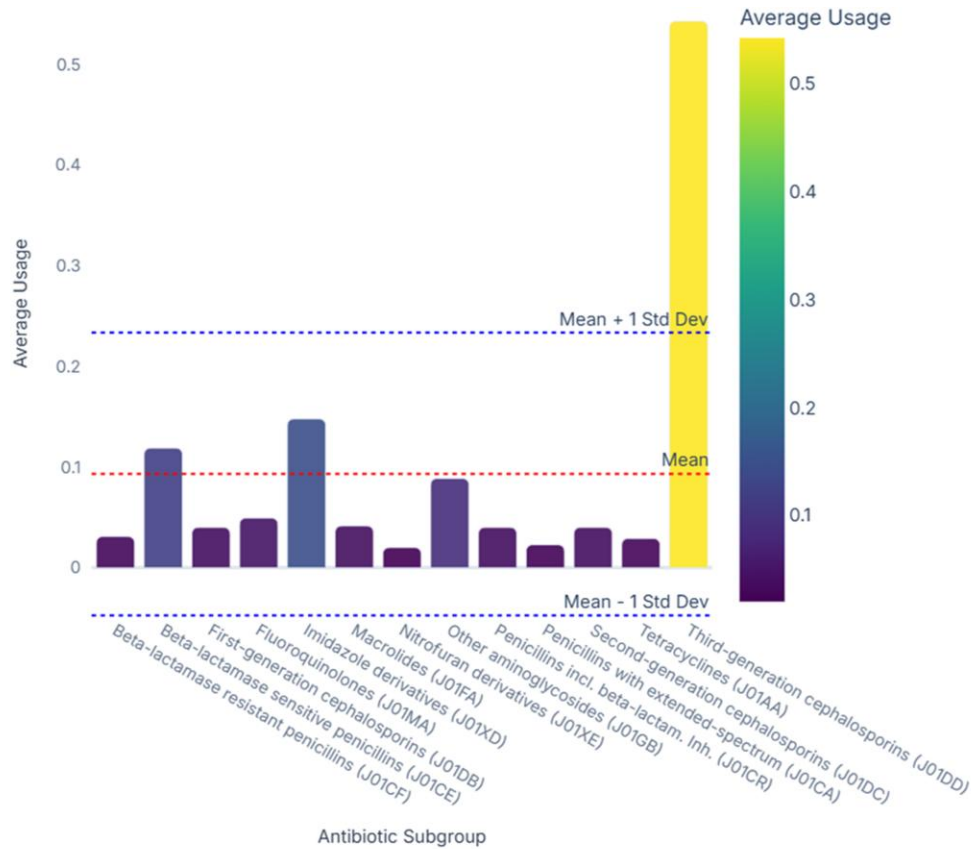

Figure 1. Average usage of antibiotic subgroups (by ATC4 code) across categories. This plot reveals the proportional use of each antibiotic subgroup, allowing us to compare their usage across the different categories. Across the hospitals, the third-generation cephalosporins (J01DD) accounted for over 50% average usage.

total score was reported as a percentage. Statistical analysis was performed using R software version 4.4.1.

Ethical considerations

Ethical approval (reference no. 2022-Apr-022) was obtained from the ERES Converge Independent Review Board (IRB no. 00005948) and the Zambia National Health Research Authority (Reference no. 0000014/01/06/2022). Official permission was granted by the Ministry of Health through the Provincial Health Office (reference no. LSKPHO 101/8/1), including the respective hospital management and ward in-charge staff at the study sites. Names of the participating hospitals were withheld, and appropriate identity codes (e.g. FLH01, etc.) were used. Data collected from the medical records were de-identified and confidentially maintained.

Results

Demographic characteristics of the participating hospitals

Table 1 shows the demographic characteristics of the hospitals, including inpatients surveyed. There was a total of 556 inpatient bed capacity across the 5 FLHs surveyed, with only two hospitals having a capacity exceeding 150 inpatient beds. All the FLHs had an MTC established. There were more male than female patients admitted by 08:00 AM on the survey day.

Antibiotic prescribing and usage patterns

Out of the 183 inpatients (Table 1), 146 were prescribed at least one antibiotic for systemic use, representing an overall point prevalence of 79.8%. All the female patients and two-thirds (77) of the male patients were on antibiotics. The majority (80.0%, 122) of those prescribed antibiotics were admitted for medical conditions, with 92.9% admitted to FLH03, followed by 87.1% to FLH01, and 80.0% to FLH04, respectively.

Across the 5 hospitals, the third-generation cephalosporins (J01DD) accounted for 54.3% average usage across the categories of the antibiotics prescribed (Figure 1). When inspecting the individual facility usage values, FLH01 (61.8%), FLH02 (60.0%), and FLH04 (60.7%) were above the overall average, suggesting that these facilities used third-generation cephalosporins at a higher rate.

Table 2 shows the antibiotic prescription encounters. Of the 220 antibiotic prescriptions issued to 146 inpatients across 5 FLHs, ceftriaxone (JOIDD04, Watch) was the most prescribed in half of the encounters, followed by metronidazole (POIAB01, Access).

Table 3 shows the antibiotic prescribing by the WHO AWaRe classification, with no prescribing of Reserve antibiotics in any of the FLHs surveyed. Out of the 220 antibiotic prescriptions issued across all hospitals, the prescribing of Access antibiotics ranged from 31.4% to 57.8%, while Watch antibiotics ranged from

Table 2. Most prescribed antibiotics by INN name, ATC5 code and WHO AWaRe classification ($N = 220$)

Antibiotic name (ATC code)	WHO AWaRe classification	Frequency, *n* (%)
Ceftriaxone (J01DD04)	Watch	110 (50.0)
Metronidazole (POIAB01)	Access	45 (20.5)
Benzylpenicillin (JOICE01)	Access	17 (7.7)
Gentamicin (JOIGB03)	Access	17 (7.7)
Ciprofloxacin (JOIMA02)	Watch	5 (2.3)
Amoxicillin (JOICA04)	Access	4 (1.8)
Azithromycin (JOIFA10)	Watch	4 (1.8)
Cloxacillin (JOICF02)	Access	4 (1.8)
Cefotaxime (JOIDD01)	Watch	3 (1.4)
Doxycycline (J01AA02)	Access	3 (1.4)
Other[a]	—	8 (3.9)
Total		**220** (**100**)

This table shows that Ceftriaxone (J01DD04, Watch group) was the most prescribed antibiotic, with 110 prescriptions. Other notable antibiotics include Metronidazole and Benzylpenicillin, with 34 and 17 prescriptions, respectively.
[a]Other includes Erythromycin (J01FA01)—'Access', Ampicillin + Cloxacillin (J01CR50)—'Access', Cefalexin (J01DB01)—'Access', Cefuroxime (J01DC02)—'Watch', Clarithromycin (J01FA09)—'Watch', Nitrofurantoin (J01XE01)—'Access', and Penicillin-V (J01CE02)—'Access'.

42.2% to 68.6%. Antibiotic prescribing by WHO AWaRe classification was significantly associated with the ward type and the route of administration, respectively, with Access antibiotic prescribing being slightly higher in the paediatric wards (52.9%, 37). Despite more prescriptions of Watch antibiotics (57.3%, 126) in 4 out of 5 hospitals, except FLH03, antibiotic prescribing by WHO AWaRe classification was not significantly associated with the hospital, sex of the patient, and case type (i.e. medical or surgical case), respectively. At the same time, the prescribing of Watch antibiotics was higher in the adult wards (62.0%, 93). The majority (62.4%, 116) of Watch group antibiotics were prescribed in parenteral dosage forms.

Antibiotic prescribing quality

Figure 2 shows the most common diagnoses by the anatomical site of infection among the inpatients prescribed antibiotics across hospitals. This figure helps understand the prevalent diagnoses concerning antibiotic prescriptions, which can be crucial for ASP actions and healthcare planning. Overall, 88.0% of 146 patients had a recorded diagnosis matching the anatomical site of infection. Pneumonia followed by other undefined diagnoses (including ear, nose, and throat infections, bone and joint infections, bacteraemia, bronchitis, malaria, TB, and other prophylaxes) accounted for nearly half (49.0%) of the diagnoses where antibiotics were prescribed.

Table 4 shows the antibiotic prescribing quality indicators across FLHs. Overall, 66.8% (147) of the encounters had documented reasons for prescribing antibiotics in the patient's medical records, with FLH01 having the highest (74.3%). Only 36.8% (81) of the prescriptions complied with the STG. Only 5.0% (11) of the prescribers recorded the antibiotic stop or review date.

Table 3. Association between antibiotic prescribing by the WHO AWaRe classification and demographic characteristics of the hospitals and patients

Variable label	WHO AWaRe class of antibiotic prescribed, *n* (%)			
	Access	Watch	Total	*P* value
Hospital				
• FLH01	11 (31.4)	24 (68.6)	35 (100)	0.1102[a]
• FLH02	20 (37.0)	34 (63.0)	54 (100)	
• FLH03	26 (57.8)	19 (42.2)	45 (100)	
• FLH04	23 (39.7)	35 (60.3)	58 (100)	
• FLH05	14 (50.0)	14 (50.0)	28 (100)	
Ward type				
• Adult wards	57 (38.0)	93 (62.0)	150 (100)	0.0416[b]
• Paediatric wards	37 (52.9)	33 (47.1)	70 (100)	
Sex				
• Male	48 (42.1)	66 (57.9)	114 (100)	0.8919[b]
• Female	46 (43.4)	60 (56.6)	106 (100)	
Patient case type				
• Medical	78 (42.6)	105 (57.4)	183 (100)	1.0000[b]
• Surgical	16 (43.2)	21 (56.8)	37 (100)	
Route of administration				
• Oral	24 (70.6)	10 (29.4)	34 (100)	0.0005[b]
• Parenteral	70 (37.6)	116 (62.4)	186 (100)	
Total	94 (42.7)	126 (57.3)	220 (100)	

This table displays how different demographic factors were associated with the prescriptions of various antibiotics categorized by the WHO AWaRe classification. Watch group antibiotics were prescribed significantly more compared with Access group in parenteral dosage forms and among patients admitted to adult wards.
[a]Pearson's chi-square test.
[b]Fisher's exact test.

Core elements of hospital ASPs

Figure 3 shows the performance scores in the 7 ASP core elements after self-assessment at each hospital.

Across the FLHs, the average score was 36.0%. Only two hospitals implemented over 50% of the core elements, with FLH03 scoring 71.1% out of the 45 items assessed, followed by FLH05 with 60.0%. Three FLHs performed poorly (below 50.0% score), with FLH04 being the lowest scoring nil across all the core elements assessed. Across the FLHs, the most deficient core elements (<40.0% score) were accountability, action, tracking, and reporting, respectively.

Table 5 summarizes the key findings from the hospital self-assessment under each domain of the ASP core elements.

Discussion

This study assessed antibiotic prescribing patterns and ASP core elements among FLHs providing PHC in Zambia. We believe this

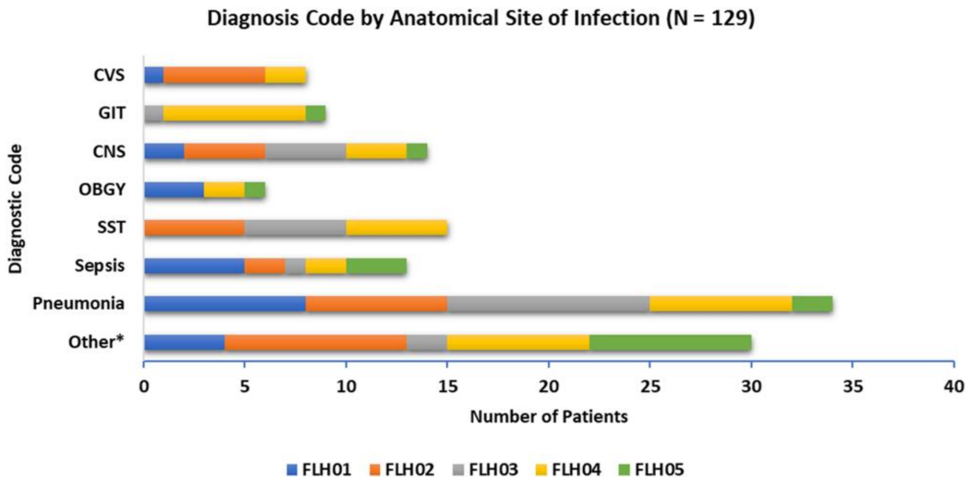

Figure 2. Common diagnoses treated with antibiotics across the FLHs surveyed. This chart displays the various frequent diagnoses by anatomical site for which antibiotics were prescribed for treatment across the hospitals. From the chart, we can see that Pneumonia, a lower respiratory tract infection, was the most common diagnosis, indicating a significant need for antibiotic treatment in these cases. Other notable diagnoses included SST infections and Sepsis, which also showed considerable prescription counts. CVS, Cardiovascular system infections; CNS, Central nervous system infections; GIT, Gastrointestinal tract infections; OBGY, Obstetrics & Gynaecology infections; SST, Skin & soft tissue infections; *Other, non-defined diagnosis groups, including Ear, Nose and Throat infections, Bone and Joint infections, Bronchitis, Tuberculosis, Malaria, and other prophylaxes.

Table 4. Prescribing quality indicators across the FLHs surveyed

	Frequency, *n* (%)					
Prescribing quality variable	FLH01	FLH02	FLH03	FLH04	FLH05	All hospitals
Reason in notes	26 (74.3)	36 (67.7)	31 (68.9)	37 (63.8)	17 (60.7)	147 (66.8)
Guideline compliance	14 (40.0)	14 (25.9)	22 (48.9)	20 (34.5)	11 (39.3)	81 (36.8)
Treatment based on microbiology test	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Stop/review date documented	0 (0.0)	2 (3.7)	6 (13.3)	1 (1.7)	2 (7.1)	11 (5.0)

This table shows the number of prescriptions per hospital where (i) the reason for prescribing antibiotics was documented, (ii) the prescription complied with the established STG, (iii) treatment was based on microbiology test results, (iv) a stop or review date for the antibiotic was documented. From the summary, we can observe that while there are varying counts for the documentation of reasons and guideline compliance, including the stop/review dates, there was no treatment based on microbiology test results across the FLHs.

is the first study to comprehensively assess the status of ASPs in public PHC-level hospitals in Zambia, building on previous studies in secondary and tertiary hospitals.[20,35,37,65] Our findings provide valuable insights into the state of ASPs among PHC-level hospitals in Zambia, providing a useful baseline upon which the quality of ASPs can be improved, including the key areas to inform decision-making.

Our study found a high prevalence (79.8%) of empirical antibiotic use, particularly the third-generation cephalosporins (J01DD, Watch) prescribed across the FLHs (Figure 1), further strengthening concerns with poor stewardship and adoption of the WHO AWaRe framework across all hospital types in Zambia. Ceftriaxone (JOIDD04, Watch)—a broad-spectrum third-generation cephalosporin, was the most prescribed antibiotic, similar to other local studies[19–22,37] and countries in Africa,[76,79–83] as well as the Middle East.[84] Arguably, its wide-spectrum antibacterial activity and accessibility within the national supply chain, coupled with weak ASPs in these settings, drive ceftriaxone overuse. This raises serious concerns for Zambia, particularly towards attaining the new UNGA goal of at least 70% of antibiotic use from the WHO Access group. We found that the WHO Access antibiotics only constituted overall 45% of total antibiotics prescribed, much lower than reported in South Africa[61,85] and Kenya.[86] For PHC-level hospitals in Zambia and elsewhere to achieve the 70% target, urgent actions are required. As a first step, facilities should integrate the WHO AWaRe framework, guidance, and associated quality indicators for monitoring the optimal use of antibiotics into revised local STG based on local AMR patterns as well as EML, while instigating potential measures to enhance compliance.[42–44,53,87,88] WHO Access antibiotics should be prioritized as first-line treatments while ensuring their consistent availability through resilient supply chains. Educating prescribers and communities is also vital for compliance with the STG, emphasising that the Access antibiotics are efficacious and safe while addressing misconceptions about their use.[53,61,84] The use of PPS and audit methods to enhance

Core Element	Assessment Score FLH01	FLH02	FLH03	FLH04	FLH05	Average Score
Hospital Leadership Commitment	0/7	5/7	5/7	0/7	6/7	**3.2/7**
Accountability	0/2	0/2	1/2	0/2	1/2	**0.4/2**
Pharmacy Expertise	0/3	2/3	3/3	0/3	3/3	**1.6/3**
Action	2/14	5/14	13/14	0/14	7/14	**5.4/14**
Tracking	0/12	6/12	7/12	0/12	5/12	**3.6/12**
Reporting	0/4	1/4	1/4	0/4	2/4	**0.8/4**
Education	0/3	1/3	2/3	0/3	3/3	**1.2/3**
Total Score (%)	**2/45 (4.4%)**	**20/45 (44.4%)**	**32/45 (71.1%)**	**0/45 (0.0%)**	**27/45 (60.0%)**	**16.2/45 (36.0%)**

Scale 0.0% *Poor performance* 50.0% *Average performance* 100.0% *Good performance*

Figure 3. Hospital ASP core element scores and performance heatmap in the self-assessment across the FLHs. This figure displays performance scores among the 5 FLHs' self-assessments in ASP core elements, which included hospital commitment, accountability, pharmacy expertise, actions taken to improve antibiotic use, tracking of antibiotic use and outcomes, reporting practices, and education initiatives. The heatmap analysis of the data revealed the strengths and weaknesses of ASPs across different hospitals.

antibiotic use surveillance in the country should continue, which is crucial to monitor AWaRe usage patterns and prescribing quality indicators, which are increasingly likely to be based on the WHO AWaRe book guidance in the first instance.[39,40,42–44]

Regarding prescribing quality, it was encouraging that over 60% of the prescribers across the FLHs recorded the reasons for prescribing antibiotics in the patient's medical records. The antibiotic stop or review date was, however, poorly documented across the hospitals surveyed. Elsewhere, initiatives such as the 'start smart, then focus' approach advocate active review of patients still on antibiotics 48 h after admission, which, when recorded, resulted in significant reductions in antibiotic use in the UK's PHC and secondary hospitals.[89] In our study, all antibiotic prescription encounters were empirical due to a general lack of laboratory capacity to conduct microbiology culture and sensitivity tests (CST) across the PHC hospitals surveyed. This agreed with previous studies suggesting that CST capacity is generally poor in Zambian hospitals.[90] We are also aware that empirical prescribing of antibiotics, largely for community-acquired infections, was common in Zambia[19,20] and elsewhere in sub-Saharan Africa,[66,80,82] mainly due to the inadequate capacity, tools, and reagents to conduct CST as well as patient co-payments.[71,90,91] Consequently, the lack of access to bacteriology testing in many LMICs is a key bottleneck to detecting AMR.[92] As reported by Ondoa *et al.*[91] the strengthening of laboratory capacity for AMR detection accounted for <20% of the proposed interventions in 86% of the NAPs analysed in 14 African countries, largely due to the resource-intensive nature of bacteriological testing.[91] Responding to these challenges in Africa, there are ongoing initiatives such as the WHO Global Antimicrobial Resistance and Use Surveillance System (GLASS), the UK's Fleming Fund program support through regional grants in Africa,[93] and recently, the Africa CDC's Antimicrobial Resistance Surveillance Network (AMRSNET).[94] These are beginning to address capacity gaps in this area. It is, therefore, pertinent for countries instigating ASPs to address current gaps in laboratory capacity for CST by leveraging ongoing support to improve antibiotic prescribing and AMR surveillance.

We found the ASP core elements sub-optimally implemented across the FLHs with potential implications on patient outcomes and costs. With an average performance score of 36.0% and hospitals implementing <50% of the ASP core elements, including some FLHs surveyed not performing any of the core elements assessed, it suggests that AMS practice was relatively poor in these settings. The significant challenges faced by these hospitals must be addressed for ASP activities to become well-established towards meeting the UNGA targets. Supporting the sustainable uptake of ASPs in PHC-level hospitals will require, as a feasible way forward, approaches similar to hub-and-spoke models recently employed in the secondary and tertiary hospitals in Zambia.[37,38] Our findings are similar to a study in Ghana where Sefah *et al.*[74] found sub-optimal performance for almost all the ASP core elements in the public PHC hospitals, hindered by human and financial resource constraints.[74] There have also been similar concerns in Nigeria[32,95] and South Africa.[96] Furthermore, Chizimu *et al.*[35] recently reported critical gaps in ASP core elements and, alongside this, identified challenges faced with ASP implementation in the secondary and tertiary-level hospitals across Zambia. Similarly, a lack of stewardship actions, education and training, poor reporting, and a limited leadership commitment to AMS activities were found contributing to inadequate AMS.[35] Building on these common challenges Zambian hospitals face in implementing ASPs[35] in Table 6, we suggest some tentative ways forward for key stakeholders to address the gaps.

We further contend that for hospital ASPs to be effectively implemented, their value must be demonstrated. In addition to establishing structures and approaches for ASP implementation in hospitals,[98] an economic value assessment demonstrating the clinical and socioeconomic impact can inform policy and an

Table 5. Key findings from the self-assessment of hospital ASP core elements

Hospital ASP core element	Main findings
Hospital leadership commitment	• Out of 7 items assessed under hospital leadership commitment, the average score was 3.2. • Only 3 FLHs had a senior executive (Head of Clinical Care) as the focal point of contact and ASP leaders who held quarterly meetings with hospital management to discuss stewardship activities, resources, and outcomes. • Only one FLH had facility leadership that dedicated time to managing and conducting daily stewardship interventions for the stewardship program. • Two FLHs had not implemented this core element.
Accountability	• Out of 2 items assessed, the average score was 0.4. • Three out of 5 FLHs indicated they had a leader or co-leaders responsible for AMS activities at the hospital.
Pharmacy expertise	• Out of 3 items assessed, the average score was 1.6. • Only 3 FHLs reported having a pharmacist participating in AMS to improve antibiotic use, and who had undergone specific training in AMS. • Regarding the implementation of interventions, 4 hospitals had an AMS action plan in place. • Only one-fifth had interventions for proven invasive infections and a review of planned parenteral antibiotic therapy. • Only one hospital reported having a formal procedure for inpatient daily antibiotic selection reviews until definitive diagnosis and treatment duration were established, including pre-authorization for specific antibiotics prescribed.
Action	• Out of 14 items assessed, the average score was 5.4. • Implementation of AMS actions was sub-optimal, with only 2 FLHs indicating some AMS actions were performed at the facility. • One FLH did not perform any of the 14 AMS actions assessed.
Tracking	• Out of 12 items assessed, the average score was 3.6. • 3 FLHs reported they actively tracked which antimicrobials were requested for infectious conditions, monitoring adherence to treatment recommendations and adherence to a documentation policy (dose, duration and indication). • In addition, 3 hospitals routinely conducted AMS evaluations to assess the course of therapy for selected antibiotics and/or infections to identify opportunities for improved use. • None of the FLHs submitted antibiotic use data to the district and national AMR coordinating committee levels. • None of the FLHs utilized antibiograms.
Reporting	• The average score in this core element was 0.8 out of the 4 items assessed. • 2 hospitals did not implement any reporting of AMS activities and outcomes, which include providing regular updates to healthcare workers, hospital leadership, and the national AMR coordinating committee on process and outcome measures that address AMR.
Education	• Three FLHs reported conducting in-house education of prescribers and other health workers on optimal prescribing, antibiotic-related adverse reactions, and AMR. • Only 2 hospitals reported conducting prospective audits and feedback sessions.

This table describes the detailed findings of the baseline self-assessment scores for each core element assessed, highlighting specific aspects of the core element that were implemented, working and not working across the hospitals.

investment case.[33] We are beginning to see this happen in Africa, and this is likely to accelerate.[53,88] Moreover, LMICs can also leverage successful AMS methods and tools tried elsewhere to address common challenges.[89,99,100] This is particularly important in PHC settings where leadership commitment was a challenge to integrate AMS into the hospital's strategic plans, considering the human and financial resource limitations to effectively manage the ASP. Ideally, establishing an active ASP with functional core elements potentially enhances the optimal utilisation of antibiotics. On the contrary, our study did not observe an association between ASP core element performance and optimal antibiotic use in the FLHs surveyed. Moreover, compliance with the STG[75] and other prescribing quality indicators was poor, similar to previous studies.[19,20] This needs to be addressed going forward, enhanced by the availability and growing use of the WHO AWaRe book guidance across countries.

We are aware of some limitations of this study. Our study focused on FLHs situated in Lusaka City providing PHC services to large population densities. Despite this, our findings could be indicative of the situation in other FLHs across Zambia. We did not qualitatively measure factors such as barriers and challenges associated with the ASP core element performance and the rationale for antibiotic use. Additionally, data on each hospital's staff complement (i.e. the number of prescribers, nurses, pharmacists, laboratory staff, and others) was unavailable to provide demographic inferences on the prescribing patterns. As mentioned, our study only measured prescribing quality indicators as per the Global-PPS protocol. Future studies can do well to measure additional indicators not covered by this study. Despite these limitations, we are confident our findings are robust and provide useful guidance to stakeholders in Zambia and beyond.

Table 6. Suggested approaches to address challenges in implementing ASP core elements in PHC-level hospitals

ASP core element	Challenges identified and reported by Chizimu *et al.*[35]	Our suggested approaches to addressing the challenges
Hospital leadership commitment	• Lack of leadership commitment to AMS • Facility action plans have no AMS activities • No funding for AMS activities • No dedicated AMS leader with a job description for AMS	The Zambian Ministry of Health must: 1. Secure hospital leadership buy-in by developing evidence-based policy direction and an economic value assessment case with intended AMS impact (e.g. reduced healthcare costs, AMR mitigation, etc.). 2. Mandate inclusion of AMS in annual facility strategic plans with specific goals, timelines, and outputs. 3. Advocate for AMS funding by aligning AMS goals with national and sub-national health priorities.
Accountability and responsibilities (Expertise)	• No active AMS multidisciplinary team	The local hospital leadership must: 1. Assign AMS leaders with a formalized task/job description, linked to measurable performance indicators at each hospital. 2. Constitute multidisciplinary AMS teams in all hospitals with defined roles and reporting structures following guidelines. 3. Leverage partnerships and collaborative support from other hospitals with established AMS capacity to provide remote expertise where in-house specialists are unavailable.
Action	• Inadequate technical personnel needed for implementation of AMS • Challenges/barriers in the mechanisms of dissemination of AMS information • No standard and updated treatment guidelines (STG) in the facilities • Lack of AMS ward rounds and antibiotic review audit • Lack of AWaRe tool for antibiotics • Lack of facility AMS policy • Lack of standardized prescription charts	The Ministry of Health and hospital leadership should: 1. Mandate and provide training to all health workers on ASP principles and their implementation. 2. Establish, adopt, and utilize electronic or mobile platforms for real-time dissemination of AMS updates, best practices, and protocols within and across hospitals. 3. Regularly update and customize treatment guidelines based on local antibiograms. 4. Address translation gaps of national-level guidelines and policies by ensuring the availability and accessibility of national STG to all hospitals and health workers in user-friendly formats, building on the WHO AWaRe guidance. 5. Establish routine AMS activities, e.g. AMS ward rounds to review, decide on and optimize antibiotic prescriptions in line with approved guidelines and good clinical practice. 6. Mainstream the implementation of the WHO AWaRe classification and AWaRe book guidance in local antibiotic use guidelines. 7. Create standardized prescription charts with integrated decision-support tools (e.g. dosing calculators, stop/review dates, etc.).
Monitoring and surveillance (Tracking)	• Absence of antibiograms • Lack of antibiotic sensitivity discs to effectively conduct surveillance • No evidence-based practice from PPSs • In hospitals that had antibiograms, they lacked regular updates due to poor surveillance	1. Where microbiology laboratory capacity is limited, partner with external laboratories or health facility networks to develop and maintain facility-specific antibiograms updated quarterly. 2. Improve the supply chain by procuring and managing a continuous stock of diagnostic tools such as sensitivity discs; explore partnerships with suppliers for sustainable procurement. 3. Conduct biannual PPS and prescription audits to use the findings to adjust AMS strategies. 4. Implement electronic surveillance systems to automate antibiogram data collection and reporting using tools such as WHONET. 5. Track among PHC physicians with high antibiotic prescription rates using antibiotic audit and feedback with peer benchmarking[97]
Reporting feedback	• Inadequate communication on the resolutions of the MTC or AMS committees to the prescribers and other health workers	1. Utilize structured communication channels like monthly reports, dashboards, and briefings to share AMS outcomes and resolutions with all stakeholders. 2. Include AMS updates in existing hospital meetings or morning briefs to enhance visibility and accountability.

Continued

Table 6. *Continued*

ASP core element	Challenges identified and reported by Chizimu *et al.*[35]	Our suggested approaches to addressing the challenges
Education	• The facilities do not include AMS programs on optimising antibiotic therapy, prescribing, dispensing, and administration of antibiotics • Inadequate training of staff on AMS	1. Utilize local or international modular AMS training programs tailored to the roles of health workers. 2. Utilize available online platforms and simulation-based training for continuous professional development (e.g. Teach AMS ECHO available at URL: https://iecho.org/program/PRGM1712739913316LZ6MBDTT3U/details) 3. Partner with professional bodies and local organizations to deliver competency-based AMS certification programs. 4. Focus AMS training on practical skills such as implementing de-escalation strategies, recognising inappropriate antibiotic use, and measuring and reporting AMS interventions.

This table highlights, under each ASP core element assessed, the key challenges earlier identified and our suggested ways forward to addressing the challenges, building on the rationale from our findings, and emphasising the critical role the solutions can play in optimising antibiotic use and improving patient outcomes based on study findings.

Conclusion

The implementation of ASP core elements was sub-optimal across the PHC-level hospitals in Zambia, with high antibiotic prescribing rates and use of broad-spectrum WHO Watch antibiotics among admitted patients contributing to their overuse. Moreover, accountability, action, tracking, and reporting were the core elements of ASPs that were the most lacking. ASPs in Zambia must be strengthened by adapting the WHO AWaRe recommendations and enhancing core elements of accountability, stewardship actions, tracking, and reporting of antibiotic use in the PHC settings as key steps to improving antibiotic prescribing practices and reducing AMR.

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