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Potential activities to improve primary care prescribing of antibiotics across Africa

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There are considerable concerns with antimicrobial resistance (AMR) across Africa, enhanced by the inappropriate prescribing of antibiotics in ambulatory care. This includes prescribing for self-limiting conditions and Watch antibiotics. Inappropriate prescribing is enhanced by concerns with ambulatory care prescribers' knowledge of antibiotics, including their perceived effectiveness for self-limiting conditions, AMR, and antimicrobial stewardship programs (ASPs). Appropriate education of prescribers, including surrounding the AWaRe (Access, Watch, and Reserve) system and guidance, which recommends the prescribing of antibiotics with less resistance potential, alongside introducing ASPs in ambulatory care, can help address these concerns. This will increasingly include instigating agreed quality indicators, and their monitoring, surrounding the AWaRe system and guidance. Improved surveillance of local resistance patterns can help with appropriately updating antibiotic prescribing guidance, including revising the AWaRe guidance based on local resistance patterns. Additional financing is also needed to help attain national goals.

KEYWORDS

antibiotics, AWaRe, antimicrobial resistance, antimicrobial stewardship programs, policy initiatives, primary care, sub-Saharan Africa

1 Introduction

Antimicrobial resistance (AMR) contributes significantly to increased morbidity and mortality while also escalating healthcare costs (1–4). As a result, AMR is now a critical global public health threat, potentially becoming the next pandemic (5, 6). The concern with the rising AMR is reflected in the recent ambitious reduction targets for AMR agreed at the United Nations General Assembly (UN-GA) in September 2024 (7). Key target countries for reducing AMR are low- and middle-income countries (LMICs) where the burden of AMR is greatest, including among African countries (8–11). It is currently estimated that LMICs are responsible for over three-quarters of the 10 million deaths globally each year attributable to AMR, with the number of deaths due to AMR continuing to grow (8, 12). The high rates of AMR in LMICs, including among African countries, are attributable to the high rates of inappropriate prescribing and dispensing of antibiotics, including those from the Watch list of the World Health Organization (WHO) with their higher resistance potential (13–16).

There are a number of ongoing international, regional, and national initiatives designed to reduce AMR, particularly among LMICs. These include the launch of the Global Action Plan (GAP) by the WHO in 2015 to provide a stimulus to countries to rapidly instigate multiple coordinated activities to improve antibiotic use across sectors in order to reduce AMR, subsequently translated into National Action Plans (NAPs) (17, 18). Other global activities include classifying antibiotics into Access, Watch, and Reserve (AWaRe) groups based on their resistance potential, with the greatest focus on reducing the high and growing use of Watch antibiotics due to their greater resistance potential among LMICs (14, 19). The WHO AWaRe book, launched in 2022, provides treatment guidance for 35 infectious conditions, including alternatives to antibiotics for self-limiting infections (20).

Regional and national initiatives across Africa increasingly incorporate measures to reduce the unnecessary prescribing of antibiotics in primary care, principally for self-limiting conditions such as upper respiratory tract infections (URTIs). Such activities are exacerbated by concerns about limited knowledge regarding antibiotics, AMR, and antimicrobial stewardship (AMS) among prescribers across Africa (Tables 1, 2, 3) (21–24). There are also ongoing initiatives to reduce the high levels of inappropriate dispensing of antibiotics without a prescription across Africa, increasing AMR, which is also observed in other LMICs (25–27). Both situations are not helped by pressure from patients on healthcare professionals (HCPs), including nurses and community pharmacists, to prescribe or dispense antibiotics typically for self-limiting infections (22, 28). Effectively addressing these issues is essential to reducing AMR in LMICs, including African countries, with primary care accounting for up to 95% of antibiotic use in humans (29, 30).

Potential ways forward to reduce the unnecessary prescribing of antibiotics in primary care across Africa are discussed in *Section 2*, which is based on the considerable knowledge of the co-authors working across Africa. This includes improved education of prescribers, with Balliram et al. (63) stating that educational campaigns targeted at key prescribers, use of and adherence to standard treatment guidelines (STGs)/essential medicine lists, and improved infection control measures are all seen as important strategies to combat AMR.

2 Policy options and the implications for reducing unnecessary prescribing of antibiotics in ambulatory care across Africa

A number of policy options have been proposed to reduce the unnecessary prescribing of antibiotics across Africa (21). These are summarized in Table 3, triangulating available evidence with the resultant implications and potential outcomes included within actionable recommendations. This does not include requests by patients for antibiotics without a prescription (22, 25, 64) or targeted educational campaigns among patients to reduce unnecessary requests to prescribers for antibiotics, especially for self-limiting conditions, which are discussed in Saleem et al. (22) and in Ramdas et al. (65). These key areas are also being explored further in future research projects. However, examples of ASPs undertaken among patients to reduce unnecessary requests and the use of antibiotics are included in Table 4. We are aware that there are concerns with the available funding and personnel in LMICs to undertake ASPs (66). In addition, issues with the limited availability of antibiotics in a number of primary healthcare centers (PHCs) across LMICs, which is exacerbated by challenges in stock control management and procurement, are barriers to the instigation of ASPs. Ongoing resistance to changing antibiotic prescribing practices, and lack of information technology to guide and monitor prescribing habits, as well as limited interprofessional collaboration, are also barriers to the successful implementation of ASPs. The lack of enforcement of possible policies, including routinely documenting and auditing prescribing practices and the lack of robust and well-researched antibiotic guidelines, are also seen as barriers to the successful implementation of ASPs in LMICs (21, 67–70). However, we are seeing an increasing number of ASPs now being undertaken across all sectors of care among African countries to improve future antibiotic use, which will continue and provide exemplars for the future (22, 71–74).

However, to improve future antibiotic prescribing across Africa, all suggested activities must be underpinned with dedicated, ring-fenced, and sustainable funding mechanisms. These include educational activities in universities and post-qualification, NAPs, and ASPs (15, 66, 75, 76). Alongside this, assess and potentially increase funding to address the 40 global research priorities identified by the WHO to reduce AMR among humans, which build on the GAP for AMR (17, 77, 78). We are beginning to see LMICs start to document their progress toward addressing the WHO research priorities, and this is

TABLE 1 Examples of inappropriate prescribing of antibiotics in ambulatory care among African countries.

Country	Author(s) and year	Key findings
Pan-Africa	Wieters et al., 2024 (31)	• Among 19,700 patients visiting rural health facilities in Burkina Faso, Côte d'Ivoire, DRC Congo, and South Africa, 36.8% had been prescribed antibiotics in the previous 10 days, with 41.5% prescribed for RTIs, 30.3% for acute febrile disease of unknown cause (AFDUC), and 22.6% for GI infections. • A higher number of enrolled patients in Burkina Faso had RTIs and AFDUC treated with antibiotics: 47.0% and 35.6%, respectively. • The most common antibiotic prescribed was ceftriaxone (31.7% of antibiotics prescribed—higher in Burkina Faso at 48.2% of all antibiotics taken), with Watch antibiotic use ranging from 17.4% among RTI patients in Côte d'Ivoire to 73.7% (630/855) among AFDUC patients in Burkina Faso. • Reported antibiotic use also included antibiotics from the WHO "Not recommended" group; however, no Reserve antibiotics were prescribed. • Amoxicillin/clavulanic acid was the most commonly prescribed antibiotic for RTIs, particularly in Côte d'Ivoire (32.3%) and Burkina Faso (41.4%).
Burkina Faso	Sie et al., 2021 (32)	• Among 61,355 children's visits to PHCs, 50.5% received an antibiotic. Of the antibiotics, 76% were prescribed for pneumonia, malaria, diarrhea, dysentery, fever, or cough—higher during the rainy season. • The highest rate of antibiotic prescribing was for children with pneumonia (97.1%) and dysentery (91.9%). • Overall, amoxicillin was the most commonly prescribed antibiotic for children with pneumonia and metronidazole/ciprofloxacin for children with dysentery. In addition, approximately 20.0% of children received an antibiotic for non-bloody diarrhea, mostly for ciprofloxacin (14.9% of the non-bloody diarrhea diagnoses).
	Valia et al., 2024 (33)	• Among 2,196 patients interviewed, 2,108 had acute illness, with the vast majority (67.9%) attending health centers, principally outpatients (87.3%). Antibiotics were more frequently prescribed at health centers (54.8%) *versus* formal pharmacies (26.2%, $p < 0.001$). • Among the antibiotics prescribed for patients visiting health centers, 85.2% were Access and 14.8% Watch antibiotics. • There was high prescribing of antibiotics in health centers for bronchitis (92.0%) and undifferentiated fever (72.1%). • Overall, the frequency of antibiotic use was highest for patients with bronchitis (79.9% antibiotic use, 12.6% Watch), undifferentiated fever (77.0%, 44.8% Watch), gastroenteritis (76.0%, 31.7% Watch), rhinopharyngitis (40.4%, 8.3% Watch), and malaria (31.9%, 23.1% Watch). • Compliance with the WHO AWaRe guidance would have averted at least 68.4% of all Watch antibiotic use.
DRC Congo	Kakumba et al., 2023 (34)	• Overall, 400 medical prescriptions were collected and analyzed from surrounding drug stores, with 75.2% of the prescriptions analyzed containing at least one antibiotic. • The majority of prescriptions (54.5%) contained one antibiotic, with 38.9% containing two antibiotics, with the remainder three or more antibiotics. • Of concern is that 43.2% of the antibiotics prescribed were from the Watch group, with only 36.5% being from the Access group. In addition, 20.3% of the antibiotics prescribed were from the "not recommended" antibiotic group.
Ethiopia	Abebe et al., 2024 (35)	• The authors analyzed patterns of antibiotic prescribing in ambulatory care, with 911 prescriptions analyzed for their appropriateness. • A total of 2,640 antibiotics were included in these prescriptions, with 55.3% of all prescriptions analyzed containing at least one antibiotic. • Overall, 49.54% of the antibiotics prescribed were non-compliant with the national treatment guidelines, with inappropriate prescribing significantly higher among those patients prescribed co-amoxiclav.
Ghana	Sefah et al., 2021 (36)	• The medical records of 1,929 patients with a diagnosis of community-acquired pneumonia (CAP) were reviewed concerning adherence rates to the current treatment guidelines. • The overall adherence rate to current CAP guidelines was suboptimal at only 32.50%. • Adherence rates to CAP guidelines were associated with the duration of antibiotic prescribing, the number of additional antibiotics prescribed, and the clinical characteristics, i.e., findings from chest X-rays and respiratory symptoms.
Kenya	Mekuria et al., 2019 (37)	• Analysis of claims data among 36,210 clinic visits involving 21,913 patients to ascertain the extent of antibiotic prescribing for patients with acute respiratory infections (ARIs) • URTIs were the most common diagnoses (39.7%), followed by other acute ARIs at 24.9%, with antibiotics prescribed in 78.5% of the patients diagnosed with ARIs. • The most prescribed antibiotics among patients presenting with ARIs were amoxycillin (45%) and azithromycin (12.5%). • High rates of antibiotic prescribing were enhanced by high patient workloads, as well as patient

(Continued)

TABLE 1 Continued

Country	Author(s) and year	Key findings
		and prescriber perceptions that antibiotics should be prescribed for ARIs, alongside the absence of any policies/current guidelines.
Lesotho	Letša et al., 2025 (38)	• Point prevalence survey of the notes of 624 patients attending PHCs in Lesotho between October and December 2022 • Overall, 898 medicines were prescribed, most frequently for URTIs (51.0%–67.1%) and UTIs (20.1%–33.8%), with patients diagnosed with URTIs (n = 624) typically prescribed amoxicillin or co-amoxiclav (36.5% and 20.4%, respectively). This is despite current guidelines stating URTIs—including influenza and common colds—as self-limiting, consequently do not warrant antibiotics. • Patients diagnosed with UTIs were typically prescribed ceftriaxone (10.7%), doxycycline (10.4%), metronidazole (10.3%), and erythromycin (4.8%). • Access antibiotics (68.7%–94%) were principally prescribed *versus* Watch antibiotics (6.0%–30.6%), with no Reserve antibiotics prescribed. • Despite low prescribing of Watch antibiotics, the use of these antibiotics needs close monitoring in the future alongside reducing the overuse of antibiotics for self-limiting conditions through ASPs and other mechanisms.
Madagascar and Senegal	Ardillon et al., 2023 (39)	• Overall, 29.3% of consultations among children seated in outpatients across three LMICs, including Madagascar and Senegal, resulted in antibiotic prescriptions in outpatient departments typically for rhinopharyngitis and bronchiolitis. • An appreciable number of prescriptions were subsequently evaluated not to require antibiotics, ranging from 71.5% in Madagascar to 73.9% in Senegal. • Cefixime was the most frequently prescribed inappropriate antibiotic in Senegal and amoxicillin in Madagascar. • Factors associated with the inappropriate prescribing of antibiotics included the patient's age greater than 3 months and rural *versus* urban settings.
Malawi	MacPherson et al., 2022 (40)	• Based on 1,348 patient consultations at 22 ambulatory care facilities, coupled with 49 in-depth interviews with staff and patients, care was typically centered around the prescribing of antimicrobials, with patients seeing medicines as an essential part of visiting these facilities. • However, healthcare facilities were often short of medicines, including antibiotics, necessitating either a change in prescribing or the prescriptions being obtained from private pharmacies. • High rates of antibiotic prescribing were exacerbated by limited time with each patient (typically 200 patients/clinic), as well as fear of criticism/disapproval from patients for not prescribing medicines including antibiotics, especially where there are shortages of antibiotics in clinics.
Nigeria	Ogaji et al., 2023 (41)	• Overall, among the participating PHCs, 3,805 medications were prescribed for 1,300 patient encounters, giving 2.9 (±0.5) medications prescribed/encounter. • Antibiotics were the most prescribed medicines—contained within 62.6% of the prescriptions—substantially higher than the WHO recommendations of 20%–26.8% among PHCs. • As a result, low scoring on an antibiotic rationality index, exacerbated by the majority of prescribers not undertaking regular audits of their antibiotic prescribing habits.
South Africa	Gasson et al., 2018 (42)	• Assess antibiotic prescribing in ambulatory care involving the review of 654 patient records • Overall, 68.7% of patients had been prescribed an antibiotic during their visit, with typically low adherence rates to the current treatment guidelines at only 45.1% of the prescriptions. • Adherence differed appreciably between the surveyed facilities and age, e.g., whether the prescription was for a child or an adult. • A number of reasons were identified for non-adherence to current guidelines. These included undocumented diagnoses (30.5% of the prescriptions), antibiotics not needed/required (21.6%), incorrect dosing of antibiotics (12.9%), incorrect duration of therapy (9.5%), and incorrect treatment (1.5%).
	Truter and Knoesen 2018 (43)	• Of the community pharmacists surveyed, 81.3% believed that antibiotics were being overprescribed by physicians. This included for viral infections—with URTIs and sinusitis seen as the most common infectious diseases for which antibiotics were being prescribed—exacerbated by pressure from patients. • Amoxicillin/co-amoxiclav was the most prescribed antibiotics, followed by azithromycin, clarithromycin, and ciprofloxacin.
	Lagarde and Blaauw 2023 (44)	• There were 102 simulated patients (SPs) presenting with viral bronchitis in public sector PHCs and 99 physicians in the private sector alongside interviewing 125 HCPs across the sectors. • Antibiotics were recommended in 72.6% of the SP consultations, higher in the public sector (78.4%) compared with the private sector (66.7%)—influenced by perceived patient pressure to prescribe antibiotics for this condition. This was despite the majority of prescribers knowing that the condition—viral bronchitis—would not be influenced by antibiotics, i.e., would not hasten recovery. • Of the patients who received antibiotics in the public sector, 91% were prescribed amoxicillin,

(Continued)

TABLE 1 Continued

Country	Author(s) and year	Key findings
		with higher rates of Watch antibiotics (20%) in the private sector. • Overall, 47% of public PHCs and 72% of private physicians believed that patients would not come back if no antibiotics were prescribed, despite SPs not demanding antibiotics.
	Chigome et al., 2025 (45)	• Among 615 patients surveyed in PHCs using an easy-to-use handheld device (46), the most common symptoms where antibiotics were prescribed included genital discharge (21.8%), painful urination (n = 8.4%), acute cough (17.7%), and a sore throat (13.5%). • Overall, at least one antibiotic was prescribed for 87.0% of patients, with 53.4% being Access antibiotics and 46.6% Watch antibiotics. These high rates of utilization of Watch antibiotics are reflected in the growing utilization of Watch antibiotics generally in the public healthcare system in South Africa, accounting for 52% of the total consumption in 2022 (47). • Ceftriaxone (29.7%), amoxicillin (29.4%), azithromycin (28.4%), and metronidazole (27.7%) were the most prescribed antibiotics.
	Van Hecke et al., 2025 (48)	• Eight out of 10 patients presenting to PHCs were prescribed an antibiotic for an "acute cough." • Of the antibiotics prescribed, 97.6% belong to the Access group. • Antibiotic prescribing improved following auditing by pharmacists and subsequent feedback communication with prescribers (Table 4).
Tanzania	Wiedenmayer et al., 2021 (49)	• An assessment of the antibiotic prescribing practices among 120 randomly selected public PHCs and 2,886 patient case files ascertained that the most common infectious diseases seen in PHCs were URTIs (25%), malaria (18%), diarrhea (9.9%), and pneumonia (6.1%). • Of concern is that the adherence to current guidelines for all infectious diseases analyzed was only 29.9%, with partial adherence seen in 38.7% of cases and non-adherence in 30.9% of cases, with the highest rates of non-adherence rates seen in patients with URTIs and diarrhea. • Of the patients seen in PHCs, 61% were prescribed an antibiotic regardless of their diagnoses, increasing the non-adherence rates, with the wrong medication given in 30.9% of cases.
	Khalfan et al., 2022 (50)	• Analysis of the records of 993 insured patients revealed that 46.4% were prescribed an antibiotic—greatest for children (65.4%) *vs*. adults (45.2%) and in lower-care facilities (77.0%). • Greater prescribing of antibiotics among assistant medical/clinical officers compared with physicians or specialists. • Of concern was that the prevalence of being prescribed an antibiotic was approximately four times higher in those patients presenting with chronic rhinitis, nasopharyngitis, or pharyngitis *versus* other indications.
	Mabilika et al., 2022 (51)	• Key findings from 1,021 consultations principally in public PHCs revealed that an antibiotic was prescribed in 76.3% of consultations, with amoxicillin and cotrimoxazole accounting for over 60% of the antibiotic prescriptions. • The most common diagnoses were URTIs (30.3%) and UTIs (12.1%), with prescribing of antibiotics by clinical officers almost 2.55 times greater than seen among physicians. Overall, only 44.9% % of antibiotic prescriptions adhered to current STGs.
Uganda	Obakiro et al., 2022 (52)	• An analysis of 4,312 observations in outpatient clinics showed high rates of non-adherence to current guidelines (82.6% non-adherence), with male HCPs twice as likely to not adhere to the current guidelines compared to female prescribers. • Genitourinary diseases (26.9%) and respiratory diseases (20.9%) were the most common infectious diseases seen, with penicillins (32.6%) being the most frequently prescribed antibiotics, followed by macrolides (7.2%).
	Igirikwayo et al., 2024 (53)	• An analysis of 1,542 medical records of patients with RTIs visiting hospital outpatients, along with interviews with HCPs, revealed high rates of inappropriate antibiotic prescribing—79.8% of outpatients were prescribed antibiotics for their RTIs, including 8.13% of the total for common colds. • Overall, 86.6% of the prescribed antibiotics are from the Access group, with 13.4% from the Watch group. Among the Watch group, azithromycin (4.56% of all antibiotics) and erythromycin (3.9%) were the most prescribed. • Encouragingly, HCPs who had access to training and current guidelines were less likely to prescribe antibiotics.
Zimbabwe	Olaru et al., 2021 (54)	• Among 91 HCPs taking part in a survey, the decision to prescribe antibiotics to patients was mainly influenced by their clinical presentation and laboratory results (98% of surveyed HCPs) alongside the severity of the illness (89%) and information on the national guidelines (97%), with these guidelines typically being the principal source for guiding prescribing (93%). • However, 89% of HCPs prescribed antibiotics to a patient with symptoms suggestive of a viral RTI, and only 8% of HCPs very often and 9% often believed they unnecessarily prescribed antibiotics despite evidence of overuse of antibiotics in the country.

AMR, antimicrobial resistance; *AMS*, antimicrobial stewardship; *AWaRe*, Access, Watch, Reserve; *ARIs*, acute respiratory tract infections; *GI*, gastrointestinal. *HCPs*, healthcare professionals; *PHCs*, primary healthcare centers; *RTIs*, respiratory tract infections; *URTIs*, upper respiratory tract infections; *UTIs*, urinary tract infections; *ASPs*, antimicrobial stewardship programs; *LMICs*, low- and middle-income countries; *HCPs*, healthcare professionals; *STGs*, standard treatment guidelines.

TABLE 2 Examples of concerns with knowledge of antibiotics, antimicrobial resistance (AMR), and antimicrobial stewardship (AMS) among prescribers in ambulatory care across Africa.

Country	Author(s) and year	Findings
Gabon	Adegbite et al., 2022 (55)	• Among 47 HCPs, 64% believed that AMR is a problem in their country, with 30% stating that AMR is a problem in their health facilities. • Knowledge of the possible causes of AMR spread was limited among participating HCPs, which was further compounded by the fact that 55% had not received any recent training on appropriate antimicrobial prescribing.
Ghana	Sefah et al., 2023 (56)	• A cross-sectional survey involving 339 HCPs ascertained that the majority of participants had poor knowledge (91.2%) and poor practice (64.6%) toward AMS. However, encouragingly, 78.8% stated that they have a good attitude toward AMS. • Ongoing exposure to AMS structured training and CPD training regarding AMS in the previous year, coupled with the number of years of working experience, were predictors of HCPs' KAP. • The authors concluded that concentrated efforts are needed by universities and others to address the current low levels of knowledge and poor practices with respect to AMS among HCPs in Ghana.
Nigeria	Chukwu et al., 2021 (57)	• Among 358 HCWs, 49.2% had good knowledge of AMR based on self-administered questionnaires, with physicians having significantly greater knowledge of key issues than other HCWs. In addition, 70.9% stated that they frequently or moderately used STGs. • Despite 70.9% of the participating HCWs stating that they frequently or moderately used STGs to guide prescribing practices, 50.3% agreed that their prescribing behavior could promote AMR. • In addition, HCWs stated that they prescribed antibiotics for viral infections, which included sore throats (75.7%) and measles (37.7%), as well as a common cold and influenza (21.2%). Of the surveyed HCWs, 60.3% also admitted prescribing antibiotics to patients just to be on the safe side.
Sierra Leone	Kabba et al., 2020 (58)	• An assessment of knowledge and attitudes toward antibiotics among 119 doctors revealed that 68% believed antibiotics may speed up recovery from a cough or cold, with 21% believing this when antibiotics are prescribed for patients with malaria. • Overall, children <5 years of age were more likely to be prescribed an antibiotic for their infectious disease than pregnant women/lactating mothers.
	Koroma et al., 2024 (59)	• Among 337 HCWs, there was overall good knowledge of antibiotics among these workers based on a pre-tested questionnaire, with the highest overall level of knowledge among medical doctors. • While 91% and 94% of HCWs respectively strongly agreed and 72% agreed that antibiotic resistance is a problem worldwide, as well as in Sierra Leone/their health facilities, with 98% strongly agreeing/agreeing that STGs are useful for guiding prescribing, 80% of the HCWs surveyed had not received any form of training on AMR in the past year. • However, despite a high percentage (87%) strongly agreeing/agreeing that excessive antibiotic use increases AMR, 51% of the surveyed HCWs had prescribed antibiotics because they were uncertain of the diagnosis, with 41% strongly agreeing that antibiotics are indicated for most infectious diseases.
South Africa	Farley et al., 2018 (60)	• A study to assess the knowledge, attitudes, and practices toward antibiotics and AMR among 264 primary care prescribers found that 95.8% believed that antibiotic resistance is a major problem in South Africa. • However, 66.5% of those surveyed felt pressure from patients to prescribe antibiotics for their patients' infectious disease irrespective of the need for an antibiotic, and 87.5% expressed a desire for more education on appropriate antibiotic use. • Of prescribers, 96.2% also requested more data on local resistance patterns, with prescribers also showing interest in the STGs being provided in various formats to enhance their use.
Uganda	Kagoya et al., 2021 (61)	• All 56 HCPs interviewed as part of this study believed that they did not have sufficient knowledge regarding the burden/impact of AMR. • They also typically admitted not having time to discuss/share information they had with patients regarding the correct use of antibiotics. • Interviewed HCPs also had healthcare workers demanding antibiotics from them for their use/use in their community, exacerbated by high rates of poverty making antibiotics typically unaffordable from private pharmacies.
Zambia	Kalungia et al., 2019 (62)	• Among 137 physicians and 61 pharmacists taking part in the study, there were concerns that, despite positive perceptions toward antibiotics, the basic knowledge of AMS was relatively low among participating physicians (51%)—although knowledge levels were significantly associated with years of practice and previous AMS training. • Having said this, 92% of the participating physicians had not undertaken any AMS training before the study.

AMR, antimicrobial resistance; *AMS*, antimicrobial stewardship; *CPD*, continual professional development; *HCPs*, healthcare professionals; *HCWs*, healthcare workers; *STGs*, standard treatment guidelines; *KAPs*, knowledge, attitudes, and practices.

TABLE 3 Possible policy options to improve future prescribing of antibiotics in ambulatory care across Africa.

Policy options	Activities/implications
Improved education of all HCPs (trainee and post-qualification)	• Published studies have demonstrated considerable concerns among African countries regarding undergraduate HCPs' knowledge and attitudes toward antibiotics, AMR, and AMS (21, 22). This needs to be addressed going forward to improve future prescribing/dispensing of antibiotics across all sectors in Africa. This will involve all universities across Africa training HCPs to continually critically evaluate their current curricula to determine if they meet current needs and standards, overseen by appropriate government departments including Ministries of Health and Education. • There are similar implications for improving continuous professional development (CPD) activities post-qualification given ongoing concerns (Tables 1, 2), with universities needing to work with national physician/nursing groups and the Department of Health within governments across Africa to make sure CPD activities are "fit-for-purpose." Otherwise, updated as necessary. This builds on, for instance, recent activities by the South African government to improve knowledge about antibiotics and AMR among HCPs (82). • Universities must also work with national physician groups and the Department of Health within governments across Africa to provide simple short guidance on the management of typical infectious diseases seen in ambulatory care, including medicines other than antibiotics, based on the WHO AWaRe book (20, 83). These could include infographics and summary key points to enhance their understanding of suggested treatment approaches and be available in readily accessible electronic formats (22). This is seen as critical across, with a recent review of antibiotic guidelines available among LMICs demonstrating critical deficiencies in their development (67). Challenges can be addressed by basing future antibiotic guidelines among African countries on the WHO AWaRe guidance and subsequently adapted according to local AMR patterns (67, 84). • Following this, universities need to work with national physician and nursing groups, as well as pertinent government personnel, across Africa to provide an AWaRe-ness training series. This can include talks/webinars, and other approaches, based on the WHO AWaRe guidance book and system relevant to each prescriber group (22). • In addition, academics and others need to address the current low levels of knowledge and poor practices with respect to antibiotics and AMS among prescribers (Table 1) and subsequently work with prescribers and others to assess the effectiveness and cost-effectiveness of any ASPs undertaken and linked to data on local resistance patterns. • Trainee/qualified HCPs also need to be aware when discussing the management of infectious diseases with patients that there can be language difficulties with terms such as antibiotics and AMR potentially not existing in the patient's primary language (85, 86). Awareness of these key issues and how they can be addressed also need to be included in future university curricula (87).
Development and monitoring of potential quality indicators	• Previous research conducted in Namibia has shown that adherence to guidelines, with associated indicators, provides greater insights into the quality of care provided, including antibiotic prescribing, compared with the previous WHO INRUD criteria (88, 89). • A number of quality indicators (QIs) have been developed principally based on the AWaRe system (90). Following this, a number of QIs have now been proposed for use within PHCs across LMICs. These include (90–98): o Percentage of antibiotic prescriptions adherent to local standard treatment guidelines and the essential medicines list including for self-limiting conditions such as URTIs, including acute coughs and influenza o Percentage of antibiotic prescriptions without a documented clinical indication o Proportion of Access antibiotics *versus* Watch and Reserve antibiotics for systemic use, relative to the total antibiotic prescriptions o Percentage of antibiotic courses prescribed at the recommended dose, frequency, and duration o Proportion of co-amoxiclav prescriptions relative to the total antibiotic prescriptions o Number of patients with acute otitis media, with symptoms for less than 3 days (72 h), treated with an antibiotic • The next step is to refine and pilot context-appropriate quality indicators within the African PHC systems to guide future rational antibiotic prescribing in the continent. Subsequently, testing agreed quality indicators as part of ASPs within PHCs—taking note of the necessary information technology (IT) and other requirements for continual monitoring and education. Such initiatives will involve all key stakeholders as part of any rollout plans, including the Department of Health and physician and nursing groups.
Implementing ASPs and assessing their effectiveness and cost-effectiveness	• Evidence from LMICs, including several African countries, demonstrates that ASPs can significantly improve antibiotic prescribing in ambulatory settings (Table 4). • Future ASPs need to be based on the WHO AWaRe system and guidance using relevant QIs for the situation and the country to improve future prescribing (48, 90, 99), with increasing use of the AWaRe system and guidance to improve future prescribing (22, 48, 100). Such initiatives will necessarily involve all key stakeholders as part of any rollout plans, including the Department of Health and physician groups. • As part of developing ASPs in ambulatory care in LMICs, there is a need for academics to combine with prescribers and others to assess the effectiveness and cost-effectiveness of ASPs building on previous studies (Table 4). The findings will help guide future ASP activities assisted by the Department of Health and physician/nursing groups.

AMR, antimicrobial resistance; *AMS*, antimicrobial stewardship; *ASP*, antimicrobial stewardship programs; *AWaRe*, Access, Watch, and Reserve (101); *HCPs*, healthcare professionals; *HCWs*, healthcare workers; *LMICs*, low- and middle-income countries; *PHCs*, primary healthcare centers; *INRUD*, International Network for the Rational Use of Drugs; *WHO*, World Health Organization.

likely to continue, driven by governments and others especially given the urgency to reduce AMR across LMICs (79). Nurses typically play a key role in managing patients within public PHCs across Africa; consequently, they are a critical group to also include in policy initiatives to improve future antibiotic prescribing (22, 80, 81).

3 Actionable recommendations

Actionable recommendations were based on their impacts in published studies across LMICs combined with the considerable experience of the co-authors. These include more general

TABLE 4 Antimicrobial stewardship programs (ASPs) and their impacts among both prescribers and patients across low- and middle-income countries (LMICs) including African countries.

Recommendation	Country, reference and target audience	Supporting information
Implementing/auditing STGs alongside education	Benin and Nigeria (102)—patients	• Evaluate and compare the impact of two educational interventions on knowledge of antibiotics and their use among pediatric home caregivers: one-to-one educational inputs or group inputs • One-on-one education had a greater impact on pediatric caregivers than group education; however, improvements were seen in both groups in key issues: o Before education: 81.7% of participants believed that antibiotics could treat malaria infection—reduced to 13.3% after education o Before education: 71.7% of respondents agreed that antibiotics could be used to treat all kinds of diarrhea and 65% that antibiotics in powder form can be reconstituted with hot or warm water before use—reduced to 11.7% after education
	Egypt (103)—physicians and patients	• The ASP included a 5-day training course alongside structured surveys with physicians presented with three clinical scenarios that did not warrant antibiotics. • There were also targeted educational campaigns for patients via social media. • The mean knowledge of physicians supporting the judicious use of antibiotics increased from 3.8 ± 0.5 to 4.0 ± 0.7 following the course. • Among parents of children and parents, the knowledge and attitude scores increased from 2.3 to 2.5 and from 2.4 to 2.6, respectively. • Their understanding that many people are unnecessarily treated with antibiotics improved—the mean scores increased from 2.9 to 3.3 and from 2.7 to 3.4, respectively, i.e., parents of children increasingly believed that antibiotics are unnecessary when the nasal discharge in their children turns from yellow to green. • Overall, there was a 25% decrease in antibiotic prescribing for children post-intervention, with the self-reported percentage of physicians who never prescribe antibiotics for colds increasing from 35.4% to 64.4%, and decreasing for bronchitis (from 65.8% to 28.4%) and sinusitis (from 43.5% to 17%).
	Eswatini (104)—prescribers	• After implementing STGs in Eswatini along with education, there was a significant decrease in the proportion of patient visits to PHCs where an antibiotic was prescribed ($p < 0.001$). • Alongside this, the prescribing of antibiotics for incorrect indications decreased from 20.4% in the initial period to 10.31% and 10.2% in subsequent periods. • In addition, incorrect dose/duration of antibiotics prescribed decreased from 10.47% in the initial period to 7.37% and 3.1% in subsequent periods, with all prescribers believing the introduction of STGs positively influenced their future prescribing of antibiotics.
	Kenya (105)—prescribers	• Changes in antibiotic use were assessed for treating common infections in PHCs following educational input, including guideline booklets coupled with continuing medical education along with feedback to improve antibiotic use. • Overall, 889 patient encounters in nine participating centers were analyzed to understand antibiotic use for common infections and assess adherence to STGs. • Antibiotics were prescribed in 94.3% of patient encounters across the four infectious diseases: highest for URTIs (97.3%) and lowest for GI infections (91.73%). • While feedback did not affect the number of antibiotics being prescribed, for, e.g., UTIs, the use of nitrofurantoin (appropriate narrow-spectrum antibiotic) increased from 9.2% to 29.9%, while the use of quinolones decreased from 30.0% to 16.1% ($p < 0.05$).
	Namibia (25, 106–108)—principally patients	• Ongoing training of pharmacists at universities regarding antibiotics and AMR, coupled with regular monitoring of their activities along with good access to PHCs, resulted in: o Recommending to parents that children under 5 with acute respiratory tract infections should be treated with cold/flu medicines, paracetamol and decongestants—with no dispensing of antibiotics without a prescription to these children in the study of Kamati et al. (106). o Advice to patients fearing/presenting to community pharmacies in Namibia with COVID-19 in the early stages of the pandemic including

(Continued)

TABLE 4 Continued

Recommendation	Country, reference and target audience	Supporting information
		education on prevention alongside potential symptomatic relief. There was no dispensing of antibiotics without a prescription among community pharmacies in the study by Kibuule et al. (107). This is in contrast with a number of other African countries where antibiotics were dispensed for actual or suspected COVID-19.
	South Africa (48)—prescribers	Following auditing of PHC prescriptions and subsequent feedback to prescribers via group messaging services, there was improved prescribing of antibiotics—the proportion of pharmacy-dispensed antibiotics that agreed with local STGs in terms of the quality of prescribing increased to 95%.
Implementing ASPs	Ghana (109)—prescribers	• Among 142 patients assigned to different groups to improve AMS in LMICs; Group 0—61 patients with no antibiotic prescription given for a URTI; Group 1—16 patients who received a postdated antibiotic prescription for a URTI; Group 2—44 patients offered a rapid reassessment of their condition by a prescriber after 3 days; and Group 3—21 patients given a postdated prescription, with the most common diagnosis being a sore throat (73%) • Only 1 out of 21 patients in Group 3 took antibiotics after 3 days. • Overall, among 141 patients contacted on day 10, 72% rated their experiences as good or very good. • Alongside this, informal discussions with staff after the AMS study revealed improved knowledge regarding AMR. • The authors concluded that an AMS strategy involving delayed/backup prescribing can be implemented safely in LMICs without compromising care.
	South Africa (92)—prescribers	• Multidisciplinary audit and monthly feedback meetings undertaken among 13 PHCs to improve future antibiotic prescribing. Key indicators included adherence to current STGs. • The mean overall level of adherence to current STGs increased from a baseline of 11% to 53% over a 2-year period, although the adherence to STGs was significantly lower in the winter and spring, potentially reflecting inappropriate antibiotic prescribing due to increased viral ARIs in this period. • An appreciable rise in correct prescriptions ($p < 0.001$) was seen following the ASP, increasing from a mean of 19% in the first 6 months (mean) to 47% in the last 6 months of the study. • Alongside this, there was a 19.3% decrease in antibiotic use over the study period.
	Zanzibar (110)—prescribers	• ASP was introduced to evaluate the impact of a performance-based financing model to improve antibiotic prescribing-based quality indicators allied to STGs, with PHCs randomized between two active and controls alongside vigorous verification of antibiotic prescribing habits. • The ASP resulted in a fall in the number of patients not treated in accordance with STGs. The number of patients decreased to 2%, 6%, and 5% in 2014, 2015, and 2016, respectively, among active facilities *versus* an increase from 25% (2013) to 31% (2014) and 22% (2015 and 2016) among the control facilities. • The authors concluded that rigorous monitoring of prescriber habits among patients with infectious diseases is needed for a sustained reduction in the proportion of unnecessary antibiotic prescriptions in primary care.
Improving knowledge of prescribers regarding antibiotics and AMR	Ethiopia (111)—prescribers and patients	• Concerns with the prescribing of antibiotics among ambulatory care physicians • Surveyed physicians (185) admitted prescribing antibiotics for 54.8% of weekly outpatient encounters with patients, with 96.2% of the participating physicians estimating they prescribed antibiotics for patients with URTIs. • Overall, physicians with good knowledge of antibiotics and AMR based on the questionnaire were less affected by perceived social pressures from patients than physicians with assessed poor knowledge, and they felt it was easier to make rational prescribing choices regarding antibiotics *versus* physicians with poor knowledge.

AMR, antimicrobial resistance; *AMS*, antimicrobial stewardship; *ASP*, antimicrobial stewardship programs; *ARIs*, acute respiratory infections; *PHCs*, primary healthcare centers; *STGs*, standard treatment guidelines; *URTIs*, upper respiratory tract infections; *UTIs*, urinary tract infections.

TABLE 5 Actionable recommendations.

Actionable recommendation	Details
HCP education	• Ensure all trainee HCPs leave African universities fully conversant with the WHO AWaRe classification and guidance, as well as the key aspects of AMS and ASPs, and followed up with continuous professional development activities post-qualification (21, 22, 83, 112, 113). This will be driven by key groups within African countries, including Department of Health personnel and universities. • This will necessitate a review and an update of the current curricula among African universities currently training HCPs, especially with respect to reducing antibiotic prescribing for essentially self-limiting infections and Watch antibiotics (14, 22, 114). • HCPs will also need to be aware of possible language difficulties, particularly if there are no terms for antibiotics, AMR, or AMS in the local language. In addition, some African countries have multiple languages. South Africa has 11 national languages (85). This again will necessitate Department of Health and physician/nursing groups working together.
Develop a key set of practical quality indicators based on the WHO AWaRe system/guidance	• Develop a key set of practical and applicable quality indicators to improve the quality/appropriateness of future antibiotic prescribing at the individual and facility levels and their clinimetric properties assessed using robust techniques (93, 115). This will necessitate the Department of Health alongside national physician/nursing groups working together. • Future quality indicators should be based on the WHO AWaRe system/guidance (83, 90) and tested as part of proof-of-concept within targeted PHCs where antibiotic prescribing has been a concern, e.g., among PHCs in South Africa (45, 112). • Subsequently, followed up in practice as part of agreed ASPs (Table 4) using easy-to-use electronic tools in order to monitor prescribing habits in real-time and provide additional educational inputs, where needed (46). • This can include introducing electronic prescribing systems, coupled with clinical decision support tools, to improve prescribing in real-time given time concerns with paper-based systems (116–118). This will also necessarily involve government input. • Such activities have worked well in high-income countries to improve prescribing (119–121) and can serve as exemplars to African countries.
Implement audit and feedback mechanisms in PHCs as part of ASPs	• Audit and feedback interventions as part of improving prescribing, and as part of ASPs, can help improve future antibiotic prescribing. This can be part of collaborative approaches between different HCPs, e.g., pharmacists monitoring antibiotic prescribing in primary care and feeding back the findings to prescribers on a regular basis to help address current challenges (48, 70, 116). • Audit and feedback tools appropriate for PHC facilities should be carefully designed, taking into consideration contextual factors that may affect their successful implementation. This will necessarily involve the Department of Health and physician/nursing groups working together. • Key features include achievable targets, guidance and resources, including all PHC prescribers, and integrating into the primary healthcare system (92, 116, 122, 123).
Improve surveillance of local AMR patterns in ambulatory care and antibiotic stock controls in PHCs	• Improve antibiotic surveillance systems and integrate the findings into updated regional prescribing guidance based on adapted AWaRe guidance (83, 113). Governments/Department of Health personnel are critical here. • Ensure that essential antibiotics, as outlined in the WHO AWaRe guidance, are consistently available at PHCs through improved forecasting and stock management (68, 124). As a result, avoid prescribing inappropriately and/or patients having to purchase prescribed antibiotics from community pharmacies, including the full course, especially where affordability is an issue (21). • Possible shortages of key antibiotics can be reduced by improving the supply chains and encouraging only a limited number of antibiotics, and their doses, to be prescribed, in line with the WHO AWaRE recommendations as part of ongoing ASPs, as a result reducing possible costs and issues of affordability through reducing the production costs (21, 22, 125, 126).
Continue to promote research in Africa on key issues relating to antibiotics, AMR, and AMS	• The WHO has identified 40 global research priorities to reduce AMR among humans building on the Global Action Plan for AMR (17, 77, 78). • The research priorities include identifying optimal methods and metrics to better monitor antibiotic prescribing and dispensing in ambulatory care, determining the key drivers of inappropriate utilization of antibiotics based on the AWaRe system and guidance to target future ASPs, alongside improving the surveillance of local resistance patterns and their communication, and developing future methods and metrics to improve future prescribing. • Such activities can build on examples across LMICs and is seen as increasingly important to reduce AMR among critical African countries (79). • There is a need to subsequently assess the effectiveness and cost-effectiveness of different approaches with the help of academic institutions in Africa.
Seek ways to improve financing of key activities associated with NAPs, including ASPs addressing current legislative and regulatory gaps	• Government/Department of Health personnel need to identify and incorporate sustainable financing mechanisms for NAPs and ASPs into future activities given current concerns and address system-level barriers to the effective implementation of ASPs (15, 66, 75, 76). However, the number of ASPs in ambulatory care across LMICs is growing to provide future guidance (Table 4). • Sustainable funding for NAPs and ASPs, as well as the monitoring of agreed activities, is important going forward to reduce AMR across Africa.

HCPs, healthcare professionals; *AMR*, antimicrobial resistance; *AMS*, antimicrobial stewardship; *ASPs*, antimicrobial stewardship programs; *AWaRe*, Access, Watch, and Reserve (101); *LMICs*, low- and middle-income countries; *PHCs*, primary healthcare centers; *NAPs*, National Action Plans.

recommendations (Table 5) and among prescribers and patients along with ASPs, with the impact of ASPs documented in Table 4. Table 4 only includes a limited number of educational campaigns among patients to reduce unnecessary requests to prescribers for antibiotics, particularly for self-limiting conditions. This is because such programmes have already been discussed in more detail in Saleem et al. (21, 22) and in Ramdas et al. (28, 65), and potential additional ASPs will also be explored in more detail in future research projects.

We are aware of a number of limitations with our policy brief. These primarily include the fact that we have not undertaken a systematic review. However, we have undertaken a narrative review that included several examples of (i) inappropriate prescribing of antibiotics in ambulatory care among African countries; (ii) concerns about knowledge of antibiotics, AMR, and AMS among prescribers; (iii) possible policy options; (iv) actionable recommendations; and (v) ASPs to provide future policy guidance based on robust examples. The guidance was based on the considerable experience of the co-authors working across Africa and other LMICs. We have successfully used this approach previously (21, 22, 25, 71, 112).

4 Conclusions

There are considerable concerns with the level of inappropriate prescribing of antibiotics across Africa, exacerbating the already excessive levels of AMR. These include the high levels of prescribing of antibiotics for essentially self-limiting infections and the high levels of prescribing of Watch antibiotics across a number of African countries. The high levels of inappropriate antibiotic prescribing are exacerbated by concerns about limited knowledge of antibiotics, AMR, and AMS among prescribers across Africa. Key activities going forward include appropriate education of HCPs, including both physicians and nurses, among African universities both before and after graduation, particularly surrounding the WHO AWaRe system and guidance. Alongside this is the introduction and monitoring of quality indicators as part of pertinent ASPs. These are essential to meet the UN-GA targets for Access antibiotics and AMR across Africa.

Author contributions

AC: Writing – original draft, Validation, Formal analysis, Writing – review & editing, Investigation, Data curation, Methodology, Conceptualization. NR: Methodology, Writing – review & editing, Investigation, Data curation, Formal analysis, Validation. SC: Data curation, Methodology, Validation, Formal analysis, Conceptualization, Investigation, Writing – review & editing. MG: Validation, Formal analysis, Writing – review & editing, Methodology, Investigation. IS: Validation, Methodology, Data curation, Formal analysis, Investigation, Writing – review & editing. EH: Formal analysis, Validation, Data curation, Methodology, Investigation, Writing – review & editing. AM: Investigation, Formal analysis, Validation, Methodology, Writing – review & editing. BG: Conceptualization, Writing – original draft, Supervision, Visualization, Validation, Methodology, Data curation, Writing – review & editing, Formal analysis, Investigation. JM: Writing – original draft, Methodology, Formal analysis, Visualization, Investigation, Data curation, Supervision, Validation, Writing – review & editing, Conceptualization.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The author(s) declare that no Generative AI was used in the creation of this manuscript.

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