

SALEEM, Z., GODMAN, B., COOK, A. et al. 2022. Ongoing efforts to improve antimicrobial utilization in hospitals among African countries and implications for the future. *Antibiotics* [online], 11(12), article number 1824. Available from: <https://doi.org/10.3390/antibiotics11121824>













Ongoing efforts to improve antimicrobial utilization in hospitals among African countries and implications for the future.

SALEEM, Z., GODMAN, B., COOK, A. et al.

2022

Article

Ongoing Efforts to Improve Antimicrobial Utilization in Hospitals among African Countries and Implications for the Future

Zikria Saleem ¹, Brian Godman ^{2,3,4,*} , Aislinn Cook ^{5,6} , Muhammad Arslan Khan ⁷, Stephen M. Campbell ^{4,8,9}, Ronald Andrew Seaton ^{10,11}, Linda Siachalinga ¹², Abdul Haseeb ¹³ , Afreenish Amir ¹⁴ , Amanj Kurdi ^{2,4,15,16}, Julius C. Mwita ¹⁷, Israel Abebrese Sefah ¹⁸ , Sylvia A. Opanga ¹⁹, Joseph O. Fadare ^{20,21} , Olayinka O. Ogunleye ^{22,23} , Johanna C. Meyer ^{4,24}, Amos Massele ²⁵, Dan Kibuule ²⁶, Aubrey C. Kalungia ²⁷ , Moyad Shahwan ^{3,28} , Hellen Nabayiga ²⁹ , Giuseppe Pichierri ³⁰  and Catrin E. Moore ⁵ 

- ¹ Department of Pharmacy Practice, Faculty of Pharmacy, Bahauddin Zakariya University, Multan 60800, Pakistan
- ² Department of Pharmacoepidemiology, Strathclyde Institute of Pharmacy and Biomedical Sciences, University of Strathclyde, Glasgow G4 0RE, UK
- ³ Centre of Medical and Bio-Allied Health Sciences Research, Ajman University, Ajman 346, United Arab Emirates
- ⁴ Department of Public Health Pharmacy and Management, School of Pharmacy, Sefako Makgatho Health Sciences University, Molotlegi Street, Garankuwa, Pretoria 0208, South Africa
- ⁵ Centre for Neonatal and Paediatric Infection, St. George's University of London, London SW17 0RE, UK
- ⁶ Health Economics Research Centre, Nuffield Department of Population Health, University of Oxford, Oxford OX1 2JD, UK
- ⁷ The Indus Hospital, Bedian Road, Lahore 54000, Pakistan
- ⁸ Centre for Epidemiology and Public Health, School of Health Sciences, University of Manchester, Manchester M13 9PL, UK
- ⁹ NIHR Greater Manchester Patient Safety Translational Research Centre, School of Health Sciences, University of Manchester, Manchester M13 9PL, UK
- ¹⁰ Queen Elizabeth University Hospital, Govan Road, Glasgow G51 4TF, UK
- ¹¹ Scottish Antimicrobial Prescribing Group, Healthcare Improvement Scotland, Delta House, 50 West Nile Street, Glasgow G1 2NP, UK
- ¹² College of Pharmacy, Yeungnam University, Daehak-Ro, Gyeongsan, Gyeongbuk 38541, Republic of Korea
- ¹³ Department of Clinical Pharmacy, College of Pharmacy, Umm Al-Qura University, Makkah 24382, Saudi Arabia
- ¹⁴ Department of Microbiology, Armed Forces Institute of Pathology, National University of Medical Sciences, Rawalpindi 46000, Pakistan
- ¹⁵ Department of Pharmacology, College of Pharmacy, Hawler Medical University, Erbil 44001, Iraq
- ¹⁶ Center of Research and Strategic Studies, Lebanese French University, Erbil 44001, Iraq
- ¹⁷ Department of Internal Medicine, Faculty of Medicine, University of Botswana, Private Bag 0713 UB, Gaborone 00704, Botswana
- ¹⁸ Pharmacy Practice Department, School of Pharmacy, University of Health and Allied Sciences, Volta Region, Hohoe PMB 31, Ghana
- ¹⁹ Department of Pharmaceutics and Pharmacy Practice, School of Pharmacy, University of Nairobi, Nairobi P.O. Box 19676-00202, Kenya
- ²⁰ Department of Pharmacology and Therapeutics, Ekiti State University, Ado Ekiti 362103, Nigeria
- ²¹ Department of Medicine, Ekiti State University Teaching Hospital, Ado Ekiti 360211, Nigeria
- ²² Department of Pharmacology, Therapeutics and Toxicology, Lagos State University College of Medicine, Ikeja, Lagos 100271, Nigeria
- ²³ Department of Medicine, Lagos State University Teaching Hospital, Ikeja 100271, Nigeria
- ²⁴ South African Vaccination and Immunisation Centre, Sefako Makgatho Health Sciences University, Molotlegi Street, Garankuwa, Pretoria 0208, South Africa
- ²⁵ Department of Clinical Pharmacology and Therapeutics, Hurler Memorial University, 70 Chwaku Road Mikocheni, Dar Es Salaam P.O. Box 65300, Tanzania
- ²⁶ Department of Pharmacology & Therapeutics, Busitema University, Mbale P.O. Box 236, Uganda
- ²⁷ Department of Pharmacy, School of Health Sciences, University of Zambia, Lusaka P.O. Box 50110, Zambia
- ²⁸ Department of Clinical Sciences, College of Pharmacy and Health Sciences, Ajman University, Ajman 346, United Arab Emirates
- ²⁹ Management Science Department, Strathclyde Business School, University of Strathclyde, 199 Cathedral Street, Glasgow G4 0QU, UK



Citation: Saleem, Z.; Godman, B.; Cook, A.; Khan, M.A.; Campbell, S.M.; Seaton, R.A.; Siachalinga, L.; Haseeb, A.; Amir, A.; Kurdi, A.; et al. Ongoing Efforts to Improve Antimicrobial Utilization in Hospitals among African Countries and Implications for the Future. *Antibiotics* **2022**, *11*, 1824. <https://doi.org/10.3390/antibiotics11121824>

Academic Editor: Masafumi Seki

Received: 17 November 2022

Accepted: 9 December 2022

Published: 15 December 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

³⁰ Microbiology Department, Torbay and South Devon Foundation Trust, Lowes Bridge Torbay Hospital, Torquay TQ2 7AA, UK

* Correspondence: brian.godman@strath.ac.uk

Abstract: There are serious concerns with rising antimicrobial resistance (AMR) across countries increasing morbidity, mortality and costs. These concerns have resulted in a plethora of initiatives globally and nationally including national action plans (NAPs) to reduce AMR. Africa is no exception, especially with the highest rates of AMR globally. Key activities in NAPs include gaining a greater understanding of current antimicrobial utilization patterns through point prevalence surveys (PPS) and subsequently instigating antimicrobial stewardship programs (ASPs). Consequently, there is a need to comprehensively document current utilization patterns among hospitals across Africa coupled with ASP studies. In total, 33 PPS studies ranging from single up to 18 hospitals were documented from a narrative review with typically over 50% of in-patients prescribed antimicrobials, up to 97.6% in Nigeria. The penicillins, ceftriaxone and metronidazole, were the most prescribed antibiotics. Appreciable extended prescribing of antibiotics up to 6 days or more post-operatively was seen across Africa to prevent surgical site infections. At least 19 ASPs have been instigated across Africa in recent years to improve future prescribing utilizing a range of prescribing indicators. The various findings resulted in a range of suggested activities that key stakeholders, including governments and healthcare professionals, should undertake in the short, medium and long term to improve future antimicrobial prescribing and reduce AMR across Africa.

Keywords: Africa; antimicrobials; antimicrobial stewardship programs; antimicrobial resistance; national action plans; quality indicators; strategies; surgical site infections; utilization patterns

1. Introduction

There are serious concerns globally with growing antimicrobial resistance (AMR), with an associated increase in morbidity, mortality and costs [1–4]. A recent study estimated that in 2019 alone there were 1.27 million deaths globally attributable to bacterial AMR and 4.95 million deaths associated with bacterial AMR, with the greatest burden in Western sub-Saharan Africa [2]. The high rates of AMR among African countries may reflect the fact that the greatest burden of all infectious diseases worldwide, including human immunodeficiency virus (HIV) and acquired immunodeficiency syndrome (AIDS), acute respiratory diseases, malaria and tuberculosis (TB), is currently in Africa [5–9], with associated prescribing of antimicrobials. This includes prophylaxis against opportunistic infections for patients with HIV/AIDS in view of their impact on morbidity and mortality [10]. Alongside this, high rates of inappropriate prescribing and dispensing of antibiotics across all sectors in Africa, including for viral infections such as acute respiratory tract infections, are exacerbated by appreciable purchasing of antibiotics without a prescription [9,11–20]. Self-purchasing of antibiotics is common across sub-Saharan Africa, enhanced by high patient co-payments, a lack of access to certain antibiotics coupled with the convenience of community drug stores and pharmacies as well as concerns with the public healthcare system alongside porous supply chains for medicines [11,12,21–27]. Having said this, Klein et al. (2019) in their recent study showed that whilst low- and middle-income countries (LMICs) had the highest rates of AMR, there was a less clear-cut link between consumption and resistance rates compared with high-income countries [28]. However, this study only involved South Africa among the African countries in its analysis, with currently very limited self-purchasing of antibiotics in South Africa with strict regulations [28,29]. There is also appreciable consumption of antibiotics in agricultural and farming sectors across Africa, often with antibiotics of concern, adding selection pressure for AMR [30–33]. This is leading to increasing calls for a One Health approach across Africa, coupled with measures to prohibit the self-purchasing of antibiotics to reduce future AMR [34–37].

The costs associated with AMR are also considerable and will continue to rise unless addressed [38]. The World Bank (2017) recently estimated that even in a low-AMR scenario, the loss of world output due to AMR could exceed USD 1 trillion annually after 2030 [39]. This could potentially increase up to USD 3.4 trillion annually, equivalent to 3.8% of annual global Gross Domestic Product [39]. As a result, increasing AMR could be devastating, becoming the next pandemic unless considerable activities are undertaken to improve the future use of antibiotics [40].

Concerns with increasing morbidity, mortality and costs associated with AMR have resulted in a plethora of international, regional, national, and local activities and strategies to try and address the situation [41]. International activities include those among the Interagency Coordination Group on Antimicrobial Resistance (ICGAR) Global Leaders group, ongoing activities within the Organisation for Economic Co-operation and Development (OECD), the Fleming Fund, and the World Bank alongside activities by the World Health Organization (WHO) including the One Health Approach and the development of Global Action Plans (GAP) to tackle AMR [36,37,42–48]. Regional initiatives within Africa include activities by the Africa CDC, the African Society for Laboratory Medicine (ASLM), the Southern Africa Centre for Infectious Disease Surveillance, other Civil Society Organisations in Africa as well as the development of African guidelines to treat common bacterial infections across age groups [49–54].

Alongside this, the WHO has reclassified antibiotics into the AWaRe list ('Access', 'Watch' and 'Reserve') taking into account the impact of different antibiotics and classes on resistance potential to reduce future AMR [55,56]. The 'Access' group are considered as first- or second-line antibiotics for up to 26 common or severe clinical syndromes, typically with a narrow spectrum and low resistance potential. The 'Watch' group have a higher resistance potential and side-effects, with the 'Reserve' group only recommended as last resort antibiotics and prioritized for Antimicrobial Stewardship Programs (ASPs) using agreed quality indicators (QIs) (Figure 1) [55–59]. Assessing antimicrobial prescribing against current guidance, and monitoring their use based on the WHO AWaRe list, is increasingly being undertaken across Africa and beyond to improve prescribing given the extent of current prescribing of 'Watch' and 'Reserve' antibiotics in Africa [13,15,58–67].

The WHO GAP resulted in the development of National Action Plans (NAPs) across countries to combat rising levels of AMR [68,69]. Africa is no exception; currently, African countries are at different stages of implementation and monitoring of their NAPs [70–74]. A key activity within the NAPs is understanding current antimicrobial utilization and resistance patterns. Some African countries have high antimicrobial utilization rates within hospitals, with published studies across Africa reporting prevalence rates between 52.0% and 88.2% of in-patients [13–16,19,63,75–82]. There has also been considerable disquiet with high rates of extended antibiotic prophylaxis to prevent surgical site infections (SSIs) across Africa [83]. This is a concern as such practices may increase adverse reactions, AMR and costs with limited or no evidence on further reducing SSIs [83]. We are already seeing high rates of AMR among patients undergoing surgery who develop SSIs among patients in African hospitals, and this urgently needs to be reversed [84].

The use of antibiotics in patients with COVID-19 in hospitals has increased exponentially since the start of the pandemic. This is despite only a limited number of patients actually being diagnosed with bacterial or fungal infections reflecting current challenges with routine culture and sensitivity testing across Africa [14,76,85–89]. This misuse of antibiotics has been exacerbated by national guidelines in Africa which advocated the prescribing of a number of antibiotics in patients with COVID-19 [90]. The authors were concerned with this worrisome development with only a limited number of patients likely to have a bacterial co-infection [90], with others documenting similar concerns [88,91–93]. This mirrors similar activities regarding the purchasing of antibiotics in patients with COVID-19 without a prescription [94,95], and both situations urgently need to be addressed to avoid further pressures to increase AMR [88,96–98]. Alongside this, whilst the use of antibiotics has changed during the COVID-19 epidemic, and even during different waves of the epi-

demographic over time in the same country [99], which needs addressing, there remains a lack of availability and access to a number of antibiotics in many LMICs [100,101]. While ‘Access’ antibiotics are placed in this group due in part to their availability in hard-to-reach areas, the availability of/access to other groups of antibiotics including ‘Watch’ and ‘Reserve’ antibiotics for use in hospitals, together with newly developed antibiotics, which may be necessary to use in areas of high resistance where antibiotic stewardship systems are available, is sorely missing and desperately needed [102]. We will be pressing for this in the future along with measures to increase COVID-19 vaccine equity. African Governments and others need to ensure that healthcare professionals (HCPs) can readily administer COVID-19 vaccines to reduce future hospitalisations [103,104]. Increasing vaccinations will reduce infection rates and subsequent consequences including hospitalisations, thereby reducing unnecessary prescribing of antimicrobials and associated AMR [96–98,105,106]. However, this requires comprehensive programs across Africa to address current high vaccine hesitancy [107–109].

A key activity to reduce AMR is the instigation of pertinent ASPs containing quality indicators [110,111]. Current indicators include adherence to prescribing guidance, which is increasingly being used to improve future antimicrobial prescribing across Africa and beyond given concerns with adherence to guidelines in practice along with rising AMR rates [112–121].

The role of quality indicators, whether as part of ASPs or separately, is also growing across countries, including African countries, to improve antibiotic prescribing in hospitals, including those based on the AWaRe classification [58,60,64,112,122,123]. This is because one way of measuring, monitoring and improving the quality of care is to use indicators, which are standardized measures of healthcare quality that make use of readily available, easy-to-use data independent of subjective judgement.

There are three main types of indicators used in healthcare (Figure 1) and there must be a clear a priori purpose for both developing, collecting and using indicator data across Africa.

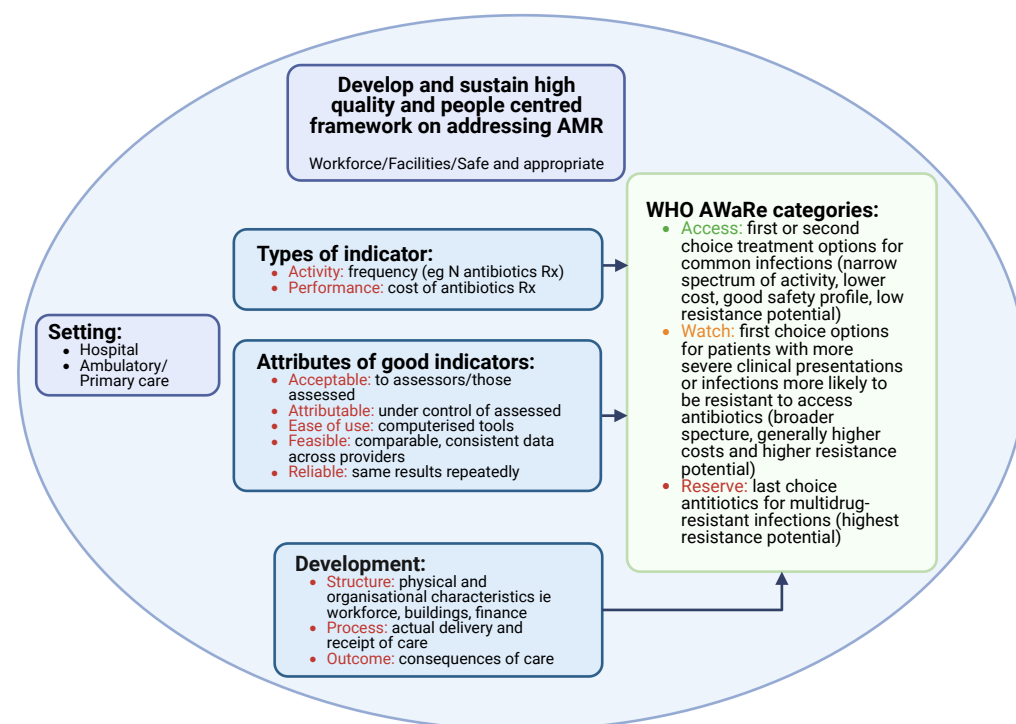


Figure 1. Key principles for indicator development for antimicrobials across Africa (adapted from [56,124–127]). NB: Created via Biorender (<https://biorender.com/>) with permission granted to Catrin Moore (accessed on 14 November 2022)).

However, there can be concerns instigating ASPs, with issues of resources, manpower, and knowledge among key stakeholders especially among low- and middle-income countries (LMICs) including African countries (Box S1—Supplementary Material) [128–131]. This though is also starting to change among African countries as well as among other LMICs [111,132–137]. We are likely to see more ASPs being instigated across Africa and beyond as part of NAPs to reduce AMR, enhanced by the availability of toolkits from the WHO and others [67,70,132,137–140].

Consequently, this study aims to comprehensively document current antimicrobial utilization patterns in hospitals right across Africa from published point-prevalence surveys (PPS) with no discrimination based on geography and income status. Here we also concentrate on the extent of inappropriate prescribing of antibiotics post-operatively to prevent SSIs. It is important that antibiotic prophylaxis is administered for the appropriate duration to prevent SSIs as they are responsible for an appreciable number of hospital-acquired infections, impacting on morbidity, mortality and costs [141–145]. However, as mentioned, extended prophylaxis increases AMR and adverse reactions with limited or no impact on further reducing SSIs [83,141,146].

Alongside this, we will document potential prescribing and quality indicators that can be used across hospitals in Africa to improve future antibiotic prescribing based on published studies. In addition, document examples of successful ASPs that have been instigated across Africa to provide future guidance. We started with hospitals as more information is currently available regarding the prescribing of antibiotics in hospitals versus ambulatory care across Africa [70]. We will not discuss potential programs to address COVID-19 vaccine hesitancy across Africa as this has already been discussed [107,109]. Similarly, programs to reduce inappropriate use of antibiotics in agriculture and farming, with the emphasis on hospital in-patient prescribing. However, both are important under a One Health approach.

2. Results

The key issues we identified to improve future antimicrobial prescribing in hospitals across Africa are described below. These include current high utilization rates among a number of African countries where studies have been undertaken; post-operative prescribing for more than one day to prevent SSIs as well as concerns with the lack of adherence to guidelines and high empiric use of antibiotics. Several potential prescribing and quality indicators have been identified to improve future antimicrobial prescribing as part of ASPs. These are being utilized among a growing number of successful ASPs across Africa to improve future prescribing. Our results can provide exemplars going forward.

2.1. Current Antimicrobial Utilization Patterns in Hospitals across Africa

Table S1 in the Supplementary Material documents current antimicrobial utilization patterns from 33 PPS studies that have recently been undertaken across Africa to a baseline for future ASPs. The documented studies include surveys from a single hospital within a country, with up to 18 hospitals in a country. However, Table S1 excludes the 12 African hospitals who were part of the Global PPS of Versporten et al. (2018) [112]. In addition, the 44 hospitals from sub-Saharan Africa that were part the updated Global PPS analysis, which includes the extent of Access, Watch and Reserve antibiotics prescribed [60]. These studies were excluded due to insufficient data for completion of Table S1 in the two publications [60,112]; the summary results though have been included. As seen, multiple PPS studies have been undertaken in low- and low-middle-income African countries despite concerns with available resources and personnel.

Antimicrobial utilization was typically high across most of the studied African countries (over 50% of patients), with similar rates in a recent study in Zambia [147]. Hospitals in Nigeria saw the highest antimicrobial utilization rates at 59.6–97.6% of in-patients surveyed Table 1. The lowest antimicrobial utilization rates were seen in South Africa (33.6–49.7% of

patients). Incidentally, a similar range was seen among the 12 African hospitals taking part in the Global PPS of Versporten et al. (2018) [112].

There have also been studies assessing antimicrobial use among selected wards in hospitals in Uganda, with similar high utilization rates (79%) as seen among hospitals in Nigeria (Table S1) [148].

The penicillin group (which are typically in the AWaRe ‘Access’ group) and the cephalosporins (typically third-generation cephalosporins, in the AWaRe ‘Watch’ category) were the most prescribed antibiotics among the African countries reporting their PPS results, followed by metronidazole. There was also high use of metronidazole (23.6%) and ceftriaxone (23.2%) and cefuroxime (8.3%) among the 44 hospitals from sub-Saharan Africa taking part in the Global PPS study of Pauwels et al. (2021) [60].

2.2. Antibiotic Prophylaxis to Prevent Surgical Site Infections

Table 1 documents the extent of extended antimicrobial prophylaxis within hospitals among African countries documenting their findings to prevent SSIs alongside details of the antimicrobials prescribed where documented. Antimicrobials prescribed for SAP were mainly third-generation cephalosporins including ceftriaxone (‘Watch’ antibiotic), metronidazole (‘Access’ antibiotic) and the penicillins including co-amoxiclav (typically ‘Access’ antibiotics). This is similar to the findings of Pauwels et al. (2021) who found that the most common antibiotics prescribed for SAP were ceftriaxone and metronidazole [60].

Published reasons for extended prophylaxis included resistance to change among HCPs, overcrowding in hospitals, concerns with hospital cleanliness, proper aseptic techniques not being followed during the operation, poor knowledge regarding antibiotics among physicians, concerns with malnutrition in some patients and patient expectations [114,149–152]. There can also be concerns with repeated door openings during surgery impacting on the potential development of SSIs [153].

Programs, including consistent and comparable ASPs, are urgently needed across Africa to reduce the extent of prolonged prescribing to reduce adverse reactions, AMR and costs [83]. Details of some of the interventions that have been successfully introduced across Africa to improve the prescribing of antibiotics to prevent SSIs, building on possible prescribing/quality indicators Table 2, are summarized in Table 3.

2.3. Prescribing Indicators Currently Being Used in Hospitals to Improve Antimicrobial Prescribing

A variety of prescribing indicators have been used among hospitals across Africa to enhance future prescribing as described in Table 2. These reflect increasing activities among hospitals across Africa to improve the future prescribing of antimicrobials in their countries thereby helping to reduce AMR.

However, a major concern across Africa is the current lack of electronic healthcare systems in hospitals to routinely track standards of care using consistent and comparable coding across countries. As a result, periodic surveys are typically undertaken to monitor care. This is likely to change as more applications and other electronic tools become available across Africa to track prescribing, building on current initiatives [61,62,172].

2.4. Antimicrobial Stewardship Programs

At least 20 ASPs have been successfully instigated across Africa in recent years (between 2013 and 2022) to improve antimicrobial prescribing, with checklists and guidance now being developed for sub-Saharan Africa and beyond to help with their development and implementation [135,139,198]. Box 1 contains key areas for hospitals to concentrate on when seeking to introduce sustainable programs to improve future antimicrobial use in hospitals.

Table 1. Extent of prolonged antimicrobial prophylaxis to prevent SSIs across sub-Saharan Africa.

Country	Year (and Reference)	Findings
Low Income *		
Burkina Faso	2019 [154]	<ul style="list-style-type: none"> • Prolonged administration of antibiotics was common (>2 days) among 62 patients in this PPS study to help prevent SSIs • Antibiotics administered for >2 days in 87.1% of cases
	2018 [155]	<ul style="list-style-type: none"> • Among patients who were prescribed antibiotics postoperatively (80 out of 90 patients) for SAP, 88.8% were prescribed for >1 day post-operatively • The majority of patients (84.5%) received ceftriaxone (W)
Ethiopia	2018 [156]	<ul style="list-style-type: none"> • 79.1% of surveyed SAP patients (153 patients) were prescribed antibiotics for 2 days or more • 34.7% were prescribed antibiotics for >5 days • Approximately 84% of the patients were prescribed ceftriaxone (W) either alone or in combination
	2022 [157]	<ul style="list-style-type: none"> • 82.6% of 218 patients undergoing surgery had antibiotics prescribed for >1 day to prevent SSIs • The average number of antibiotics prescribed per patient was 1.32 • Ceftriaxone (54.7% of antibiotics—W) was the widely prescribed antibiotic for SAP
Rwanda	2019 [158]	<ul style="list-style-type: none"> • Nearly all women who received antibiotics pre-operatively (66.7% of 550 women undergoing a caesarean section) had antibiotics post operatively to reduce SSIs • Typically, a single dose of 1 g ceftriaxone (W) was given within 1 h before incision
	2020 [159]	<ul style="list-style-type: none"> • Out of 57 patients, 33% had antibiotics prescribed for SAP for 2–3 days and 56% for >3 days • Ceftriaxone (W) was the most prescribed antibiotic for SAP ($n = 28$; 49%)
Tanzania	2020 [160]	<ul style="list-style-type: none"> • Typically, SAP was administered for 3 days post operatively prior to the intervention followed by oral antibiotics, i.e., 3 days of intravenous ceftriaxone (W) plus metronidazole (A), followed by oral penicillins (A) plus metronidazole for at least 5 days—timing was highly variable ranging from 1 to 24 h post-caesarean section • This appreciably changed following the education of key stakeholders and monitoring of future prescribing habits with patients. A pre-operative prophylaxis with 1 g ampicillin (A) was administered 30–60 min before the incision with antibiotics only prescribed post-operatively for treatment • Combined with training, overall a reduction in SSIs despite limiting antibiotic prescribing post-operatively among 320 studied patients • Overall, the educational intervention provided savings of EUR 1500 for the hospital with reduced antibiotic prescribing
	2021 [81]	<ul style="list-style-type: none"> • 97% of patients undergoing surgery (96 patients overall) had antibiotics prescribed for SAP for >1 day

Table 1. Cont.

Country	Year (and Reference)	Findings
Uganda	2020 [161]	<ul style="list-style-type: none"> • Most patients received prolonged antibiotic therapy for SAP after their surgery (907 patients) • Combination of ceftriaxone (W) and metronidazole (A) was the most common regimen (609/907 patients—67.1%)
	2021 [81]	<ul style="list-style-type: none"> • 97.1% of antibiotics prescribed for SAP were for >1 day (170 patients overall)
	2022 [13]	<ul style="list-style-type: none"> • 98.4% of patients surveyed had multiple doses of antibiotics for SAP for >1 day (301 patients overall) • Ceftriaxone (W) and metronidazole (A) were the principal antibiotics prescribed in this PPS study including for prophylaxis
Low-Middle Income *		
Congo	2020 [162]	<ul style="list-style-type: none"> • 69.1% of surveyed patients (265 patients in total) were prescribed antibiotics for 3 days or longer post operatively • Ampicillin (A) was the most frequent antibiotic prescribed (43.8% of patients) followed by cloxacillin (13.2%) (A), gentamicin (9.4%) (A) and ceftriaxone (9.1%) (W) either alone or in combination
Ghana	2019 [163]	<ul style="list-style-type: none"> • 88.4% of patients (out of 121 patients) were prescribed antibiotics for >1 day to prevent SSIs • 9.9% of patients were prescribed antibiotics for one day with only 1.6% of patients receiving a single dose of antibiotics to prevent SSIs • The most commonly prescribed antibiotics for SAP were cephalosporins (28.9% of patients) and co-amoxiclav (A) (28.1%)
	2020 [76]	<ul style="list-style-type: none"> • Antibiotics for SAP were typically prescribed for >1 day in 69.0% of patients in one of the surveyed hospitals and 77.0% in the other (26 patients overall)
	2021 [81]	<ul style="list-style-type: none"> • 75.5% of antibiotics prescribed for SAP were for >1 day (478 patients overall)
	2021 [164]	<ul style="list-style-type: none"> • 78.0% of 318 patients surveyed undergoing surgery received antibiotics for >1 day to prevent SSIs • 13.0% of those surveyed were prescribed antibiotics for one day post operatively, and only 9% received a single dose
	2022 [141]	<ul style="list-style-type: none"> • Duration of antibiotics to prevent SSIs among those surveyed was 6.9 ± 2.1 days • The most common antibiotics prescribed were a combination of cefuroxime (W) and metronidazole (56.1%, $n = 335$) (A) followed by co-amoxiclav (14.2%) (A)

Table 1. Cont.

Country	Year (and Reference)	Findings
Kenya	2017 [165]	<ul style="list-style-type: none"> In all 69 patients surveyed, the duration of SAP ranged from one to three days Ceftriaxone (W) was the most common antibiotic prescribed for SAP (78% of patients)
	2018 [78]	<ul style="list-style-type: none"> The average number of doses of antibiotics for SAP in surveyed patients was 19.1 The most frequently prescribed antibiotics on the surgical wards (most for SAP) were third-generation cephalosporins
	2018 [166]	<ul style="list-style-type: none"> Most antibiotics prescribed in the surgical ward of this hospital were for prophylaxis (56.3%) vs. treatment (43.7%) The mean duration of antibiotic administration in the surgical ward was 6 ± 4.7 days, with most patients prescribed antibiotics for 1–3 days (30.2%) or 4–6 days (40.9%) The most prescribed antibiotics among those surveyed were ceftriaxone (W) and flucloxacillin (A) either alone or in combination with metronidazole (A)
	2019 [79]	<ul style="list-style-type: none"> 76.9% of surveyed patients with antibiotics for SAP were prescribed these for >1 day with only 9.6% of patients administered a single dose for SAP
Nigeria	2016 [167]	<ul style="list-style-type: none"> Prolonged administration of antibiotics to prevent SSIs was common among 100 patients undergoing SAP along with the prescribing of broad-spectrum antibiotics including third-generation cephalosporins
	2017 [168]	<ul style="list-style-type: none"> Antibiotic prescriptions for SAP were given for >1 day in 95.0% of 277 patients undergoing surgery Ceftriaxone (28.0% of situations) (W), metronidazole (20.0%) (A) and cefuroxime (17.0%) (W) were the most prescribed antibiotics for SAP
	2020 [82,169]	<ul style="list-style-type: none"> All antibiotics prescribed for SAP were for >1 day in both studies In the study of Abubakar, nitroimidazoles including metronidazole (33.7% of total prescriptions), third-generation cephalosporins (20.8%), and combinations of penicillins and beta-lactamase inhibitors (10.9%) (A) were the most prescribed antibiotics
	2020 [114]	<ul style="list-style-type: none"> 89% of surveyed patients (127 undergoing prophylaxis) were given antibiotics for >24 h to help prevent SSIs
	2021 [16]	<ul style="list-style-type: none"> 94.8% of 96 patients had antibiotics administered for longer than 24 h to prevent SSIs 4.2% had antibiotics administered for one day and only 1.0% of patients were prescribed one dose of SAP Metronidazole (A), cefuroxime (W), ceftriaxone (W) and ciprofloxacin (W) were the most prescribed antibiotics in the surgical wards
	2022 [14]	<ul style="list-style-type: none"> All 63 patients were prescribed antibiotics for SAP post-operatively—24 h in 23.8% of patients and >1 day in 76.2% of patients

Table 1. Cont.

Country	Year (and Reference)	Findings
Zambia	2021 [81]	<ul style="list-style-type: none"> 96.5% of patients undergoing surgery had antibiotics prescribed for SAP for >1 day (83 patients overall)
Upper-Middle Income *		
	2018 [170]	<ul style="list-style-type: none"> Prolonged administration of antibiotics was common for SAP with a mean (SD) duration of 5 (+/- 2.6) days, greatest for emergency surgery (72.7% of occasions among 104 patients) The most commonly prescribed antibiotics were cefotaxime (80.7% of situations) (W), metronidazole (63.5%) (A) and cefradine (A) (13.6%)
Botswana	2019 [19]	<ul style="list-style-type: none"> Extended prophylaxis for SAP (>1 day) was common—greatest among Primary hospitals (100% of 2 patients surveyed) and Tertiary hospitals (100% of 58 patients surveyed) versus District hospitals (90.3% of 31 patients surveyed) and Specialist hospitals (66.7% of 27 patients surveyed) Principal antibiotics prescribed for SAP were ampicillin (26.77% of occasions) (A), amoxicillin (24.41%) (A), metronidazole (17.32%) (A) and ceftriaxone (7.09%) (W)
South Africa	2021 [171]	<ul style="list-style-type: none"> In 73.2% of cases surveyed (<i>n</i> = 108 patients) for SAP were prescribed antibiotics for >1 day Cefazolin (A) was the most commonly prescribed antimicrobial (45.5% of cases) for SAP followed by co-amoxiclav (22.3% of cases) (A), ceftriaxone (9.8%) (W) metronidazole (5.4%) (A)
	2022 [61]	<ul style="list-style-type: none"> In 66.7% of paediatric cases (10 out of 15 patients), antibiotics for SAP were prescribed for >1 day

A and W: Access and Watch (AWaRe classification); SAP: Surgical Antibiotic Prophylaxis; SSIs: Surgical Site Infections; * World Bank Status (Based on [59]).

Table 2. Indicators that have been used among in-patients in hospitals across Africa to assess the prescribing of antibiotics.

Indicator	References
Activity/Performance Indicators	
% of in-patients prescribed antibiotics in a single PPS/ over specific time periods, e.g., successive waves of COVID-19	[19,61,112,172]
% of antibiotics prescribed by defined daily doses (DDDs), e.g., DDDs/1000 patient-days in a PPS or over a specified time	[171,173–175]
% of a course of antibiotics prescribed (duration) in accordance with agreed guidance/ Days of antibiotic therapy per 1000 patient-days	[166,176]
% of antibiotics administered to in-patients within the first hour of prescribing within a designated period of time	[177]
% of patients where the indication for prescribing and/ or stop and review dates are included in patients' notes	[15,19,76,81,114,168,169,178,179]

Table 2. Cont.

Indicator	References
% oral vs. IV antibiotics (including as part of de-escalation policies)	[15,76,82,114,166,168,171,178–181]
% of missed doses documented in patients' notes, e.g., as part of a PPS	[19,148]
% of antibiotics prescribed by their international non-proprietary name, e.g., as part of a PPS	[182,183]
% compliance to agreed process measures surrounding AMS	[184]
% of patients prescribed antibiotics within the country's essential medicine list over an agreed period of time	[61,171,180,182,183]
Process quality indicators	
% of in-patients prescribed antibiotics in adherence to agreed guidelines within a specified time period/part of a PPS	[81,112,134,168,184–191]
% of patients prescribed a course of antibiotics in accordance with guideline duration recommendations within a specified time period/ part of a PPS	[166,176]
% of patients where cultures are taken and sent for analysis to guide antibiotic prescribing/ targeted therapy within a specified time period/ part of a PPS	[76,114,169,192]
% of antibiotics prescribed based on the AWaRe classification/% reduction in the prescribing of target antibiotics, e.g., 'Watch' cephalosporins to potential 'Access' antibiotics (current target is 60% of current prescribing should be 'Access' antibiotics)	[60,76,81,193]
% of patients prescribed antibiotics post-operatively to prevent SSIs/% appropriate use of antibiotics to prevent SSIs during an agreed time period	[194,195]
% of key antibiotics available for prescribing/ Whether there are agreed therapeutic interchange policies in the hospital when there are likely to be shortages of standard antibiotics for the condition (over a specific time period)	[183,196]
% of all admitted patients with pneumonia to the hospital correctly classified and treated to agreed guidelines (over a specified time period)	[187,190]
Outcome Indicators	
% SSIs following operations (over an agreed time period)	[160,194,197]
% Mortality rates (post-intervention versus pre-intervention) following changes in antimicrobial prescribing, e.g., reducing extensive antimicrobial prescribing post-surgery for SAP or reducing extensive prescribing of 'Watch' antibiotics	[175,176,193]

AMS: Antimicrobial Stewardship; DDDs: Defined Daily Doses; SAP: Surgical Antibiotic prophylaxis; SSIs: surgical site infections.

Box 1. Selected Antimicrobial Stewardship Checklist (adapted from [135]).

- Has your hospital management formally identified AMS as a priority objective and included it as a key performance indicator?
- Does your hospital have a formalized structure and group responsible for AMS activities including researching and promoting appropriate antibiotic use as part of agreed ASPs?
- Is this currently a multidisciplinary AMS group available in your hospital to implement agreed ASPs, and does this group include a designated leader?
- Is there access to HCPs in infection management and stewardship in the hospital willing to be part of AMS teams?
- Does your hospital currently offer educational resources to support training of HCPs regarding antimicrobial prescribing and its monitoring to improve future care?
- Is there dedicated and sufficient budget to support AMS activities?
- Do you have access to laboratory/imaging services to support improved antibiotic use and away from untargeted and unnecessary prescribing, and are the results available in a timely manner to support diagnosis and appropriate antibiotic prescribing?
- Does your ASP currently monitor compliance with one or more agreed interventions, e.g., improved compliance to national or local guidelines, and report back the findings to improve future care including any changes in the quality/appropriateness of antimicrobial prescribing in agreed areas?
- Has your hospital conducted a PPS in the past year and used the findings to improve future antimicrobial prescribing?
- Does your hospital have available and up-to-date recommendations for infection management, and are these readily available to prescribers?
- Does your hospital currently have any published AMS protocols such as a restricted antimicrobial list especially surrounding 'Watch' and 'Reserve' antibiotics and IV to oral switching policies?
- Does your hospital currently have any published Infection Prevention and Control protocols, and are these regularly monitored, e.g., surrounding hand hygiene protocols?

AMS—Antimicrobial Stewardship; ASP—Antimicrobial Stewardship program; HCP—Healthcare Professional.

Their details and documented impact are summarized in Table 3. Typically, multiple interventions are more successful with improving future prescribing than single interventions. In addition, activities need to be continually followed up. Otherwise, prescribing habits could drift back towards pre-intervention levels.

One problem is the regular turn-around of junior staff, who subsequently need training on antimicrobial prescribing for continuous improvement. The increasing availability of electronic tools should help in this regard in the future [199].

2.5. Suggested Activities to Improve Future Antimicrobial Prescribing in Hospitals

The suggested strategies to improve antibiotic utilization among hospitals across Africa, which will be crucial to reduce AMR, have been divided into short- and long-term initiatives (Table 4). These build on the potential for developing and expanding the use of digital technologies surrounding electronic health records and electronic prescribing to improve appropriate antibiotic use [199,201–203]. Such developments are essential to develop and regularly monitor antimicrobial prescribing against agreed prescribing/quality indicators.

Table 3. Summary of published studies across Africa documenting ASPs and their impact.

Author, Country and Year	Intervention and Aim	Impact of the Intervention
Low Income *		
Gebretekle et al., Ethiopia, 2020 [176]	<ul style="list-style-type: none"> • 1109 individual patients took part (707 during the intervention and 402 in the post-intervention periods) • Principally Education as an intervention. This included: • Intervention—weekly audit meetings and immediate (verbal and written) feedback sessions regarding antibiotic prescriptions of admitted patients on 4 wards • This built on recently developed institutional guidelines and training sessions with relevant clinicians on ASPs and guidelines • Aim: auditing of antibiotic prescriptions post intervention • However, no feedback initiatives to remind physicians 	<ul style="list-style-type: none"> • Most commonly prescribed antibiotics were ceftriaxone, cefepime, meropenem, metronidazole and vancomycin • 96% of the recommendations made by the AMS team were accepted • Once the intervention ceased, total antimicrobial use increased by 51.6% and the mean duration of treatment increased by 4.1 days/patient respectively • Mean hospital stay and crude mortality decreased during the intervention; however, increased significantly after the intervention

Table 3. Cont.

Author, Country and Year	Intervention and Aim	Impact of the Intervention
Alabi et al., Liberia, 2022 [134]	<ul style="list-style-type: none"> ● Intervention: education and engineering involving a collation of three activities: <ul style="list-style-type: none"> ○ production and dissemination of local treatment guidelines ○ training and regular AMS ward rounds ○ monitoring agreed QIs ● QIs included prescribing of correct antibiotics (incorporating completeness of microbiological diagnostics) as well as dosages and duration ● QIs were assessed in a case series after AMS ward rounds and fed back to key personnel ● 620 patients overall—310 pre intervention and 310 post intervention ● Aim: Assess the impact of AMS programs with improving antibiotic prescribing 	<p>Improvements were seen in all QIs:</p> <ul style="list-style-type: none"> ● Adherence to local guidelines improved from 34.5% (107/310) to 61.0% (189/310) ($p < 0.0005$) ● Correct dosing improved from 15.2% (47/310) to 36.5% (113/310) ($p < 0.0005$) ● Optimal duration of antibiotic use improved from 13.2% (41/310) to 31.0% (96/310) ($p < 0.0005$) ● Proportion of patients receiving ceftriaxone reduced from 51.3% (159/310) to 14.2% (44/310) ($p < 0.0005$). ● Following the ASP, 79.7% (247/310) of patients had samples sent for microbiological analysis
Lester et al., Malawi, 2020 [193]	<ul style="list-style-type: none"> ● Intervention: education and engineering involving guidelines, posters and the application of smartphones to help with clinical decision making as well as regular PPS studies combined with prescriber feedback ● 503 patients were involved—203 pre implementation, 200 in the implementation phase and 100 patients post implementation ● Aim: Reduce extensive prescribing of third-generation cephalosporins within the hospital and associated costs with no adverse impact on mortality—especially with high rates of HIV among in-patients in the hospital (approximately 61% across the surveys) 	<ul style="list-style-type: none"> ● The proportion of prescriptions for an IV 3rd-generation cephalosporin fell from 80.1% (193/241) of all prescriptions in the first survey to 53.6% (177/330) by the last survey ● The median length of a ceftriaxone course was reduced from 5 to 4 days aided by an increase in the number of clinician reviews of prescriptions at 48 h—increasing from 22.4% (54/241) at the start to 73.3% (242/330) by the final antibiotic survey ● Overall annual savings from the 3 wards was estimated at USD 15,000 with no change in mortality or median length of hospital stay
Suliman et al., Sudan, 2020 [188]	<ul style="list-style-type: none"> ● Intervention—principally education. ● Activities included: <ul style="list-style-type: none"> ○ Verbal contact by clinical pharmacists with all consultants and registrars involved with performing emergency caesarean sections (ECSs) separately about agreed updated guidelines for the use of prophylactic antibiotics in ECS to prevent SSIs ○ Brochures giving details about proposed changes in prophylactic antibiotic recommendations for patients undergoing ECS ○ These included no longer administering metronidazole (IV before cord clamping and on discharge) and oral amoxicillin-clavulanic acid on discharge ○ Subsequent auditing and feedback of the findings ● Overall, 195 participants were included, 94 participants before and 101 participants after the intervention ● Aim: To improve the rational use of prophylactic antibiotics among patients undergoing a cesarean section and to assess the impact of clinical pharmacist intervention on subsequent antibiotic utilization/adherence to guidelines and possible cost-savings 	<ul style="list-style-type: none"> ● The hospital protocol was fully followed so no patient subsequently received either metronidazole (IV or oral) or oral amoxicillin-clavulanic acid on discharge following the ASP intervention ● Cost saving of 31% on antibiotics administered to prevent SSIs post ASP ● No patient in the revised administration group developed any symptoms or signs of SSI (at days 15 and 30 post discharge)

Table 3. Cont.

Author, Country and Year	Intervention and Aim	Impact of the Intervention
Gentilotti et al., Tanzania, 2020 [160]	<ul style="list-style-type: none"> Intervention: principally Education. Activities included formal and on-job training including seminars on infection prevention and control/ evidence-based education on antimicrobial resistance and good antimicrobial prescribing practice Prior to this—antibiotics were typically prescribed post-operatively (98.2%) and for 8–10 days when given 1377 women undergoing caesarean sections were enrolled, 664 in the pre-intervention phase and 713 in the post-intervention phase Aim: Enhance appropriate antibiotic prescribing to prevent SSIs for patients undergoing caesarean sections 	<ul style="list-style-type: none"> Pre-incision antibiotic prophylaxis was administered in significantly more cases post the educational intervention ($p < 0.001$) The extent of antibiotics administered post-operatively to prevent SSIs was also appreciably lower post intervention ($p < 0.001$) The timing of prophylaxis was adequate only in 28% of cases in the post intervention group, but this did not seem to affect SSI prevalence rates The total number of SSIs decreased from 48% pre-intervention to 17% post intervention ($p < 0.001$)
Ashiru-Oredope et al., 2022 [135]	<ul style="list-style-type: none"> Intervention: Principally Education and Engineering. Activities included developing a checklist of 54 items across 8 sections to identify current AMS activities surrounding key areas (highlighted in Box 1) across 19 participating hospitals with the number of inpatient beds ranging from 100 to 2000 (average 536) Educational initiatives undertaken to improve AMS capabilities within the hospitals, which included guideline development and promotion Post-intervention monitoring to record improvements in AMS activities to improve future antimicrobial prescribing 	<ul style="list-style-type: none"> Improvements in AMS activities recorded across all hospitals (overall 79% improvement in AMS activities)—before this program only 3 hospital sites had a formal AMS structure Increased multidisciplinary membership of AMS teams including an increasing number of nurses and pharmacists to assist with future sustainability of AMS activities New guidelines, policies, posters developed/ implemented across participating hospitals to improve future antimicrobial prescribing Increased awareness of the WHO AWaRe classification of antimicrobials across most participating hospitals (79%)
Ngonzi et al., Uganda, 2021 [197]	<ul style="list-style-type: none"> Intervention: Principally Education and Engineering regarding the World Health Organization's checklist of activities to reduce SSIs in patients undergoing caesarean sections Educational interventions combined with daily audits and feedback 678 patients' charts were reviewed (200 in the pre-intervention phase, 230 in the intervention phase and 248 in the post-intervention phase). Aim: reduction in SSIs among patients undergoing caesarean sections in the hospital 	<ul style="list-style-type: none"> The use of the WHO's checklist for SSIs increased from 7% (13/200) pre-intervention to 92% (211/230) in the intervention phase ($p < 0.001$) Subsequently, fell to 77% ((191/248) post-intervention ($p < 0.001$) Prescribing of antibiotics rose from 18% (36/200) of patients pre-intervention to 90% (208/230) in the intervention phase ($p < 0.001$); subsequently, reduced to 84% (208/248) post-intervention phase ($p < 0.001$) The documented SSI rate fell from 15% pre-intervention phase to 7% in the intervention phase ($p = 0.02$)
Low-Middle Income *		
Aitken et al., Kenya, 2013 [152]	<ul style="list-style-type: none"> Intervention: Education and Engineering to develop, implement and monitor a policy within the hospital to improve post-operative prescribing of antibiotics among patients undergoing surgical operations Aim: Improve antibiotic prescribing for SAP and reduce costs 	<ul style="list-style-type: none"> Appreciable improvement in reducing extensive post-operative prescribing of antibiotics to 40% (18/45) of operations within the first week and just 10% (5/50) by week 6 following the policy implementation ($p < 0.0001$) Overall, net reduction in the costs for IV antibiotics and associated consumables used to prevent SSIs at approximately, USD 2.50/operation

Table 3. Cont.

Author, Country and Year	Intervention and Aim	Impact of the Intervention
Amdany et al., Kenya, 2014 [181]	<ul style="list-style-type: none"> Intervention: Principally an educational initiative to enhance the use of oral vs. IV metronidazole including education, audit and feedback. Aim: Increase the use of oral vs. IV metronidazole 	<ul style="list-style-type: none"> Post implementation audit showed an increase of more than 40% compliance in all the four criteria utilized to assess an increase in oral use. These are: <ul style="list-style-type: none"> ○ Criterion 1: Oral metronidazole is used in preference to IV metronidazole ○ Criterion 2: For each IV administration of metronidazole, there are records indicating why this route was used in preference to oral metronidazole ○ Criterion 3: For each IV administration, there are records indicating that the need was re-examined daily ○ Criterion 4: For each prescription for IV metronidazole, there are records indicating the switch to oral after significant improvement in patient's condition and patients able to tolerate oral medication. As a result, reduced costs, patient discomfort and possible iatrogenic infections
Ntumba et al., Kenya, 2015 [194]	<ul style="list-style-type: none"> Intervention: Education and Engineering to improve the use of antibiotics in to prevent SSIs including reducing the number of patients prescribed antibiotics post-operatively. Activities included: <ol style="list-style-type: none"> Local adaptation of published guidelines Creation and tools for advocacy, training, and leadership around appropriate antibiotic use to prevent SSIs 406 patients pre-intervention, 353 post-intervention Aim: Improve antimicrobial use of SAP and reduce SSI rates 	<ul style="list-style-type: none"> Patients receiving antibiotics post-operatively decreased from 50% to 26% Alongside this, crude SSI rates significantly decreased from 9.3% to 5% of patients
Ayieko et al., Kenya, 2019 [187]	<ul style="list-style-type: none"> Intervention—education and engineering involving two groups, with both groups receiving a half-day training on the new Kenyan pneumonia guidelines, with physicians in all hospitals supplied with updated protocol booklets including specific pneumonia algorithms. All hospitals also received continued network support The two groups were: <ol style="list-style-type: none"> standard feedback with regular auditing and bimonthly feedback of general paediatric care and enhanced feedback group—Regular auditing of agreed indicators of pneumonia care, with monthly feedback using specific feedback sheets Overall 2299 childhood pneumonia admissions, 1087 within the hospitals randomized to enhanced feedback and 1212 to standard feedback Aim: Examined whether providing enhanced audit and feedback might accelerate adoption of new pneumonia guidelines 	<ul style="list-style-type: none"> An improvement was seen in the enhanced feedback group regarding the correct classification and treatment of pneumonia after each round of enhanced feedback However, the performance declined in the standard feedback arm over time, which was attributable to consistently poor performances among four out of the six participating facilities

Table 3. Cont.

Author, Country and Year	Intervention and Aim	Impact of the Intervention
Allegranzi et al., Kenya, Uganda, Zambia, and Zimbabwe, 2018 [195]	<ul style="list-style-type: none"> Intervention: Education and Engineering to improve antibiotic prescribing for the prevention of SSIs Activities included: <ul style="list-style-type: none"> Five planned visits to each participating hospital among four African countries during the study period—supported by a range of educational tools Local teams identified key areas of concern with preventing SSIs; subsequently monitoring an agreed range of indicators (six pre-identified ones including skin preparation and optimal timing of prophylaxis) Subsequent launch of pertinent tools and agreed indicators alongside monitoring/feedback to improve future prescribing Aim: Improve antibiotic prescribing for the prevention of SSIs 	<ul style="list-style-type: none"> Appropriate use of antibiotics to prevent SSIs improved from 12.8% (205/1604) at baseline to 39.1% (714/1827) in the follow-up phase ($p < 0.0001$) among the studied hospitals Concurrently, the cumulative incidence of SSIs decreased from a baseline of 8.0% (129/1604) to 3.8% (70/1827) post intervention ($p < 0.0001$)
Abubakar et al., Nigeria, 2019 [200]	<ul style="list-style-type: none"> Intervention: Principally education and engineering Activities included: <ul style="list-style-type: none"> The development and dissemination of an agreed protocol—agreed before its adoption to enhance subsequent adoption rates Educational meetings held with key clinicians to enhance the uptake of agreed protocols combined with wall mounted posters Alongside this, regular audit and feedback meetings using the baseline data to try and improve future antibiotic prescribing There were 226 and 238 surgical procedures in the pre- and post-intervention periods respectively Aim: To improve antibiotic prescribing by reducing the extent of extended prophylaxis to prevent SSIs. 	<ul style="list-style-type: none"> Patients in the post-intervention period were 5.6 times more likely to receive antibiotics within 60 min before the incision to prevent SSIs vs. pre-intervention ($p < 0.001$) The prescribing of 3rd-generation cephalosporins for SAP was reduced from 29.2% in the pre-intervention period to 20.6% in the post-intervention period ($p = 0.032$). The rate of redundant antibiotic prescriptions was reduced by 19.1%—from 70.8% in the pre-intervention period to 51.7% in the post-intervention period The mean cost of SAP among patients was reduced by USD 4.2 ($p < 0.001$) after the interventions
Upper-Middle Income *		
Messina et al., South Africa, 2015 [177]	<ul style="list-style-type: none"> Intervention: Education and Engineering with pharmacists conducting daily AMS rounds in ICUs and ICU step-down wards among 33 private hospitals in South Africa to evaluate hang-time compliance among patients A total of 32,985 patients who received day 1 IV antibiotics were assessed for hang-time compliance Hang-time compliance was seen as patients receiving appropriate antimicrobials within an hour following the prescription Aim: To evaluate the change in compliance with administering antimicrobials within an hour of the prescription after implementation of a national antibiotic stewardship pharmacist-driven hang-time process improvement protocol 	<ul style="list-style-type: none"> Overall hang-time compliance improved from 41.2% (164/398) pre-intervention to 78.4% (480/612) post-intervention ($p < 0.0001$) Post-intervention was analysed at week 60 among participating hospitals ($p < 0.0001$)

Table 3. Cont.

Author, Country and Year	Intervention and Aim	Impact of the Intervention
Brink et al., South Africa, 2016 [174]	<ul style="list-style-type: none"> • Intervention: Principally Education. Activities involved: • Initial training sessions with key stakeholders in each hospital among a total of 47 hospitals discussing the five process measures that would subsequently be audited by pharmacists in each hospital were provided through face-to-face regional learning sessions • Subsequently, each pharmacist was required to undertake audits of the five measures in their hospitals • The five measures included: (a) Cultures not performed before starting empiric treatment; (b) prolonged treatment (7 and 14 days); (c) more than 4 antibiotics prescribed concurrently; (d) concurrent double or EUR redundant antibiotic coverage • 16,662 patients on antibiotics were reviewed during the 104 weeks of standardized measurement, with 7934 interventions by pharmacists recorded for the five targeted measures • Aim: Improve antibiotic prescribing including increasing culture and sensitivity testing and reducing prolonged administration 	<ul style="list-style-type: none"> • Combined reduction in mean antibiotic prescribing in defined daily doses/ 100 patient days—down from 101.38 to 83.04 ($p < 0.0001$) • Reductions across participating hospitals in the number of cultures not performed before starting empiric treatment or prolonged antibiotic treatment (7 and 14 days) • Reductions also in the prescribing of more than 4 antibiotics prescribed concurrently, and the prescribing of concurrent double or redundant antibiotic coverage among participating hospitals
Boyles et al., South Africa, 2017 [175]	<ul style="list-style-type: none"> • Intervention: Education and Engineering to improve future antibiotic use in the hospital • Key activities included: <ol style="list-style-type: none"> 1. A comprehensive ASP program comprising online education, a dedicated antibiotic prescription chart and weekly dedicated ward rounds to discuss current prescribing practices—continued over 4 years 2. Pre- and post-intervention data compared to provide future guidance Aim: To improve future antibiotic use in the hospital 	<ul style="list-style-type: none"> • Total antibiotic consumption fell from 1046 defined daily doses/1000 patient days (pre-intervention) to 868 (first 2 years of the intervention—remaining at similar levels for the next 2 years). Improvements driven by reductions in IV antibiotic use, particularly ceftriaxone • Laboratory testing increased over the same period • Cost savings on antibiotics (inflation adjusted) were ZAR3.2 million over 4 years • No significant change in mortality or 30-day readmission rates over the 4 years
Brink et al., South Africa, 2017 [189]	<ul style="list-style-type: none"> • Intervention: Education and Engineering to reduce inappropriate prescribing of antibiotics to prevent SSIs. • Key activities (driven by hospital pharmacists) included: <ol style="list-style-type: none"> 1. Testing and revising the developed guidelines and toolkits at pilot sites prior to their launch at regional training and institutional workshops 2. Obtaining consensus and endorsement from key professionals within each hospital—enhanced by adapting and modifying guidelines where appropriate (building on current knowledge within each participating hospital including current SSI rates) 3. Choosing at least one or more surgical procedures to audit—including recording pre-intervention practices and trends to demonstrate improvements 4. Measuring compliance to agreed measures over a 4-week period and giving feedback • 24,206 surgical cases were reviewed during the 70 weeks of standard measurements • Aim: Implement a model utilizing existing resources in order to improve antimicrobial use for SAP in line with current guidelines among 34 hospitals in South Africa 	<ul style="list-style-type: none"> • Significant improvement in compliance with all process measures (composite compliance—choice, dosage, timely administration and duration) from 66.8% to 83.3% (95% CI 80.8–85.8) • SSI rate decreased by 19.7% from a mean group rate of 2.46 pre-intervention to 1.97 post-intervention ($p = 0.0029$) • Timely administration of antibiotics increased to 56.4% of surgical patients ($p < 0.0001$)—representing a 62.4% increase • Antibiotic choice consistent with the guidelines increased to 95.9% of patients and the duration of prophylaxis was now appropriate among 93.9% of patients

Table 3. Cont.

Author, Country and Year	Intervention and Aim	Impact of the Intervention
Junaid et al., South Africa, 2018 [192]	<ul style="list-style-type: none"> • Intervention: Principally education in a single hospital over 3 years • Key activities included: <ol style="list-style-type: none"> 1. Weekly dedicated AMS ward rounds 2. A dedicated prescription chart with key issues including dose, frequency, duration, route of administration and possible de-escalation 3. Audit tools for pharmacy, IPC and ward rounds, with regular multi-professional patient reviews 4. A hospital-wide education program incorporating current principles of AMS, posters and e-training modules 5. Infection prevention and control program monitoring • Aim: Describe the development of an institutional ASP over a 3-year period in a single hospital and its impact to provide future guidance 	<ul style="list-style-type: none"> • Dosing considerations completed on patient's charts improved for weight and eGFR; however, allergy entries decreased leading to additional training • Education on sending of cultures prior to antibiotic commencement resulted in increased awareness of HCPs need to improve future prescribing • Staff members reported increased knowledge on AMS principles following the various ASP activities
van den Bergh et al., South Africa, 2020 [184]	<ul style="list-style-type: none"> • Intervention: Principally education to improve compliance to agreed guidelines for CAP. • Activities included: <ol style="list-style-type: none"> 1. A CAP bundle was developed which incorporated seven process measures, which included admission criteria, antibiotic choices, dose and length, as well as three outcome measures including length of hospital stay and mortality, which pharmacists subsequently used to audit compliance to the bundle and provide feedback 2. Training sessions were conducted on the CAP guidelines and implementing ASPs within hospitals across South Africa. Following each learning session, a checklist of essential activities and deadlines was provided to each attending pharmacist 3. Baseline data were collected to identify areas for improvement 4. In a four-week period following the learning sessions, pharmacists subsequently applied the learnt ideas to improve compliance to the CAP guidelines and ways to give feedback to address identified gaps to further improve future compliance • Overall, 3117 patients were reviewed of which 2464 were included in the final analysis—1247 patients at baseline that were compared to 1217 post intervention. • Aim: To improve compliance to agreed guidelines for CAP to improve future care of patients 	<ul style="list-style-type: none"> • 2464 patients from 39 hospitals were included with the ASP showing positive results: • CAP bundle compliance improved from 47.8% to 53.6% ($p < 0.0001$) • Diagnostic stewardship compliance improved from 49.1% to 54.6% ($p < 0.0001$) • Improved compliance with process measures was significant for 5 of the 7 components, which included choice and dose of antibiotics prescribed as well as IV to oral switching • However, there was no significant difference in mortality or median length of stay pre- and post-intervention
Bashar et al., South Africa, 2021 [173]	<ul style="list-style-type: none"> • Intervention: Education and Engineering involving regular ASP ward rounds on two surgical wards • During the ward rounds—each condition was discussed especially concerning antibiotic selection and laboratory investigations • In addition, potential switching from intravenous to oral agents, dose optimisation and any dose adjustments in patients with renal and hepatic impairment • 476 patients were involved—264 at baseline vs 212 in ASP phase • Aim: Demonstrate a reduction in antibiotic usage (measured by the volume of antibiotic consumption following the ASP)—as a result improve overall antibiotic prescribing 	<ul style="list-style-type: none"> • Reduction in the volume of antibiotic consumption from 739.30 DDDs/1000 to 564.93 DDDs/1000 patient days following the ASP • Reduction in inappropriate antibiotic use from 35% to 26% of patients • An overall increase in culture targeted therapy • Reduction in antibiotic administration for more than one day post operatively to prevent SSIs (from 7.3% to 6.6%) • Small (non-significant reduction) in total antibiotics administered IV (from 89.4% to 84.2%) alongside an increase in appropriate IV administration from 56.9% to 60.8%

AMS: Antimicrobial Stewardship; ASP: Antimicrobial Stewardship Program; CAP: Community Acquired Pneumonia; ECS: Emergency Caesarean Sections; ICU: Intensive Care Unit; HCP: Healthcare Professional; IPC: Infection, Prevention and Control; PPS: Point Prevalence Survey; QI: Quality Indicator; SSI: Surgical Site Infection; * World Bank Status.

Table 4. Suggested strategies to improve future antimicrobial utilization among hospitals across Africa.

Timescale	Potential Strategies
Short to Medium Term (e.g., 1 to 5 years)	<i>Health authorities/Governments (if not already instigated)</i>
	<ul style="list-style-type: none"> • NAPs: Governments and health authorities across Africa must be committed to reducing the inappropriate use of antibiotics in hospitals. This will necessarily involve resources (technical/personnel and financial) to address current challenges, including currently limited activities surrounding ASPs, alongside building the necessary infrastructure, including electronic records, to routinely collect prescribing data. Electronic systems are essential to be able to routinely monitor prescribing against agreed prescribing/quality indicators. • Potential prescribing/quality indicators: Agree with all key stakeholder groups on indicators for use within different hospitals in a country, building on the key principles for indicator development (Figure 1). Existing prescribing/quality indicators (Table 2) can be used as a starting point. However, need to ensure that any agreed indicators are prioritized to prevent overload. • Record keeping: The content and nature of any agreed indicator will depend on the nature of current patient record keeping, e.g., electronic or paper based, and how often the data are collected/ prescribing monitored. • Indicators: Any agreed indicators need to be part of ongoing ASPs within hospitals. Training, resources and personnel must be devoted to instigating ASPs to enhance their chance of success (Box 1). If there are concerns with current limited activities within hospitals and a lack of knowledge and expertise within hospitals to undertake these, this can also be part of NAPs as well as ongoing ASP activities surrounding the WHO AwaRE list [56,64,204]. • Culture differences: Any ASP activities must recognize that there are differences in cultures between countries. Any ASPs instigated will need to be country and culture specific, as well as multidisciplinary, to enhance their long-term sustainability among African countries [205,206], building on successful programs already instigated across Africa (Table 3). • Key targets: For NAPs/ hospital ASPs across Africa include reducing the extent of prolonged prophylaxis to prevent SSIs given the extent of their overuse (Table 1), as well as the general overuse of antimicrobials in patients admitted to hospitals with COVID-19 [81,85,87,88]. • Other key targets: Encouraging greater use of CST to guide future prescribing in hospitals. This depends on available and timely facilities and no/limited co-payments from patients for sensitivity testing [76]. National AMR surveillance facilities are growing across Africa, and this will continue alongside addressing infrastructure challenges, to help achieve NAP goals [9,53,207]. • Robust guidelines: Need to be developed/ updated/ disseminated for the management of key infectious diseases within hospitals among African countries, recognizing that active dissemination and communication of guidelines, as well as trust in those developing guidelines and their content, combined with their ease of use, are key to enhancing subsequent adherence rates [185,208–212]. This should include encouraging greater prescribing of ‘Access’ antibiotics where indicated [56,58], aided by the development of specific Apps to monitor the progress of ASPs and their impact on subsequent prescribing [135]. • Monitoring prescribing: Monitoring against current guidelines and NAPs, enhanced by auditing, academic detailing and use of electronic record systems [208,211]. In addition, groups such as the Commonwealth Pharmacists developing and testing specific applications to assist with prescribing and ASPs [81,135,213]. AMS teams have a key role here along with Drug and Therapeutic Committees in hospitals [214,215]. This may mean increasing resources and training to ensure functioning AMS teams and DTCs where there are limited activities to date (Box 1) [216]. • Adequate training: Ensure physicians, hospital pharmacists, microbiologists and other key healthcare professionals regarding antibiotics, AMR and ASPs are trained and continue to train post qualification (CPD) [130,217–220]. Increasingly, this is likely to involve hybrid learning building on the experiences during the COVID-19 pandemic [221]. • Supply chains: Address supply chain bottlenecks which affect the routine availability of first-line (‘Access’) antibiotics and/or over-supply of ‘Watch’ antibiotics against current approved local guidelines. This is particularly important in low and low-middle-income countries where there can be considerable supply and access issues, e.g., Uganda. • Strengthen prevention and detection of counterfeit/sub-standard antibiotics: This can be achieved through regional collaborative initiatives for capacity-building of regulatory authorities to enhance Good Manufacturing Practice (GMP), quality assurance, pharmacovigilance, and law enforcement, e.g., ZaZiBoNA which is an initiative among the SADC countries [222]. This builds on the recent WHO Lomé initiative [223].

Table 4. Cont.

Timescale	Potential Strategies
<i>Healthcare professionals in hospitals</i>	<ul style="list-style-type: none"> • Ascertain current beliefs/knowledge: Regarding antibiotics, AMR, ASPs and NAPs especially where there are concerns with the current situation within hospitals and gaps in the knowledge of key HCPs. • Multidisciplinary work: Work with Governments, health authorities and other key national organisations to develop (where pertinent) national/local evidence-based guidelines for important infectious diseases in hospitals, which are regularly updated and easily accessible increasingly through simple, easy to use applications and other systems [135,185]. This builds on current Pan-African initiatives [50,51,224]. • Communication: Encourage physicians and other HCPs through auditing and other approaches to regularly consult their national/local guidelines about optimal treatment for their patients. This includes encouraging CST to reduce the extent of untargeted prescribing. • Evidence: Microbiology, infectious disease specialists and other groups within hospitals actively producing and updating antibiograms to improve empiric prescribing whilst awaiting the results from sensitivity testing. • Guidelines: Become actively involved in developing/reviewing national/local guidelines and ASPs, including the development of pertinent prescribing/quality indicators as part of hospital and NAP activities. This can also include ensuring, and be part of, active IPC groups within hospitals as well as Drugs and Therapeutic Committees where antibiotic use and availability is discussed building on concerns among African countries [214,216]. • Training: Ensure students and HCPs continue training to improve their knowledge of antibiotics, AMR and ASPs building on national and international initiatives [46,225]. This can include improving communication skills with patients to address any concerns [226]. • In addition, hospital pharmacists: <ul style="list-style-type: none"> (a) Education: Where necessary, enrol in courses to become knowledgeable about antibiotics and prescribing to assist physicians with their prescribing decisions; and in certain situations also potentially become prescribers. (b) Inclusion in ASPs: Must become actively involved with instigating and progressing ASPs in the hospital, building on activities within African countries such as South Africa and beyond [135,227]. (c) Provide educational support to physicians and other HCPs: Address any concerns regarding a lack of understanding or activities pertaining to antibiotics, AMR and ASPs within hospitals across Africa [129,130]. Outline appropriate antimicrobials to prescribe—especially pertinent where the main educational input on antibiotic prescribing in hospitals is via pharmaceutical companies and their literature [228,229]. (d) Guideline and prescribing/quality indicator development: Become involved with these initiatives as well as undertake PPS studies in hospitals. Promote targets for key quality improvement areas including antimicrobial use to prevent SSIs (Table 1) as well as documentation for the rationale for antibiotic prescribing, start and stop dates as well as active de-escalation from IV to oral antibiotics (Table 2). The development of an application and other electronic monitoring approaches should help [61,172], coupled with regularly feeding back concerns with antimicrobial usage patterns within hospitals to all key stakeholder groups and working with them on potential ways forward. (e) Antibiotic shortages: Actively work with key groups in hospitals and wider to proactively address possible antibiotic shortages where these occur. This means ascertaining key areas to address within current supply chains including ensuring timely payment of suppliers, checking suppliers have the capacity to deliver requested supplies as well as agreeing in advance potential therapeutic interchange recommendations ready for when the need arises [196,230].
Long Term (5 to 10 years)	<p data-bbox="427 1509 799 1532">Potential long-term strategies include:</p> <ul style="list-style-type: none"> • Health authorities/Governments: <ul style="list-style-type: none"> ○ NAPs: Regularly monitor antimicrobial utilization patterns across sectors as part of agreed NAPs across Africa [70]. This includes instigating electronic record systems within hospitals to track prescribing. ○ Antibiotic utilization: Instigate where pertinent additional multiple strategies to improve antibiotic utilization in hospitals, including the provision of necessary resources required for implementing ASPs/IPC committees in hospitals, routine CST and the development of hospital specific antibiograms, instigation of clinical decision support systems, and regular updating of guidelines. ○ Prescribing/quality indicators: Developing additional indicators/refining current indicators where pertinent to remain current as well as avoiding overloading HCPs. ○ Increasing investment in research: new and existing antimicrobials, diagnostic tools, and vaccines are all needed across Africa.

Table 4. Cont.

Timescale	Potential Strategies
Long Term (5 to 10 years)	Potential long-term strategies include:
	<ul style="list-style-type: none"> ● Physicians and other healthcare professionals: <ul style="list-style-type: none"> ○ Educational activities: Regularly review current educational activities in medical/pharmacy/nursing schools regarding students' knowledge of antibiotics, ASPs and AMR and keep up to date. ○ Key stakeholder groups: Keep engaging with key stakeholder groups to instigate additional ASPs where pertinent including where there is still extended antibiotic prescribing to prevent SSIs, there are concerns with lack of de-escalation of antibiotics and a continued lack of documentation in patients' notes as part of ongoing NAPs. ○ Prescribing/quality indicators: Work with all key stakeholders to continue to develop/refine/update these—especially if outdated and where there is perceived overload. ○ Empiric prescribing: Continue to develop, update and communicate hospital antibiograms to improve empiric prescribing whilst awaiting CST results. ○ Regularly monitor prescribing activities: Quality improvement programs in hospitals including increased accountability of prescribers with a requirement to justify their treatment approach; Building restrictions for certain antibiotics where necessary based on the WHO AWaRe list and agreed quality indicators [56,58,66,231]. ○ Communication: Keep working with key stakeholders to enhance adherence to agreed national/local guidelines to improve patient outcomes and reduce AMR. ○ Hospital Pharmacists—Improve antibiotic utilization: Continue to monitor antimicrobial utilization patterns against agreed prescribing/quality indicators as part of agreed NAPs. In addition, regularly review therapeutic interchange policies for possible antimicrobial shortages as part of DTC and AMS programs. ○ Clinical Microbiologists/Laboratory scientists: Conduct and provide timely CST, including updating local antibiogram data in line with susceptibility patterns.

AMR: Antimicrobial Resistance; AMS: Antimicrobial stewardship; ASPs: Antimicrobial Stewardship Programs; CST: Culture and Sensitivity Testing; DTC: Drug and Therapeutic Committees; HCP: Healthcare Professional; IPC: Infection, Prevention and Control; NAP: National Action Plans for AMR; PPS: Point Prevalence Surveys; SSIs: Surgical Site Infections.

3. Discussion

Reducing the burden of AMR is a high priority across Africa given its appreciable impact on morbidity, mortality and costs [38,39,43,232]. This is in part driven by the inappropriate and overuse of antimicrobials; however, this association appears less clear cut in LMICs due to the risks of contagion [28,232–237]. The multiple PPS studies undertaken across Africa in recent years (Table 1) have shown considerable usage across most African countries compared with other countries and continents [112], with the highest rates seen in Nigeria between 59.6 and 97.6% of surveyed patients. These utilization rates are appreciably higher than the suggested WHO target of 40% of hospital in-patients [238]. The lower utilization rates seen in South Africa, at 33.6% to 49.7% of hospital in-patients, may reflect the fact that the South African Government launched its 'Antimicrobial Resistance National Strategy Framework' in 2014, coupled with the availability of microbiology laboratories and the performance of hospitals being regularly monitored since 2014 [171,239]. Greater implementation of the NAPs is needed to reduce future utilization rates in hospitals; however, some African countries have only just started on this activity [70]. An average compliance of 59.5% to the National strategy was recently recorded among 26 public sector facilities across South Africa helping to improve antimicrobial prescribing and reducing AMR [239].

Encouragingly, the penicillins (typically in the Access group) and metronidazole were among the most prescribed antibiotics across Africa (Table S1), with currently limited prescribing of 'Reserve' antibiotics. However, there was appreciable prescribing of cephalosporins, which are typically third-generation cephalosporins incorporating ceftriaxone, in hospitals including for SAP, which is a concern as ceftriaxone is a 'Watch' category antibiotic. Greater prescribing of 'Access' antibiotics in hospitals, where appropriate, can be achieved through establishing pertinent prescribing/quality targets as well as monitoring subsequent utilization patterns in hospitals as part of ASPs. This can be part of a plethora of both short- and longer-term initiatives that can be undertaken across Africa to improve

future antimicrobial use and combat AMR (Table 4). Other prescribing/quality targets are needed to ensure appropriate use of SAP to prevent SSIs by moving away from extended use post-operatively. As seen (Table 1), there is currently appreciable extended use of antibiotics for SAP across Africa, which needs urgently to be addressed to reduce adverse reactions, AMR and costs [83]. Successful ASPs have been implemented among African countries to improve antimicrobial use for SAP (Table 3) providing exemplars.

The number of PPS studies have grown across Africa over time (Table S1) despite concerns with available resources and personnel, providing future guidance, and this acceleration will continue. In addition, we are seeing the number of successful ASPs increase across Africa (Table 3), despite again initial concerns regarding available financial resources and personnel to conduct ASPs in LMICs, providing exemplars to others [128,132,137,138]. This will continue as part of NAPs to reduce rising AMR rates across Africa [2,70].

Potential strategies for all key stakeholders to improve future prescribing of antimicrobials in the hospital sector have been consolidated into suggested short-, medium- and longer-term activities to provide future direction (Table 4). The key is Government commitment and activities through NAPs, and we are already seeing African countries develop and implement these [70]. However, considerable challenges still remain in terms of available finances to undertake agreed activities as well as available personnel to undertake suggested ASP activities and monitor their progress in hospitals. We will continue to monitor the situation given, as mentioned, concerns with rising AMR rates across Africa and the resultant impact on mortality and costs.

It is imperative that Africa progresses with activities to reduce AMR, with AMR seen as the next pandemic and the highest resistance rates are currently in Africa [2,40]. Suggested future research activities will also include a greater understanding of current antimicrobial utilization patterns in ambulatory care given the extent of utilization in this sector versus hospital use, especially for self-limiting conditions such as acute respiratory tract infections [12,70]. Increased digitalization of patient records within healthcare systems across Africa will assist with this [240].

We are aware of a number of limitations with this paper. These include the fact that we have not undertaken full systematic reviews for each topic including PPS and SSI studies as well as QIs and ASPs for the reasons discussed. However, we have documented an appreciable number of PPS and SSI studies across Africa, together with current prescribing/quality indicators in use and ASPs. This has been achieved with the considerable knowledge of the senior level co-authors, similar to discussions on potential future strategies. Despite these limitations, we believe our findings and suggestions are robust given the extent of examples coupled with our methodology providing future direction.

4. Materials and Methods

The principal approach was a narrative review of key areas. This was supplemented by the considerable experience of the co-authors across countries and continents dealing with patients with infectious diseases as well as recording current utilization patterns, implementing policies to improve future prescribing including the development of pertinent quality indicators as well as researching and implementing ASPs.

This mirrors similar studies undertaken by the co-authors across a number of African countries and wider when providing future guidance regarding the management of both infectious and non-infectious diseases, as well as more general approaches, and is in line with institutional guidance [9,12,70,83,95,107,221,241–246].

4.1. Antimicrobial Utilization Patterns in Hospitals across Africa

The methodology built on a recent systematic review of PPS studies undertaken by some of the co-authors [247], and involved studies from 2016 onwards until October 2022. This methodology was employed since some of the sourced studies known to the co-authors would not have been incorporated in databases including PubMed and Web of Science. In addition, the principal objective of this paper was to document the findings from across

Africa to provide a basis for the future. As such, we did not pre-specify which African countries would be included in this narrative review in order to provide as complete a picture as possible to provide exemplars for the future.

Similar to the systematic review of Saleem et al. (2020) [247], key categories included the number of participating hospitals, the PPS methodology, e.g., ECDC, Global PPS or WHO [16,65,77,81,238]; first, second or third most prescribed antibiotic broken down by ATC code and AWaRe classification [56,58,248]; whether prescribed for prophylaxis or treatment and the average number of antibiotics prescribed per patient.

As mentioned, we did not include the 12 hospitals taking part in the Global PPS study of Versporten et al. (2018) in the collation of published PPS studies alongside the African hospitals taking part in the study of Pauwels et al. (2021) as different parameters were collected in these studies including details of the most prescribed antibiotics across the indications [60,112]. However, we did include the study of D'Arcy et al. (2021) involving several African countries as this did contain relevant detailed information [81].

We are aware that some of the PPS studies referenced may contain the same hospital. For this reason, we did not include in the Table (Table S1) the total number of hospitals per country in the various PPS studies. The intention was to list the various studies as exemplars going forward. The various African countries were broken down by their World Bank classification, i.e., low-income, low-middle and upper-middle-income countries, building on the recent study of Adekoya et al. (2021) for consistency [59]. This is because, as mentioned, there have been concerns with available resources and personnel within hospitals among LMICs to undertake PPS studies, and we wanted to explore this further.

4.2. Antibiotic Prophylaxis to Prevent Surgical Site Infections

The principal approach was a narrative review, building on recent publications involving some of the co-authors [83,150]. This was supplemented by additional studies from 2016 onwards known to the co-authors, which included details of antibiotics being prescribed to prevent SSIs incorporated in the sourced PPS studies (Table S1). This is similar to the approach adopted by the co-authors in other studies. The various African countries were again broken down by their World Bank classification, i.e., low-income, low-middle and upper-middle-income countries, building on the recent study of Adekoya et al. (2021) for consistency [59].

4.3. Prescribing Indicators

The principal approach was again a narrative review building on recent publications involving the co-authors supplemented by additional studies known to the senior-level co-authors. This is similar to the approach adopted by the co-authors for the PPS and SSI studies.

4.4. Antimicrobial Stewardship Programs

The principal approach was a narrative review of recent ASPs that had been instigated across Africa. This built on recent reviews coupled with additional studies known to the co-authors from 2013 onwards [132,137,138]. The objective was again to provide guidance to African countries planning ASPs rather than undertaking a systematic review of the studies.

In order to enhance understanding, the different activities that can be undertaken by groups within hospitals when instigating ASPs will be broken down into the 4Es. These are Education, Engineering, Economics and Enforcement [83,249]. Education incorporates a number of activities including developing and communicating formularies as well as developing and monitoring adherence to agreed guidance [116,214,215,249,250]. Engineering includes organizational or managerial interventions [240]. This incorporates for instance prescribing targets such as an agreed percentage of antibiotics being prescribed according to accepted guidelines, an agreed percentage of prescribing of 'Access' antibiotics from the WHO AWaRe list, as well as an agreed percentage of patients prescribed short courses of antibiotics to prevent SSIs [9,58,116]. Economics includes financial incentives to

clinicians, patients, pharmacists or hospitals to improve the rational use of medicines such as incentives for clinicians when reaching agreed prescribing targets as well as fining pharmacists for dispensing an antibiotic without a prescription when this is prohibited [249,251]. Enforcement includes enforcing regulations by law including prohibiting the dispensing of antibiotics within pharmacies without a prescription or regulations banning the use of colistin unless under strict regulations [9,251–253].

The various African countries were again broken down by their World Bank classification, i.e., low-income, low-middle and upper-middle-income countries, building on the recent study of Adekoya et al. (2021) for consistency [59]. This is because, as mentioned, there have been serious concerns about the ability of especially low- and low-middle-income countries to undertake ASPs in practice due to lack of resources and personnel [128].

5. Conclusions

In conclusion, reducing AMR has to be a high priority among all African countries given its clinical and economic impact. Without such activities, AMR will become the next pandemic. However, reducing AMR rates requires multiple coordinated activities across sectors driven by Governments and others across Africa as part of NAPs. This includes an urgent need for HCPs to appreciably reduce inappropriate prescribing of antibiotics across hospitals as well as increased cognisance of classifications and their implications such as the AWaRe classification when prescribing. This necessitates active surveillance of current utilization and resistance patterns across hospitals as well as initiating ASPs for target areas. Such activities include reducing the extent of antibiotic prophylaxis post-operatively for SAP, routinely incorporating the rationale for prescribing of antibiotics in patients' notes alongside inserting start and stop dates, as well as developing and disseminating locally agreed guidelines.

This is essential given limited new antimicrobials being developed as well as concerns with the routine availability of specific antibiotics to tackle resistance; however, this is compensated, to some extent, by developments in vaccine technologies. The latter will require strategies to address the current high rates of vaccine hesitancy that exist across Africa as seen in the recent COVID-19 pandemic. A coordinated approach including all key stakeholder groups is also essential to minimize misinformation and maximize the impact of future interventions to reduce AMR rates. This can be part of an agreed One Health approach incorporated into NAPs.

Supplementary Materials: The following are available online at <https://www.mdpi.com/article/10.3390/antibiotics11121824/s1>, Box S1: Potential barriers to instigating ASPs in hospitals and improving future antimicrobial prescribing, Table S1: Literature review of point prevalence surveys across Africa.

Author Contributions: Conceptualization, Z.S., B.G., S.M.C., L.S., I.A.S., J.C.M. and C.E.M.; methodology, Z.S., B.G., A.C., M.A.K., S.M.C., L.S., A.H., A.A., J.O.F., H.N. and C.E.M.; validation, Z.S., B.G., A.C., M.A.K., S.M.C., R.A.S., L.S., A.H., A.A., A.K., J.C.M. (Julius C. Mwita), I.A.S., S.A.O., J.O.F., O.O.O., J.C.M. (Johanna C. Meyer), A.M., D.K., A.C.K., M.S., H.N., G.P. and C.E.M.; investigation, Z.S., B.G., A.C., M.A.K., S.M.C., R.A.S., L.S., A.H., A.A., A.K., J.C.M. (Julius C. Mwita), I.A.S., S.A.O., J.O.F., O.O.O., J.C.M. (Johanna C. Meyer), A.M., D.K., A.C.K., M.S., H.N., G.P. and C.E.M.; resources, Z.S., B.G., A.C., L.S. and C.E.M.; data curation, Z.S., B.G., A.C., M.A.K., S.M.C., R.A.S., L.S., A.H., A.A., A.K., J.C.M. (Julius C. Mwita), I.A.S., S.A.O., J.O.F., O.O.O., J.C.M. (Johanna C. Meyer), A.M., D.K., A.C.K., M.S., G.P. and C.E.M.; writing—original draft preparation, B.G.; writing—review and editing, Z.S., B.G., A.C., M.A.K., S.M.C., R.A.S., L.S., A.H., A.A., A.K., J.C.M. (Julius C. Mwita), I.A.S., S.A.O., J.O.F., O.O.O., J.C.M. (Johanna C. Meyer), A.M., D.K., A.C.K., M.S., H.N. and C.E.M.; visualization, Z.S., B.G., A.C., S.M.C., L.S. and C.E.M.; supervision, B.G.; project administration, B.G. All authors have read and agreed to the published version of the manuscript.

Funding: A.C. and C.E.M. are funded by the Wellcome Trust (222051/Z/20/Z) for the ADILA project.

Institutional Review Board Statement: There was no ethical approval as this study did not involve direct contact with humans or animals. We have used this approach before when undertaking similar studies. This is in line with previous similar papers published by the co-authors [9,12,70,83,241,245,247,253,254].

Informed Consent Statement: There was no informed consent as this study did not involve direct contact with patients.

Data Availability Statement: Additional data are available on reasonable request from the corresponding author. However, all informational sources and papers have been extensively referenced. References [255–266] are cited in Supplementary Materials file.

Acknowledgments: The authors would like to thank the Deanship of Scientific research at the Umm Al-Qura University for their help with this work via grant code: 22UQU4290073DSR05.

Conflicts of Interest: The authors declare no relevant conflict of interest.

References

- Hofer, U. The cost of antimicrobial resistance. *Nat. Rev. Microbiol.* **2019**, *17*, 3. [[CrossRef](#)] [[PubMed](#)]
- Murray, C.J.; Ikuta, K.S.; Sharara, F.; Swetschinski, L.; Aguilar, G.R.; Gray, A.; Han, C.; Bisignano, C.; Rao, P.; Wool, E.; et al. Global burden of bacterial antimicrobial resistance in 2019: A systematic analysis. *Lancet* **2022**, *399*, 629–655. [[CrossRef](#)]
- Cassini, A.; Högberg, L.D.; Plachouras, D.; Quattrocchi, A.; Hoxha, A.; Simonsen, G.S.; Colomb-Cotinat, M.; Kretzschmar, M.E.; Devleeschauwer, B.; Michele Cecchini, M.; et al. Attributable deaths and disability-adjusted life-years caused by infections with antibiotic-resistant bacteria in the EU and the European Economic Area in 2015: A population-level modelling analysis. *Lancet Infect. Dis.* **2019**, *19*, 56–66. [[CrossRef](#)] [[PubMed](#)]
- Founou, R.C.; Founou, L.L.; Essack, S.Y. Clinical and economic impact of antibiotic resistance in developing countries: A systematic review and meta-analysis. *PLoS ONE* **2017**, *12*, e0189621. [[CrossRef](#)] [[PubMed](#)]
- Nkengasong, J.N.; Tessema, S.K. Africa Needs a New Public Health Order to Tackle Infectious Disease Threats. *Cell* **2020**, *183*, 296–300. [[CrossRef](#)]
- Bell, D.; Schultz Hansen, K. Relative Burdens of the COVID-19, Malaria, Tuberculosis, and HIV/AIDS Epidemics in Sub-Saharan Africa. *Am. J. Trop. Med. Hyg.* **2021**, *105*, 1510–1515. [[CrossRef](#)]
- Dwyer-Lindgren, L.; Cork, M.A.; Sligar, A.; Steuben, K.M.; Wilson, K.F.; Provost, N.R.; Mayala, B.K.; VanderHeide, J.D.; Collison, M.L.; Hall, J.B.; et al. Mapping HIV prevalence in sub-Saharan Africa between 2000 and 2017. *Nature* **2019**, *570*, 189–193. [[CrossRef](#)]
- Williams, P.C.M.; Isaacs, D.; Berkley, J.A. Antimicrobial resistance among children in sub-Saharan Africa. *Lancet Infect. Dis.* **2018**, *18*, e33–e44. [[CrossRef](#)]
- Godman, B.; Egwuenu, A.; Haque, M.; Malande, O.; Schellack, N.; Kumar, S.; Saleem, Z.; Sneddon, J.; Hoxha, I.; Islam, S.; et al. Strategies to Improve Antimicrobial Utilization with a Special Focus on Developing Countries. *Life* **2021**, *11*, 528. [[CrossRef](#)]
- Prevention of Opportunistic Infections in HIV/AIDS. In *StatPearls*; StatPearls Publishing Copyright © 2022; StatPearls Publishing LLC.: Treasure Island, FL, USA, 2022.
- Belachew, S.A.; Hall, L.; Selvey, L.A. Non-prescription dispensing of antibiotic agents among community drug retail outlets in Sub-Saharan African countries: A systematic review and meta-analysis. *Antimicrob. Resist. Infect. Control* **2021**, *10*, 13. [[CrossRef](#)]
- Godman, B.; Haque, M.; McKimm, J.; Abu Bakar, M.; Sneddon, J.; Wale, J.; Campbell, S.; Martin, A.P.; Hoxha, I.; Abilova, V.; et al. Ongoing strategies to improve the management of upper respiratory tract infections and reduce inappropriate antibiotic use particularly among lower and middle-income countries: Findings and implications for the future. *Curr. Med. Res. Opin.* **2020**, *36*, 301–327. [[CrossRef](#)]
- Kiggundu, R.; Wittenauer, R.; Waswa, J.; Nakambale, H.N.; Kitutu, F.E.; Murungi, M.; Okuna, N.; Morries, S.; Lawry, L.L.; Joshi, M.P.; et al. Point Prevalence Survey of Antibiotic Use across 13 Hospitals in Uganda. *Antibiotics* **2022**, *11*, 199. [[CrossRef](#)]
- Ogunleye, O.O.; Oyawole, M.R.; Odunuga, P.T.; Kalejaye, F.; Yinka-Ogunleye, A.F.; Olalekan, A.; Ogundele, S.O.; Ebruke, B.E.; Richard, A.K.; Paramadhas, B.D.A.; et al. A multicentre point prevalence study of antibiotics utilization in hospitalized patients in an urban secondary and a tertiary healthcare facilities in Nigeria: Findings and implications. *Expert Rev. Anti-Infect. Ther.* **2022**, *20*, 297–306. [[CrossRef](#)]
- Gwebu, P.C.; Meyer, J.C.; Schellack, N.; Matsebula-Myeni, Z.C.; Godman, B. A web-based point prevalence survey of antimicrobial use and quality indicators at Raleigh Fitkin Memorial Hospital in the Kingdom of Eswatini and the implications. *Hosp. Pract.* **2022**, *50*, 214–221. [[CrossRef](#)]
- Aboderin, A.O.; Adeyemo, A.T.; Olayinka, A.A.; Oginni, A.S.; Adeyemo, A.T.; Oni, A.A.; Olabisi, O.F.; Fayomi, O.D.; Anuforo, A.C.; Egwuenu, A.; et al. Antimicrobial use among hospitalized patients: A multi-center, point prevalence survey across public healthcare facilities, Osun State, Nigeria. *Germs* **2021**, *11*, 523–535. [[CrossRef](#)]
- Sulis, G.; Adam, P.; Nafade, V.; Gore, G.; Daniels, B.; Daftary, A.; Das, J.; Gandra, S.; Pai, M. Antibiotic prescription practices in primary care in low- and middle-income countries: A systematic review and meta-analysis. *PLoS Med.* **2020**, *17*, e1003139. [[CrossRef](#)]

18. Gasson, J.; Blockman, M.; Willems, B. Antibiotic prescribing practice and adherence to guidelines in primary care in the Cape Town Metro District, South Africa. *S. Afr. Med. J.* **2018**, *108*, 304–310. [[CrossRef](#)]
19. Anand Paramadhas, B.D.; Tiroyakgosi, C.; Mpinda-Joseph, P.; Morokotso, M.; Matome, M.; Sinkala, F.; Gaolebe, M.; Malone, B.; Molosiwa, E.; Shanmugam, M.G.; et al. Point prevalence study of antimicrobial use among hospitals across Botswana; findings and implications. *Expert Rev. Anti-Infect. Ther.* **2019**, *17*, 535–546. [[CrossRef](#)]
20. Guma, S.P.; Godman, B.; Campbell, S.M.; Mahomed, O. Determinants of the Empiric Use of Antibiotics by General practitioners in South Africa: Observational, Analytic, Cross-Sectional Study. *Antibiotics* **2022**, *11*, 1423. [[CrossRef](#)]
21. Ndaki, P.M.; Mushi, M.F.; Mwangi, J.R.; Konje, E.T.; Ntinginya, N.E.; Mmbaga, B.T.; Keenan, K.; Sabiiti, W.; Kesby, M.; Benitez-Paez, F.; et al. Dispensing Antibiotics without Prescription at Community Pharmacies and Accredited Drug Dispensing Outlets in Tanzania: A Cross-Sectional Study. *Antibiotics* **2021**, *10*, 1025. [[CrossRef](#)]
22. Auta, A.; Hadi, M.A.; Oga, E.; Adewuyi, E.O.; Abdu-Aguye, S.N.; Adeloye, D.; Strickland-Hodge, B.; Morgan, D.J. Global access to antibiotics without prescription in community pharmacies: A systematic review and meta-analysis. *J. Infect.* **2019**, *78*, 8–18. [[CrossRef](#)] [[PubMed](#)]
23. Batista, A.D.; Rodrigues, D.A.; Figueiras, A.; Zapata-Cachafeiro, M.; Roque, F.; Herdeiro, M.T. Antibiotic Dispensation without a Prescription Worldwide: A Systematic Review. *Antibiotics* **2020**, *9*, 786. [[CrossRef](#)] [[PubMed](#)]
24. Kalungia, A.C.; Burger, J.; Godman, B.; Costa, J.O.; Simuwelu, C. Non-prescription sale and dispensing of antibiotics in community pharmacies in Zambia. *Expert Rev. Anti-Infect. Ther.* **2016**, *14*, 1215–1223. [[CrossRef](#)] [[PubMed](#)]
25. Kibuule, D.; Kagoya, H.R.; Godman, B. Antibiotic use in acute respiratory infections in under-fives in Uganda: Findings and implications. *Expert Rev. Anti-Infect. Ther.* **2016**, *14*, 863–872. [[CrossRef](#)] [[PubMed](#)]
26. Sakeena, M.H.F.; Bennett, A.A.; McLachlan, A.J. Non-prescription sales of antimicrobial agents at community pharmacies in developing countries: A systematic review. *Int. J. Antimicrob. Agents* **2018**, *52*, 771–782. [[CrossRef](#)]
27. Afari-Asiedu, S.; Oppong, F.B.; Tostmann, A.; Abdulai, M.A.; Boamah-Kaali, E.; Gyaase, S.; Agyei, O.; Kinsman, J.; Hulscher, M.; Wertheim, H.F.L.; et al. Determinants of Inappropriate Antibiotics Use in Rural Central Ghana Using a Mixed Methods Approach. *Front Public Health* **2020**, *8*, 90. [[CrossRef](#)]
28. Klein, E.Y.; Tseng, K.K.; Pant, S.; Laxminarayan, R. Tracking global trends in the effectiveness of antibiotic therapy using the Drug Resistance Index. *BMJ Glob. Health* **2019**, *4*, e001315. [[CrossRef](#)]
29. Mokwele, R.N.; Schellack, N.; Bronkhorst, E.; Brink, A.J.; Schweickerdt, L.; Godman, B. Using mystery shoppers to determine practices pertaining to antibiotic dispensing without a prescription among community pharmacies in South Africa—A pilot survey. *JAC-Antimicrob. Resist.* **2022**, *4*, dlab196. [[CrossRef](#)]
30. Kaupitwa, C.J.; Nowaseb, S.; Godman, B.; Kibuule, D. Analysis of policies for use of medically important antibiotics in animals in Namibia: Implications for antimicrobial stewardship. *Expert Rev. Anti-Infect. Ther.* **2022**, *20*, 1365–1379. [[CrossRef](#)]
31. Mudenda, S.; Mukosha, M.; Godman, B.; Fadare, J.; Malama, S.; Munyeme, M.; Hikaambo, C.N.; Kalungia, A.C.; Hamachila, A.; Kainga, H.; et al. Knowledge, Attitudes, and Practices of Community Pharmacy Professionals on Poultry Antibiotic Dispensing, Use, and Bacterial Antimicrobial Resistance in Zambia: Implications on Antibiotic Stewardship and WHO AWaRe Classification of Antibiotics. *Antibiotics* **2022**, *11*, 1210. [[CrossRef](#)]
32. Van Boeckel, T.P.; Pires, J.; Silvester, R.; Zhao, C.; Song, J.; Criscuolo, N.G.; Gilbert, M.; Bonhoeffer, S.; Laxminarayan, R. Global trends in antimicrobial resistance in animals in low- and middle-income countries. *Science* **2019**, *365*, eaaw1944. [[CrossRef](#)]
33. Jibril, A.H.; Okeke, I.N.; Dalsgaard, A.; Olsen, J.E. Association between antimicrobial usage and resistance in Salmonella from poultry farms in Nigeria. *BMC Vet. Res.* **2021**, *17*, 234. [[CrossRef](#)]
34. Njoga, E.O.; Ogugua, A.J.; Nwankwo, I.O.; Awoyomi, O.J.; Okoli, C.E.; Buba, D.M.; Oyeleye, F.A.; Ajibo, F.E.; Azor, N.; Ogunniran, T.M. Antimicrobial drug usage pattern in poultry farms in Nigeria: Implications for food safety, public health and poultry disease management. *Vet. Ital.* **2021**, *57*, 5–12.
35. Hedman, H.D.; Vasco, K.A.; Zhang, L. A Review of Antimicrobial Resistance in Poultry Farming within Low-Resource Settings. *Animals* **2020**, *10*, 264. [[CrossRef](#)]
36. Aslam, B.; Khurshid, M.; Arshad, M.I.; Muzammil, S.; Rasool, M.; Yasmeen, N.; Shah, T.; Chaudhry, T.H.; Rasool, M.H.; Shahid, A.; et al. Antibiotic Resistance: One Health One World Outlook. *Front. Cell. Infect. Microbiol.* **2021**, *11*, 771510. [[CrossRef](#)]
37. Hernando-Amado, S.; Coque, T.M.; Baquero, F.; Martínez, J.L. Defining and combating antibiotic resistance from One Health and Global Health perspectives. *Nat. Microbiol.* **2019**, *4*, 1432–1442. [[CrossRef](#)]
38. Dadgostar, P. Antimicrobial Resistance: Implications and Costs. *Infect. Drug Resist.* **2019**, *12*, 3903–3910. [[CrossRef](#)]
39. The World Bank. Final Report—DRUG-RESISTANT INFECTIONS. A Threat to Our Economic Future March 2017. Available online: <http://documents1.worldbank.org/curated/en/323311493396993758/pdf/final-report.pdf> (accessed on 15 November 2022).
40. Gautam, A. Antimicrobial Resistance: The Next Probable Pandemic. *JNMA J. Nepal Med. Assoc.* **2022**, *60*, 225–228. [[CrossRef](#)]
41. Lim, J.M.; Singh, S.R.; Duong, M.C.; Legido-Quigley, H.; Hsu, L.Y.; Tam, C.C. Impact of national interventions to promote responsible antibiotic use: A systematic review. *J. Antimicrob. Chemother.* **2020**, *75*, 14–29. [[CrossRef](#)]
42. Kamere, N.; Garwe, S.T.; Akinwotu, O.O.; Tuck, C.; Krockow, E.M.; Yadav, S.; Olawale, A.G.; Diyaolu, A.H.; Munkombwe, D.; Muringu, E.; et al. Scoping Review of National Antimicrobial Stewardship Activities in Eight African Countries and Adaptable Recommendations. *Antibiotics* **2022**, *11*, 1149. [[CrossRef](#)]

43. Interagency Coordination Group on Antimicrobial Resistance. No Time to Wait: Securing the Future from Drug-Resistant Infections—Report to the Secretary-General of the United Nations. 2019. Available online: https://www.who.int/antimicrobial-resistance/interagency-coordination-group/IACG_final_report_EN.pdf?ua=1 (accessed on 15 November 2022).
44. OECD Health Policy Studies. Stemming the Superbug Tide. 2018. Available online: <https://www.oecd-ilibrary.org/sites/9789264307599-en/index.html?itemId=/content/publication/9789264307599-en&mimeType=text/html> (accessed on 15 November 2022).
45. World Health Organization (WHO); Food and Agriculture Organization of the United Nations (FAO); World Organisation for Animal Health (OIE). Monitoring Global Progress on Antimicrobial Resistance: Tripartite Amr Country Self-Assessment Survey (Tracss) 2019–2020 Global Analysis Report. 2021. Available online: [https://www.who.int/publications/i/item/monitoring-global-progress-on-antimicrobial-resistance-tripartite-amr-country-self-assessment-survey-\(tracss\)-2019-2020](https://www.who.int/publications/i/item/monitoring-global-progress-on-antimicrobial-resistance-tripartite-amr-country-self-assessment-survey-(tracss)-2019-2020) (accessed on 14 November 2022).
46. BSAC. Global Antimicrobial Stewardship Accreditation Scheme. 2021. Available online: <https://bsac.org.uk/global-antimicrobial-stewardship-accreditation-scheme/> (accessed on 15 November 2022).
47. World Bank Group. Pulling Together to Beat Superbugs Knowledge and Implementation Gaps in Addressing Antimicrobial Resistance. 2019. Available online: <https://openknowledge.worldbank.org/bitstream/handle/10986/32552/Pulling-Together-to-Beat-Superbugs-Knowledge-and-Implementation-Gaps-in-Addressing-Antimicrobial-Resistance.pdf?sequence=1&isAllowed=y> (accessed on 14 November 2022).
48. WHO. Global Action Plan on Antimicrobial Resistance—Report by the Secretariat. 2016. Available online: https://apps.who.int/gb/ebwha/pdf_files/WHA69/A69_24-en.pdf (accessed on 15 November 2022).
49. Matee, M. Antimicrobial resistance (AMR) at the Southern Africa Centre for Infectious Disease Surveillance. 2018. Available online: <https://www.openaccessgovernment.org/southern-africa-centre-for-infectious-disease/52063/> (accessed on 14 November 2022).
50. Craig, J.; Frost, I.; Sriram, A.; Nuttall, J.; Kapoor, G.; Alimi, Y.; Varma, J. Development of the first edition of African treatment guidelines for common bacterial infections and syndromes. *J. Public Health Afr.* **2021**, *12*, 2009. [CrossRef] [PubMed]
51. Africa Centres for Disease Control and Prevention and Center for Disease Dynamics, Economics & Policy. African Antibiotic Treatment Guidelines for Common Bacterial Infections and Syndromes—Recommended Antibiotic Treatments in Neonatal and Pediatric Patients. 2021. Available online: https://africaguidelines.cddep.org/wp-content/uploads/2021/11/Quick-Reference-Guide_Peds_English.pdf (accessed on 15 November 2022).
52. ASLM. The African Society for Laboratory Medicine. Available online: <https://aslm.org/> (accessed on 14 November 2022).
53. Tornimbene, B.; Eremin, S.; Abednego, R.; Abualas, E.O.; Boutiba, I.; Egwuenu, A.; Fuller, W.; Gahimbare, L.; Githii, S.; Kasambara, W.; et al. Global Antimicrobial Resistance and Use Surveillance System on the African continent: Early implementation 2017–2019. *Afr. J. Lab. Med.* **2022**, *11*, 1594. [CrossRef]
54. Fraser, J.L.; Alimi, Y.H.; Varma, J.K.; Muraya, T.; Kujinga, T.; Carter, V.K.; Schultz, C.; Vilas, V.J.D.R. Antimicrobial resistance control efforts in Africa: A survey of the role of Civil Society Organisations. *Glob. Health Action.* **2021**, *14*, 1868055. [CrossRef] [PubMed]
55. Sharland, M.; Pulcini, C.; Harbarth, S.; Zeng, M.; Gandra, S.; Mathur, S.; Magrini, N. Classifying antibiotics in the WHO Essential Medicines List for optimal use—be AWaRe. *Lancet Infect. Dis.* **2018**, *18*, 18–20. [CrossRef] [PubMed]
56. Sharland, M.; Gandra, S.; Huttner, B.; Moja, L.; Pulcini, C.; Zeng, M.; Mendelson, M.; Cappello, B.; Cooke, G.; Magrini, N.; et al. Encouraging AWaRe-ness and discouraging inappropriate antibiotic use—the new 2019 Essential Medicines List becomes a global antibiotic stewardship tool. *Lancet Infect. Dis.* **2019**, *19*, 1278–1280. [CrossRef]
57. Klein, E.Y.; Milkowska-Shibata, M.; Tseng, K.K.; Sharland, M.; Gandra, S.; Pulcini, C.; Laxminarayan, R. Assessment of WHO antibiotic consumption and access targets in 76 countries, 2000–2015: An analysis of pharmaceutical sales data. *Lancet Infect. Dis.* **2021**, *21*, 107–115. [CrossRef]
58. Hsia, Y.; Lee, B.R.; Versporten, A.; Yang, Y.; Bielicki, J.; Jackson, C.; Newland, J.; Goossens, H.; Magrini, N.; Sharland, M.; et al. Use of the WHO Access, Watch, and Reserve classification to define patterns of hospital antibiotic use (AWaRe): An analysis of paediatric survey data from 56 countries. *Lancet Glob. Health* **2019**, *7*, e861–e871. [CrossRef]
59. Adekoya, I.; Maraj, D.; Steiner, L.; Yaphe, H.; Moja, L.; Magrini, N.; Cooke, G.; Loeb, M.; Persaud, N. Comparison of antibiotics included in national essential medicines lists of 138 countries using the WHO Access, Watch, Reserve (AWaRe) classification: A cross-sectional study. *Lancet Infect. Dis.* **2021**, *21*, 1429–1440. [CrossRef]
60. Pauwels, I.; Versporten, A.; Drapier, N.; Vlieghe, E.; Goossens, H. Hospital antibiotic prescribing patterns in adult patients according to the WHO Access, Watch and Reserve classification (AWaRe): Results from a worldwide point prevalence survey in 69 countries. *J. Antimicrob. Chemother.* **2021**, *76*, 1614–1624. [CrossRef]
61. Skosana, P.; Schellack, N.; Godman, B.; Kurdi, A.; Bennie, M.; Kruger, D.; Meyer, J. A national, multicentre, web-based point prevalence survey of antimicrobial use and quality indices among hospitalised paediatric patients across South Africa. *J. Glob. Antimicrob. Resist.* **2022**, *29*, 542–550. [CrossRef]
62. Skosana, P.P.; Schellack, N.; Godman, B.; Kurdi, A.; Bennie, M.; Kruger, D.; Meyer, J.C. A national, multicentre web-based point prevalence survey of antimicrobial use in community healthcare centres across South Africa and the implications. *Hosp. Pract.* **2022**, *50*, 306–317. [CrossRef]
63. Amponsah, O.K.O.; Buabeng, K.O.; Owusu-Ofori, A.; Ayisi-Boateng, N.K.; Hämeen-Anttila, K.; Enlund, H. Point prevalence survey of antibiotic consumption across three hospitals in Ghana. *JAC Antimicrob. Resist.* **2021**, *3*, dlab008. [CrossRef]

64. Seni, J.; Mapunjo, S.G.; Wittenauer, R.; Valimba, R.; Stergachis, A.; Werth, B.J.; Saitoti, S.; Mhadu, N.H.; Lusaya, E.; Konduri, N. Antimicrobial use across six referral hospitals in Tanzania: A point prevalence survey. *BMJ Open* **2020**, *10*, e042819. [CrossRef]
65. Hsia, Y.; Sharland, M.; Jackson, C.; Wong, I.C.K.; Magrini, N.; Bielicki, J.A. Consumption of oral antibiotic formulations for young children according to the WHO Access, Watch, Reserve (AWaRe) antibiotic groups: An analysis of sales data from 70 middle-income and high-income countries. *Lancet Infect. Dis.* **2019**, *19*, 67–75. [CrossRef]
66. Moolla, M.S.; Whitelaw, A.; Decloedt, E.H.; Koegelenberg, C.F.N.; Parker, A. Opportunities to enhance antibiotic stewardship: Colistin use and outcomes in a low-resource setting. *JAC Antimicrob. Resist.* **2021**, *3*, dlab169. [CrossRef]
67. Prusakov, P.; Goff, D.A.; Wozniak, P.S.; Cassim, A.; Scipion, C.E.; Urzúa, S.; Ronchi, A.; Zeng, L.; Ladipo-Ajayi, O.; Aviles-Otero, N.; et al. A global point prevalence survey of antimicrobial use in neonatal intensive care units: The no-more-antibiotics and resistance (NO-MAS-R) study. *eClinicalMedicine* **2021**, *32*, 100727. [CrossRef]
68. Munkholm, L.; Rubin, O. The global governance of antimicrobial resistance: A cross-country study of alignment between the global action plan and national action plans. *Glob. Health* **2020**, *16*, 109. [CrossRef]
69. Iwu, C.D.; Patrick, S.M. An insight into the implementation of the global action plan on antimicrobial resistance in the WHO African region: A roadmap for action. *Int. J. Antimicrob. Agents* **2021**, *58*, 106411. [CrossRef]
70. Godman, B.; Egwuenu, A.; Wesangula, E.; Schellack, N.; Kalungia, A.C.; Tiroyakgosi, C.; Kgatlwane, J.; Mwita, J.C.; Patrick, O.; Niba, L.L.; et al. Tackling antimicrobial resistance across sub-Saharan Africa: Current challenges and implications for the future. *Expert Opin. Drug Saf.* **2022**, *21*, 1089–1111. [CrossRef]
71. Federal Ministries of Agriculture, Rural Development, Environment and Health, Abuja, Nigeria. National Action Plan for Antimicrobial Resistance, 2017–2022. 2017. Available online: https://ncdc.gov.ng/themes/common/docs/protocols/77_1511368219.pdf (accessed on 15 November 2022).
72. Ghana Ministry of Health, Ministry of Food and Agriculture, Ministry of Environment, Science, Technology and Innovation, Ministry of Fisheries and Aquaculture Development. Ghana National Action Plan for Antimicrobial Use and Resistance. 2017–2021. Available online: http://www.moh.gov.gh/wp-content/uploads/2018/04/NAP_FINAL_PDF_A4_19.03.2018-SIGNED-1.pdf (accessed on 14 November 2022).
73. Sangeda, R.Z.; Kibona, J.; Munishi, C.; Arabi, F.; Manyanga, V.P.; Mwambete, K.D.; Horumpende, P.G. Assessment of Implementation of Antimicrobial Resistance Surveillance and Antimicrobial Stewardship Programs in Tanzanian Health Facilities a Year After Launch of the National Action Plan. *Front. Public Health* **2020**, *8*, 454. [CrossRef]
74. Koduah, A.; Gyansa-Lutterodt, M.; Hedidor, G.K.; Sekyi-Brown, R.; Asiedu-Danso, M.; Asare, B.A.; Ackon, A.A.; Annan, E.A. Antimicrobial resistance national level dialogue and action in Ghana: Setting and sustaining the agenda and outcomes. *One Health Outlook* **2021**, *3*, 18. [CrossRef] [PubMed]
75. Labi, A.-K.; Obeng-Nkrumah, N.; Dayie, N.T.K.D.; Egyir, B.; Sampene-Donkor, E.; Newman, M.J.; Opintan, J.A. Antimicrobial use in hospitalized patients: A multicentre point prevalence survey across seven hospitals in Ghana. *JAC Antimicrob. Resist.* **2021**, *3*, dlab087. [CrossRef] [PubMed]
76. Afriyie, D.K.; Sefah, I.A.; Sneddon, J.; Malcolm, W.; McKinney, R.; Cooper, L.; Kurdi, A.; Godman, B.; Seaton, R.A. Antimicrobial point prevalence surveys in two Ghanaian hospitals: Opportunities for antimicrobial stewardship. *JAC Antimicrob. Resist.* **2020**, *2*, dlaa001. [CrossRef] [PubMed]
77. Dodoo, C.; Orman, E.; Alalabila, T.; Mensah, A.; Jato, J.; Mfoafo, K.; Folitse, I.; Hutton-Nyameaye, A.; Ben, I.O.; Mensah-Kane, P.; et al. Antimicrobial Prescription Pattern in Ho Teaching Hospital, Ghana: Seasonal Determination Using a Point Prevalence Survey. *Antibiotics* **2021**, *10*, 199. [CrossRef] [PubMed]
78. Okoth, C.; Opanga, S.; Okalebo, F.; Oluka, M.; Baker Kurdi, A.; Godman, B. Point prevalence survey of antibiotic use and resistance at a referral hospital in Kenya: Findings and implications. *Hosp. Pract.* **2018**, *46*, 128–136. [CrossRef]
79. Momanyi, L.; Opanga, S.; Nyamu, D.; Oluka, M.; Kurdi, A.; Godman, B. Antibiotic Prescribing Patterns at a Leading Referral Hospital in Kenya: A Point Prevalence Survey. *J. Res. Pharm. Pract.* **2019**, *8*, 149–154.
80. Omulo, S.; Oluka, M.; Ombajo, L.; Osoro, E.; Kinuthia, R.; Guantai, A.; Ndegwa, L.; Verani, J.; Opanga, S.; Wesangula, E.; et al. Point-Prevalence Surveys of Antibiotic Use at Three Large Public Hospitals in Kenya. *Infect. Control Hosp. Epidemiol.* **2020**, *41*, s353–s354. [CrossRef]
81. D’Arcy, N.; Ashiru-Oredope, D.; Olaoye, O.; Afriyie, D.; Akello, Z.; Ankrah, D.; Asima, D.M.; Banda, D.C.; Barrett, S.; Brandish, C.; et al. Antibiotic Prescribing Patterns in Ghana, Uganda, Zambia and Tanzania Hospitals: Results from the Global Point Prevalence Survey (G-PPS) on Antimicrobial Use and Stewardship Interventions Implemented. *Antibiotics* **2021**, *10*, 1122. [CrossRef]
82. Abubakar, U. Antibiotic use among hospitalized patients in northern Nigeria: A multicenter point-prevalence survey. *BMC Infect. Dis.* **2020**, *20*, 86. [CrossRef]
83. Mwita, J.C.; Ogunleye, O.O.; Olalekan, A.; Kalungia, A.C.; Kurdi, A.; Saleem, Z.; Sneddon, J.; Godman, B. Key Issues Surrounding Appropriate Antibiotic Use for Prevention of Surgical Site Infections in Low- and Middle-Income Countries: A Narrative Review and the Implications. *Int. J. Gen. Med.* **2021**, *14*, 515–530. [CrossRef]
84. Bediako-Bowan, A.; Owusu, E.; Debrah, S.; Kjerulf, A.; Newman, M.; Kurtzhals, J.; Mølbak, K. Surveillance of surgical site infection in a teaching hospital in Ghana: A prospective cohort study. *J. Hosp. Infect.* **2020**, *104*, 321–327. [CrossRef]
85. Alshaikh, F.S.; Godman, B.; Sindi, O.N.; Seaton, R.A.; Kurdi, A. Prevalence of bacterial coinfection and patterns of antibiotics prescribing in patients with COVID-19: A systematic review and meta-analysis. *PLoS ONE* **2022**, *17*, e0272375. [CrossRef]

86. Langford, B.J.; So, M.; Raybardhan, S.; Leung, V.; Westwood, D.; MacFadden, D.R.; Soucy, J.-P.R.; Daneman, N. Bacterial co-infection and secondary infection in patients with COVID-19: A living rapid review and meta-analysis. *Clin. Microbiol. Infect.* **2020**, *26*, 1622–1629. [[CrossRef](#)]
87. Langford, B.J.; So, M.; Raybardhan, S.; Leung, V.; Soucy, J.-P.R.; Westwood, D.; Daneman, N.; MacFadden, D.R. Antibiotic prescribing in patients with COVID-19: Rapid review and meta-analysis. *Clin. Microbiol. Infect.* **2021**, *27*, 520–531. [[CrossRef](#)]
88. Jeon, K.; Jeong, S.; Lee, N.; Park, M.-J.; Song, W.; Kim, H.-S.; Kim, H.S.; Kim, J.-S. Impact of COVID-19 on Antimicrobial Consumption and Spread of Multidrug-Resistance in Bacterial Infections. *Antibiotics* **2022**, *11*, 535. [[CrossRef](#)]
89. Fukushige, M.; Ngo, N.-H.; Lukmanto, D.; Fukuda, S.; Ohneda, O. Effect of the COVID-19 pandemic on antibiotic consumption: A systematic review comparing 2019 and 2020 data. *Front. Public Health* **2022**, *10*, 946077. [[CrossRef](#)]
90. Adebisi, Y.A.; Jimoh, N.D.; Ogunkola, I.O.; Uwizeyimana, T.; Olayemi, A.H.; Ukori, N.A.; Lucero-Prisno, D.E. The use of antibiotics in COVID-19 management: A rapid review of national treatment guidelines in 10 African countries. *Trop. Med. Health* **2021**, *49*, 51. [[CrossRef](#)]
91. Al-Hadidi, S.H.; Alhussain, H.; Hadi, H.A.; Johar, A.; Yassine, H.M.; Al Thani, A.A.; Eltai, N.O. The Spectrum of Antibiotic Prescribing During COVID-19 Pandemic: A Systematic Literature Review. *Microb. Drug Resist.* **2021**, *27*, 1705–1725. [[CrossRef](#)]
92. Founou, R.C.; Blocker, A.J.; Noubom, M.; Tsayem, C.; Choukem, S.P.; Dongen, M.V.; Founou, L.L. The COVID-19 pandemic: A threat to antimicrobial resistance containment. *Future Sci. OA* **2021**, *7*, Fso736. [[CrossRef](#)]
93. Ghosh, S.; Bornman, C.; Zafer, M.M. Antimicrobial Resistance Threats in the emerging COVID-19 pandemic: Where do we stand? *J. Infect. Public Health* **2021**, *14*, 555–560. [[CrossRef](#)]
94. Quincho-Lopez, A.; Benites-Ibarra, C.A.; Hilario-Gomez, M.M.; Quijano-Escate, R.; Taype-Rondan, A. Self-medication practices to prevent or manage COVID-19: A systematic review. *PLoS ONE* **2021**, *16*, e0259317. [[CrossRef](#)] [[PubMed](#)]
95. Sefah, I.A.; Ogunleye, O.O.; Essah, D.O.; Opanga, S.A.; Butt, N.; Wamaiitha, A.; Guantai, A.N.; Chikowe, I.; Khuluza, F.; Kibuule, D.; et al. Rapid Assessment of the Potential Paucity and Price Increases for Suggested Medicines and Protection Equipment for COVID-19 Across Developing Countries With a Particular Focus on Africa and the Implications. *Front. Pharmacol.* **2020**, *11*, 588106. [[CrossRef](#)] [[PubMed](#)]
96. Hsu, J. How COVID-19 is accelerating the threat of antimicrobial resistance. *Bmj* **2020**, *369*, m1983. [[CrossRef](#)] [[PubMed](#)]
97. Iwu, C.J.; Jordan, P.; Jaja, I.F.; Iwu, C.D.; Wiysonge, C.S. Treatment of COVID-19: Implications for antimicrobial resistance in Africa. *Pan Afr. Med. J.* **2020**, *35* (Suppl. S2), 119. [[CrossRef](#)]
98. Lai, C.C.; Chen, S.Y.; Ko, W.C.; Hsueh, P.R. Increased antimicrobial resistance during the COVID-19 pandemic. *Int. J. Antimicrob. Agents* **2021**, *57*, 106324. [[CrossRef](#)]
99. Ramzan, K.; Shafiq, S.; Raees, I.; Mustafa, Z.U.; Salman, M.; Khan, A.H.; Meyer, J.C.; Godman, B. Co-Infections, Secondary Infections, and Antimicrobial Use in Patients Hospitalized with COVID-19 during the First Five Waves of the Pandemic in Pakistan; Findings and Implications. *Antibiotics* **2022**, *11*, 789. [[CrossRef](#)]
100. Do, N.T.T.; Vu, H.T.L.; Nguyen, C.T.K.; Punpuing, S.; Khan, W.A.; Gyapong, M.; Asante, K.P.; Munguambe, K.; Gómez-Olivé, F.X.; John-Langba, J.; et al. Community-based antibiotic access and use in six low-income and middle-income countries: A mixed-method approach. *Lancet Glob. Health* **2021**, *9*, e610–e619. [[CrossRef](#)]
101. Laxminarayan, R.; Matsoso, P.; Pant, S.; Brower, C.; Røttingen, J.-A.; Klugman, K.; Davies, S. Access to effective antimicrobials: A worldwide challenge. *Lancet* **2016**, *387*, 168–175. [[CrossRef](#)]
102. Källberg, C.; Årdal, C.; Salvesen Blix, H.; Klein, E.; MMartinez, E.; Lindbæk, M.; Outtersen, K.; Røttingen, J.A.; Laxminarayan, R. Introduction and geographic availability of new antibiotics approved between 1999 and 2014. *PLoS ONE* **2018**, *13*, e0205166. [[CrossRef](#)]
103. Wang, K.; Wang, L.; Li, M.; Xie, B.; He, L.; Wang, M.; Zhang, R.; Hou, N.; Zhang, Y.; Jia, F. Real-World Effectiveness of Global COVID-19 Vaccines Against SARS-CoV-2 Variants: A Systematic Review and Meta-Analysis. *Front. Med.* **2022**, *9*, 820544. [[CrossRef](#)]
104. Mohammed, I.; Nauman, A.; Paul, P.; Ganesan, S.; Chen, K.-H.; Jalil, S.M.S.; Jaouni, S.H.; Kawas, H.; Khan, W.A.; Vattoth, A.L.; et al. The efficacy and effectiveness of the COVID-19 vaccines in reducing infection, severity, hospitalization, and mortality: A systematic review. *Hum. Vaccines Immunother.* **2022**, *18*, 2027160. [[CrossRef](#)]
105. Martínez-Baz, I.; Miqueleiz, A.; Casado, I.; Navascués, A.; Trobajo-Sanmartín, C.; Burgui, C.; Guevara, M.; Ezpeleta, C.; Castilla, J. Effectiveness of COVID-19 vaccines in preventing SARS-CoV-2 infection and hospitalisation, Navarre, Spain, January to April 2021. *Eurosurveillance* **2021**, *26*, 2100438. [[CrossRef](#)]
106. Korang, S.K.; von Rohden, E.; Veroniki, A.A.; Ong, G.; Ngalamika, O.; Siddiqui, F.; Juul, S.; Nielsen, E.E.; Feinberg, J.B.; Petersen, J.J.; et al. Vaccines to prevent COVID-19: A living systematic review with Trial Sequential Analysis and network meta-analysis of randomized clinical trials. *PLoS ONE* **2022**, *17*, e0260733. [[CrossRef](#)]
107. Ogunleye, O.O.; Godman, B.; Fadare, J.O.; Mudenda, S.; Adeoti, A.O.; Yinka-Ogunleye, A.F.; Ogundele, S.O.; Oyawole, M.R.; Schönfeldt, M.; Rashed, W.M.; et al. Coronavirus Disease 2019 (COVID-19) Pandemic across Africa: Current Status of Vaccinations and Implications for the Future. *Vaccines* **2022**, *10*, 1553. [[CrossRef](#)]
108. Njoga, E.O.; Mshelbwala, P.P.; Abah, K.O.; Awoyomi, O.J.; Wangdi, K.; Pewan, S.B.; Oyeleye, F.A.; Galadima, H.B.; Alhassan, S.A.; Okoli, C.E.; et al. COVID-19 Vaccine Hesitancy and Determinants of Acceptance among Healthcare Workers, Academics and Tertiary Students in Nigeria. *Vaccines* **2022**, *10*, 626. [[CrossRef](#)]

109. Njoga, E.O.; Awoyomi, O.J.; Onwumere-Idolor, O.S.; Awoyomi, P.O.; Ugochukwu, I.C.I.; Ozioko, S.N. Persisting Vaccine Hesitancy in Africa: The Whys, Global Public Health Consequences and Ways-Out-COVID-19 Vaccination Acceptance Rates as Case-in-Point. *Vaccines* **2022**, *10*, 1934. [CrossRef]
110. Nathwani, D.; Varghese, D.; Stephens, J.; Ansari, W.; Martin, S.; Charbonneau, C. Value of hospital antimicrobial stewardship programs [ASPs]: A systematic review. *Antimicrob. Resist. Infect. Control* **2019**, *8*, 35. [CrossRef]
111. de Carvalho, F.R.T.; Telles, J.P.; Tuon, F.F.B.; Rabello Filho, R.; Caruso, P.; Correa, T.D. Antimicrobial Stewardship Programs: A Review of Strategies to Avoid Polymyxins and Carbapenems Misuse in Low Middle-Income Countries. *Antibiotics* **2022**, *11*, 378. [CrossRef]
112. Versporten, A.; Zarb, P.; Caniaux, I.; Gros, M.-F.; Drapier, N.; Miller, M.; Jarlier, V.; Nathwani, D.; Goossens, H.; Koraqi, A.; et al. Antimicrobial consumption and resistance in adult hospital inpatients in 53 countries: Results of an internet-based global point prevalence survey. *Lancet Glob. Health* **2018**, *6*, e619–e629. [CrossRef]
113. Le Maréchal, M.; Tebano, G.; Monnier, A.A.; Adriaenssens, N.; Gyssens, I.C.; Huttner, B.; Milanic, R.; Schouten, J.; Benic, M.S.; Versporten, A.; et al. Quality indicators assessing antibiotic use in the outpatient setting: A systematic review followed by an international multidisciplinary consensus procedure. *J. Antimicrob. Chemother.* **2018**, *73* (Suppl. S6), vi40–vi49. [CrossRef]
114. Nnadozie, U.U.; Umeokonkwo, C.D.; Maduba, C.C.; Igwe-Okomiso, D.; Onah, C.K.; Madubueze, U.C.; Anikwe, C.C.; Versporten, A.; Pauwels, I.; Goossens, H.; et al. Antibiotic use among surgical inpatients at a tertiary health facility: A case for a standardized protocol for presumptive antimicrobial therapy in the developing world. *Infect. Prev. Pract.* **2020**, *2*, 100078. [CrossRef] [PubMed]
115. Niaz, Q.; Godman, B.; Massele, A.; Campbell, S.; Kurdi, A.; Kagoya, H.R.; Kibuule, D. Validity of World Health Organisation prescribing indicators in Namibia’s primary healthcare: Findings and implications. *Int. J. Qual. Health Care* **2018**, *31*, 338–345. [CrossRef] [PubMed]
116. Campbell, S.M.; Meyer, J.C.; Godman, B. Why Compliance to National Prescribing Guidelines is Important Especially across Sub-Saharan Africa and Suggestions for the Future. *Biomed. Pharm. Sci.* **2021**, *4*, 1–7.
117. Sulis, G.; Sayood, S.; Gandra, S. Antimicrobial resistance in low- and middle-income countries: Current status and future directions. *Expert Rev. Anti-Infect. Ther.* **2022**, *20*, 147–160. [CrossRef] [PubMed]
118. Haldeman, M.S.; Kishimbo, P.; Seddon, M.; Sangare, A.; Mwasomola, D.; Hall, J.; Shaffer, M.; Leclair, R.; Caulder, C.; Bookstaver, P.B.; et al. Evaluation of Antimicrobial Utilization and Concordance with National Guidelines at a Tertiary Hospital in the Southern Highlands Zone of Tanzania. *Am. J. Trop. Med. Hyg.* **2020**, *102*, 370–376. [CrossRef]
119. Alsaeed, O.M.; Bukhari, A.A.; Alshehri, A.A.; Alsumairi, F.A.; Alnami, A.M.; Elsheikh, H.A. The Use of Antibiotics for the Prevention of Surgical Site Infections in Two Government Hospitals in Taif, Saudi Arabia: A Retrospective Study. *Cureus* **2022**, *14*, e26731. [CrossRef]
120. Alagha, H.Z.; Al Telbani, M.J. Investigating antibiotic use in Gaza Strip hospitals: A retrospective cross-sectional analysis. *J. Infect. Dev. Ctries.* **2022**, *16*, 1739–1747. [CrossRef]
121. Eticha, E.M.; Gemechu, W.D. Adherence to Guidelines for Assessment and Empiric Antibiotics Recommendations for Community-Acquired Pneumonia at Ambo University Referral Hospital: Prospective Observational Study. *Patient Prefer. Adherence* **2021**, *15*, 467–473. [CrossRef]
122. Mugada, V.; Mahato, V.; Andhavaram, D.; Vajhala, S.M. Evaluation of Prescribing Patterns of Antibiotics Using Selected Indicators for Antimicrobial Use in Hospitals and the Access, Watch, Reserve (AWaRe) Classification by the World Health Organization. *Turk. J. Pharm. Sci.* **2021**, *18*, 282–288. [CrossRef]
123. Dechasa, M.; Chelkeba, L.; Jorise, A.; Sefera, B.; Melaku, T. Antibiotics use evaluation among hospitalized adult patients at Jimma Medical Center, southwestern Ethiopia: The way to pave for antimicrobial stewardship. *J. Pharm. Policy Pract.* **2022**, *15*, 84. [CrossRef]
124. WHO; World Bank; OECD. Delivering Quality Health Services: A Global Imperative for Universal Health Coverage. 2018. Available online: <https://documents1.worldbank.org/curated/en/482771530290792652/pdf/127816-REVISED-quality-joint-publication-july2018-Complete-vignettes-ebook-L.pdf> (accessed on 14 November 2022).
125. Campbell, S.M.; Braspenning, J.; Hutchinson, A.; Marshall, M. Research methods used in developing and applying quality indicators in primary care. *Qual. Saf. Health Care* **2002**, *11*, 358–364. [CrossRef]
126. Campbell, S.M.; Kontopantelis, E.; Hannon, K.; Burke, M.; Barber, A.; Lester, H.E. Framework and indicator testing protocol for developing and piloting quality indicators for the UK quality and outcomes framework. *BMC Fam. Pract.* **2011**, *12*, 85. [CrossRef]
127. Campbell, S.M.; Godman, B.; Diogene, E.; Fürst, J.; Gustafsson, L.L.; MacBride-Stewart, S.; Malmström, R.E.; Pedersen, H.; Selke, G.; Vlahović-Palčevski, V.; et al. Quality indicators as a tool in improving the introduction of new medicines. *Basic Clin. Pharmacol. Toxicol.* **2015**, *116*, 146–157. [CrossRef]
128. Cox, J.A.; Vlieghe, E.; Mendelson, M.; Wertheim, H.; Ndegwa, L.; Villegas, M.V.; Gould, I.; Hara, G.L. Antibiotic stewardship in low- and middle-income countries: The same but different? *Clin. Microbiol. Infect.* **2017**, *23*, 812–818. [CrossRef]
129. Fadare, J.O.; Ogunleye, O.; Iliyasu, G.; Adeoti, A.; Schellack, N.; Engler, D.; Massele, A.; Godman, B. Status of antimicrobial stewardship programmes in Nigerian tertiary healthcare facilities: Findings and implications. *J. Glob. Antimicrob. Resist.* **2019**, *17*, 132–136. [CrossRef]
130. Kalungia, A.C.; Mwambula, H.; Munkombwe, D.; Marshall, S.; Schellack, N.; May, C.; Jones, A.S.C.; Godman, B. Antimicrobial stewardship knowledge and perception among physicians and pharmacists at leading tertiary teaching hospitals in Zambia: Implications for future policy and practice. *J. Chemother.* **2019**, *31*, 378–387. [CrossRef]

131. Hall, J.W.; Bouchard, J.; Bookstaver, P.B.; Haldeman, M.S.; Kishimbo, P.; Mbwanji, G.; Mwakyula, I.; Mwasomola, D.; Seddon, M.; Shaffer, M.; et al. The Mbeya Antimicrobial Stewardship Team: Implementing Antimicrobial Stewardship at a Zonal-Level Hospital in Southern Tanzania. *Pharmacy* **2020**, *8*, 107. [[CrossRef](#)]
132. Akpan, M.R.; Isemin, N.U.; Udoh, A.E.; Ashiru-Oredope, D. Implementation of antimicrobial stewardship programmes in African countries: A systematic literature review. *J. Glob. Antimicrob. Resist.* **2020**, *22*, 317–324. [[CrossRef](#)]
133. Ackers, L.; Ackers-Johnson, G.; Seekles, M.; Odur, J.; Opio, S. Opportunities and Challenges for Improving Anti-Microbial Stewardship in Low- and Middle-Income Countries; Lessons Learnt from the Maternal Sepsis Intervention in Western Uganda. *Antibiotics* **2020**, *9*, 315. [[CrossRef](#)]
134. Alabi, A.S.; Picka, S.W.; Sirleaf, R.; Ntirenganya, P.R.; Ayebare, A.; Correa, N.; Anyango, S.; Ekwen, G.; Agu, E.; Cook, R.; et al. Implementation of an antimicrobial stewardship programme in three regional hospitals in the south-east of Liberia: Lessons learned. *JAC Antimicrob. Resist.* **2022**, *4*, dlac069. [[CrossRef](#)]
135. Ashiru-Oredope, D.; Garraghan, F.; Olaoye, O.; Krockow, E.M.; Matuluko, A.; Nambatya, W.; Babigumira, P.A.; Tuck, C.; Amofah, G.; Ankrah, D.; et al. Development and Implementation of an Antimicrobial Stewardship Checklist in Sub-Saharan Africa: A Co-Creation Consensus Approach. *Healthcare* **2022**, *10*, 170. [[CrossRef](#)] [[PubMed](#)]
136. Gulumbe, B.H.; Haruna, U.A.; Almazan, J.; Ibrahim, I.H.; Faggo, A.A.; Bazata, A.Y. Combating the menace of antimicrobial resistance in Africa: A review on stewardship, surveillance and diagnostic strategies. *Biol. Proced. Online* **2022**, *24*, 19. [[CrossRef](#)] [[PubMed](#)]
137. Siachalinga, L.; Mufwambi, W.; Lee, I.H. Impact of antimicrobial stewardship interventions to improve antibiotic prescribing for hospital inpatients in Africa: A systematic review and meta-analysis. *J. Hosp. Infect.* **2022**, *129*, 124–143. [[CrossRef](#)] [[PubMed](#)]
138. Otieno, P.A.; Campbell, S.; Maley, S.; Obinju Arunga, T.; Otieno Okumu, M. A Systematic Review of Pharmacist-Led Antimicrobial Stewardship Programs in Sub-Saharan Africa. *Int. J. Clin. Pract.* **2022**, *2022*, 3639943. [[CrossRef](#)] [[PubMed](#)]
139. WHO. Antimicrobial stewardship programmes in health-care facilities in low- and middle-income countries: A WHO practical toolkit. *JAC Antimicrob. Resist.* **2019**, *1*, dlz072. [[CrossRef](#)]
140. WHO. Antimicrobial Stewardship Programmes in Health-Care Facilities in Low- and Middle-Income Countries. A WHO Practical Toolkit. 2019. Available online: <https://apps.who.int/iris/bitstream/handle/10665/329404/9789241515481-eng.pdf> (accessed on 15 November 2022).
141. Sefah, I.A.; Denoo, E.Y.; Bangalee, V.; Kurdi, A.; Sneddon, J.; Godman, B. Appropriateness of surgical antimicrobial prophylaxis in a teaching hospital in Ghana: Findings and implications. *JAC Antimicrob. Resist.* **2022**, *4*, dlac102. [[CrossRef](#)]
142. Abubakar, U. Point-prevalence survey of hospital acquired infections in three acute care hospitals in Northern Nigeria. *Antimicrob. Resist. Infect. Control* **2020**, *9*, 63. [[CrossRef](#)]
143. Martinez-Sobalvarro, J.V.; Júnior, A.A.P.; Pereira, L.B.; Baldoni, A.O.; Ceron, C.S.; Dos Reis, T.M. Antimicrobial stewardship for surgical antibiotic prophylaxis and surgical site infections: A systematic review. *Int. J. Clin. Pharm.* **2022**, *44*, 301–319. [[CrossRef](#)]
144. Forrester, J.D.; Maggio, P.M.; Tennakoon, L. Cost of Health Care-Associated Infections in the United States. *J. Patient Saf.* **2022**, *18*, e477–e479. [[CrossRef](#)]
145. Liu, X.; Cui, D.; Li, H.; Wang, Q.; Mao, Z.; Fang, L.; Ren, N.; Sun, J. Direct medical burden of antimicrobial-resistant healthcare-associated infections: Empirical evidence from China. *J. Hosp. Infect.* **2020**, *105*, 295–305. [[CrossRef](#)]
146. Branch-Elliman, W.; O'Brien, W.; Strymish, J.; Itani, K.; Wyatt, C.; Gupta, K. Association of Duration and Type of Surgical Prophylaxis With Antimicrobial-Associated Adverse Events. *JAMA Surg.* **2019**, *154*, 590–598. [[CrossRef](#)]
147. Kalungia, A.C.; Mukosha, M.; Mwila, C.; Banda, D.; Mwale, M.; Kagulura, S.; Ogunleye, O.O.; Meyer, J.C.; Godman, B. Antibiotic Use and Stewardship Indicators in the First- and Second-Level Hospitals in Zambia: Findings and Implications for the Future. *Antibiotics* **2022**, *11*, 1626. [[CrossRef](#)]
148. Kiguba, R.; Karamagi, C.; Bird, S.M. Extensive antibiotic prescription rate among hospitalized patients in Uganda: But with frequent missed-dose days. *J. Antimicrob. Chemother.* **2016**, *71*, 1697–1706. [[CrossRef](#)]
149. Butt, S.Z.; Ahmad, M.; Saeed, H.; Saleem, Z.; Javaid, Z. Post-surgical antibiotic prophylaxis: Impact of pharmacist's educational intervention on appropriate use of antibiotics. *J. Infect. Public Health* **2019**, *12*, 854–860. [[CrossRef](#)]
150. Cooper, L.; Sneddon, J.; Afriyie, D.K.; Sefah, I.A.; Kurdi, A.; Godman, B.; Seaton, R.A. Supporting global antimicrobial stewardship: Antibiotic prophylaxis for the prevention of surgical site infection in low- and middle-income countries (LMICs): A scoping review and meta-analysis. *JAC-Antimicrob. Resist.* **2020**, *2*, dlac070. [[CrossRef](#)]
151. Abubakar, U.; Syed Sulaiman, S.A.; Adesiyun, A.G. Utilization of surgical antibiotic prophylaxis for obstetrics and gynaecology surgeries in Northern Nigeria. *Int. J. Clin. Pharm.* **2018**, *40*, 1037–1043. [[CrossRef](#)]
152. Aiken, A.M.; Wanyoro, A.K.; Mwangi, J.; Juma, F.; Mugoya, I.K.; Scott, J.A. Changing use of surgical antibiotic prophylaxis in Thika Hospital, Kenya: A quality improvement intervention with an interrupted time series design. *PLoS ONE* **2013**, *8*, e78942. [[CrossRef](#)]
153. Bediako-Bowan, A.A.A.; Mølbak, K.; Kurtzhals, J.A.L.; Owusu, E.; Debrah, S.; Newman, M.J. Risk factors for surgical site infections in abdominal surgeries in Ghana: Emphasis on the impact of operating rooms door openings. *Epidemiol. Infect.* **2020**, *148*, e147. [[CrossRef](#)]
154. Ouedraogo, A.S.; Versporten, A.; Nagalo, A.; Pauwels, I.; Goossens, H.; Ouedraogo, A.; Poda, A. The Global Point Prevalence Survey of Antimicrobial Consumption and Resistance (Global-PPS)—Results of antimicrobial prescribing in Burkina Faso.

2019. Available online: https://www.global-pps.com/wp-content/uploads/2021/02/The-Global-PPS_results-of-antimicrobial-prescribing-in-Burkina-Faso.pdf (accessed on 15 November 2022).
155. Halawi, E.; Assefa, T.; Hussien, S. Pattern of antibiotics use, incidence and predictors of surgical site infections in a Tertiary Care Teaching Hospital. *BMC Res. Notes* **2018**, *11*, 538. [CrossRef]
156. Alemkere, G. Antibiotic usage in surgical prophylaxis: A prospective observational study in the surgical ward of Nekemte referral hospital. *PLoS ONE* **2018**, *13*, e0203523. [CrossRef]
157. Fentie, A.M.; Degefaw, Y.; Asfaw, G.; Shewarega, W.; Woldearegay, M.; Abebe, E.; Gebretekle, G.B. Multicentre point-prevalence survey of antibiotic use and healthcare-associated infections in Ethiopian hospitals. *BMJ Open* **2022**, *12*, e054541. [CrossRef] [PubMed]
158. Nkurunziza, T.; Kateera, F.; Sonderman, K.; Gruendl, M.; Nihiwacu, E.; Ramadhan, B.; Cherian, T.; Nahimana, E.; Ntakiyiruta, G.; Habiyakare, C.; et al. Prevalence and predictors of surgical-site infection after caesarean section at a rural district hospital in Rwanda. *Br. J. Surg.* **2019**, *106*, e121–e128. [CrossRef] [PubMed]
159. Horumpende, P.G.; Mshana, S.E.; Mouw, E.F.; Mmbaga, B.T.; Chilongola, J.O.; de Mast, Q. Point prevalence survey of antimicrobial use in three hospitals in North-Eastern Tanzania. *Antimicrob. Resist. Infect. Control* **2020**, *9*, 149. [CrossRef] [PubMed]
160. Gentilotti, E.; De Nardo, P.; Nguhuni, B.; Piscini, A.; Damian, C.; Vairo, F.; Chaula, Z.; Mencarini, P.; Torokaa, P.; Zumla, A.; et al. Implementing a combined infection prevention and control with antimicrobial stewardship joint program to prevent caesarean section surgical site infections and antimicrobial resistance: A Tanzanian tertiary hospital experience. *Antimicrob. Resist. Infect. Control* **2020**, *9*, 69. [CrossRef] [PubMed]
161. Saito, H.; Inoue, K.; Ditai, J.; Weeks, A.D. Pattern of Peri-Operative Antibiotic Use among Surgical Patients in a Regional Referral and Teaching Hospital in Uganda. *Surg. Infect.* **2020**, *21*, 540–546. [CrossRef]
162. Bunduki, G.K.; Mukululi, M.P.; Masumbuko, C.K.; Uwonda, S.A. Compliance of antibiotics used for surgical site infection prophylaxis among patients undergoing surgery in a Congolese teaching hospital. *Infect. Prev. Pract.* **2020**, *2*, 100075. [CrossRef]
163. Bediako-Bowan, A.A.A.; Owusu, E.; Labi, A.-K.; Obeng-Nkrumah, N.; Sunkwa-Mills, G.; Bjerrum, S.; Opintan, J.A.; Bannerman, C.; Mølbak, K.; Kurtzhals, J.A.L.; et al. Antibiotic use in surgical units of selected hospitals in Ghana: A multi-centre point prevalence survey. *BMC Public Health* **2019**, *19*, 797. [CrossRef]
164. Ankrah, D.; Owusu, H.; Aggor, A.; Osei, A.; Ampomah, A.; Harrison, M.; Nelson, F.; Aboagye, G.O.; Ekpale, P.; Laryea, J.; et al. Point Prevalence Survey of Antimicrobial Utilization in Ghana's Premier Hospital: Implications for Antimicrobial Stewardship. *Antibiotics* **2021**, *10*, 1528. [CrossRef]
165. Opanga, S.A.; Mwangombe, N.J.; Okalebo, F.A.; Godman, B.; Oluka, M.; Kuria, K.A.M. Determinants of the Effectiveness of Antimicrobial Prophylaxis among Neurotrauma Patients at a Referral Hospital in Kenya: Findings and Implications. *Infect. Dis. Prev. Med.* **2017**, *5*, 169.
166. Talaam, R.C.; Abungana, M.M.; Ooko, P.B. An antibiotic audit of the surgical department at a rural hospital in Western Kenya. *Pan Afr. Med. J.* **2018**, *29*, 219. [CrossRef]
167. Nsofor, C.; Es, A.; Obijuru, C.; Ohaleta, C.; Ukwandu, N. Prevalence of Antimicrobial Use in Major Hospitals in Owerri, Nigeria. *EC Microbiol.* **2016**, *3*, 522–527.
168. Oduyebo, O.; Olayinka, A.; Iregbu, K.; Versporten, A.; Goossens, H.; Nwajiobi-Princewill, P.; Jimoh, O.; Ige, T.; Aigbe, A.; Ola-Bello, O.; et al. A point prevalence survey of antimicrobial prescribing in four Nigerian Tertiary Hospitals. *Ann. Trop. Pathol.* **2017**, *8*, 42–46. [CrossRef]
169. Fowotade, A.; Fasuyi, T.; Aigbovo, O.; Versporten, A.; Adekanmbi, O.; Akinyemi, O.; Goossens, H.; Kehinde, A.; Oduyebo, O. Point Prevalence Survey of Antimicrobial Prescribing in a Nigerian Hospital: Findings and Implications on Antimicrobial Resistance. *West Afr. J. Med.* **2020**, *37*, 216–220.
170. Mwita, J.C.; Souda, S.; Magafu, M.; Massele, A.; Godman, B.; Mwandri, M. Prophylactic antibiotics to prevent surgical site infections in Botswana: Findings and implications. *Hosp. Pract.* **2018**, *46*, 97–102. [CrossRef]
171. Skosana, P.; Schellack, N.; Godman, B.; Kurdi, A.; Bennie, M.; Kruger, D.; Meyer, J. A point prevalence survey of antimicrobial utilisation patterns and quality indices amongst hospitals in South Africa; findings and implications. *Expert Rev. Anti-Infect. Ther.* **2021**, *19*, 1353–1366. [CrossRef]
172. Kruger, D.; Dlamini, N.; Meyer, J.; Godman, B.; Kurdi, A.; Lennon, M.; Bennie, M.; Schellack, N. Development of a web-based application to improve data collection of antimicrobial utilization in the public health care system in South Africa. *Hosp. Pract.* **2021**, *49*, 184–193. [CrossRef]
173. Bashar, M.A.; Miot, J.; Shoul, E.; van Zyl, R.L. Impact of an antibiotic stewardship programme in a surgical setting. *S. Afr. J. Infect. Dis.* **2021**, *36*, 307. [CrossRef]
174. Brink, A.J.; Messina, A.P.; Feldman, C.; Richards, G.A.; Becker, P.J.; Goff, D.A.; Bauer, K.A.; Nathwani, D.; van den Bergh, D.; on behalf of the Netcare Antimicrobial Stewardship Study Alliance. Antimicrobial stewardship across 47 South African hospitals: An implementation study. *Lancet Infect. Dis.* **2016**, *16*, 1017–1025. [CrossRef]
175. Boyles, T.H.; Naicker, V.; Rawoot, N.; Raubenheimer, P.J.; Eick, B.; Mendelson, M. Sustained reduction in antibiotic consumption in a South African public sector hospital; Four year outcomes from the Groote Schuur Hospital antibiotic stewardship program. *S. Afr. Med. J.* **2017**, *107*, 115–118. [CrossRef]

176. Gebretekle, G.B.; Mariam, D.H.; Taye, W.A.; Fentie, A.M.; Degu, W.A.; Alemayehu, T.; Beyene, T.; Libman, M.; Fenta, T.G.; Yansouni, C.P.; et al. Half of Prescribed Antibiotics Are Not Needed: A Pharmacist-Led Antimicrobial Stewardship Intervention and Clinical Outcomes in a Referral Hospital in Ethiopia. *Front. Public Health* **2020**, *8*, 109. [[CrossRef](#)]
177. Messina, A.P.; van den Bergh, D.; Goff, D.A. Antimicrobial Stewardship with Pharmacist Intervention Improves Timeliness of Antimicrobials Across Thirty-three Hospitals in South Africa. *Infect. Dis. Ther.* **2015**, *4* (Suppl. S1), 5–14. [[CrossRef](#)] [[PubMed](#)]
178. Labi, A.-K.; Obeng-Nkrumah, N.; Nartey, E.T.; Bjerrum, S.; Adu-Aryee, N.A.; Ofori-Adjei, Y.A.; Yawson, A.E.; Newman, M.J. Antibiotic use in a tertiary healthcare facility in Ghana: A point prevalence survey. *Antimicrob. Resist. Infect. Control* **2018**, *7*, 15. [[CrossRef](#)] [[PubMed](#)]
179. Nakwatumbah, S.; Kibuule, D.; Godman, B.; Haakuria, V.; Kameera, F.; Baker, A.; Mubita, M. Compliance to guidelines for the prescribing of antibiotics in acute infections at Namibia's national referral hospital: A pilot study and the implications. *Expert Rev. Anti-Infect. Ther.* **2017**, *15*, 713–721. [[CrossRef](#)] [[PubMed](#)]
180. Dlamini, N.N.; Meyer, J.C.; Kruger, D.; Kurdi, A.; Godman, B.; Schellack, N. Feasibility of using point prevalence surveys to assess antimicrobial utilisation in public hospitals in South Africa: A pilot study and implications. *Hosp. Pract.* **2019**, *47*, 88–95. [[CrossRef](#)] [[PubMed](#)]
181. Amdany, H.K.; Mcmillan, M. Metronidazole intravenous formulation use in in-patients in Kapkatet District Hospital, Kenya: A best practice implementation project. *JBI Evid. Synth.* **2014**, *12*, 419–432. [[CrossRef](#)]
182. Umar, L.W.; Isah, A.; Musa, S.; Umar, B. Prescribing pattern and antibiotic use for hospitalized children in a Northern Nigerian Teaching Hospital. *Ann. Afr. Med.* **2018**, *17*, 26–32. [[CrossRef](#)]
183. Amaha, N.D.; Berhe, Y.H.; Kaushik, A. Assessment of inpatient antibiotic use in Halibet National Referral Hospital using WHO indicators: A retrospective study. *BMC Res. Notes* **2018**, *11*, 904. [[CrossRef](#)]
184. van den Bergh, D.; Messina, A.P.; Goff, D.A.; van Jaarsveld, A.; Coetzee, R.; de Wet, Y.; Bronkhorst, E.; Brink, A.; Mendelson, M.; Richards, G.A.; et al. A pharmacist-led prospective antibiotic stewardship intervention improves compliance to community-acquired pneumonia guidelines in 39 public and private hospitals across South Africa. *Int. J. Antimicrob. Agents* **2020**, *56*, 106189. [[CrossRef](#)]
185. Niaz, Q.; Godman, B.; Campbell, S.; Kibuule, D. Compliance to prescribing guidelines among public health care facilities in Namibia; findings and implications. *Int. J. Clin. Pharm.* **2020**, *42*, 1227–1236. [[CrossRef](#)]
186. Maina, M.; Mwaniki, P.; Odira, E.; Kiko, N.; McKnight, J.; Schultsz, C.; English, M.; Tosas-Auguet, O. Antibiotic use in Kenyan public hospitals: Prevalence, appropriateness and link to guideline availability. *Int. J. Infect. Dis.* **2020**, *99*, 10–18. [[CrossRef](#)]
187. Ayieko, P.; Irimu, G.; Ogero, M.; Mwaniki, P.; Malla, L.; Julius, T.; Chepkirui, M.; Mbevi, G.; Oliwa, J.; Agweyu, A.; et al. Effect of enhancing audit and feedback on uptake of childhood pneumonia treatment policy in hospitals that are part of a clinical network: A cluster randomized trial. *Implement. Sci.* **2019**, *14*, 20. [[CrossRef](#)]
188. Suliman, S.M.; Yousef, B.A.; Hamadelnil, A.A. Impact of guidelines implementation for the rational use of prophylactic antibiotics in elective cesarean sections at Elqutainah Teaching Hospital. *J. Fam. Med. Prim. Care* **2020**, *9*, 162–167.
189. Brink, A.J.; Messina, A.P.; Feldman, C.; Richards, G.A.; van den Bergh, D. From guidelines to practice: A pharmacist-driven prospective audit and feedback improvement model for peri-operative antibiotic prophylaxis in 34 South African hospitals. *J. Antimicrob. Chemother.* **2017**, *72*, 1227–1234. [[CrossRef](#)]
190. Sefah, I.A.; Essah, D.O.; Kurdi, A.; Sneddon, J.; Alalabila, T.M.; Kordorwu, H.; Godman, B. Assessment of adherence to pneumonia guidelines and its determinants in an ambulatory care clinic in Ghana: Findings and implications for the future. *JAC Antimicrob. Resist.* **2021**, *3*, dlab080. [[CrossRef](#)]
191. Nambasa, V.; Ndagije, H.B.; Serwanga, A.; Manirakiza, L.; Atuhaire, J.; Nakitto, D.; Kiguba, R.; Figueras, A. Prescription of Levofloxacin and Moxifloxacin in Select Hospitals in Uganda: A Pilot Study to Assess Guideline Concordance. *Antibiotics* **2020**, *9*, 439. [[CrossRef](#)]
192. Junaid, E.; Jenkins, L.; Swanepoel, H.; North, Z.; Gould, T. Antimicrobial stewardship in a rural regional hospital—Growing a positive culture. *S. Afr. Med. J.* **2018**, *108*, 546–550. [[CrossRef](#)]
193. Lester, R.; Haigh, K.; Wood, A.; MacPherson, E.E.; Maheswaran, H.; Bogue, P.; Hanger, S.; Kalizang'oma, A.; Srirathan, V.; Kulapani, D.; et al. Sustained Reduction in Third-generation Cephalosporin Usage in Adult Inpatients Following Introduction of an Antimicrobial Stewardship Program in a Large, Urban Hospital in Malawi. *Clin. Infect. Dis.* **2020**, *71*, e478–e486. [[CrossRef](#)]
194. Ntumba, P.; Mwangi, C.; Barasa, J.; Aiken, A.; Kubilay, Z.; Allegranzi, B. Multimodal approach for surgical site infection prevention—Results from a pilot site in Kenya. *Antimicrob. Resist. Infect. Control* **2015**, *4*, P87. [[CrossRef](#)]
195. Allegranzi, B.; Aiken, A.M.; Kubilay, N.Z.; Nthumba, P.; Barasa, J.; Okumu, G.; Mugarura, R.; Elobo, A.E.; Jombwe, J.; Maimbo, M.; et al. A multimodal infection control and patient safety intervention to reduce surgical site infections in Africa: A multicentre, before-after, cohort study. *Lancet Infect. Dis.* **2018**, *18*, 507–515. [[CrossRef](#)]
196. Chigome, A.K.; Matlala, M.; Godman, B.; Meyer, J.C. Availability and Use of Therapeutic Interchange Policies in Managing Antimicrobial Shortages among South African Public Sector Hospitals; Findings and Implications. *Antibiotics* **2020**, *9*, 4. [[CrossRef](#)]
197. Ngonzi, J.; Bebell, L.M.; Boatman, A.A.; Owaraganise, A.; Tiibajuka, L.; Fajardo, Y.; Lugobe, H.M.; Wylie, B.J.; Jacquemyn, Y.; Obua, C.; et al. Impact of an educational intervention on WHO surgical safety checklist and pre-operative antibiotic use at a referral hospital in southwestern Uganda. *Int. J. Qual. Health Care* **2021**, *33*, mzab089. [[CrossRef](#)] [[PubMed](#)]

198. BSAC. Antimicrobial Stewardship from Principles to Practice. 2018. Available online: <https://www.bsac.org.uk/antimicrobialstewardshipebook/BSAC-AntimicrobialStewardship-FromPrinciplestoPractice-eBook.pdf> (accessed on 14 November 2022).
199. Olaoye, O.; Tuck, C.; Khor, W.P.; McMenamin, R.; Hudson, L.; Northall, M.; Panford-Quainoo, E.; Asima, D.M.; Ashiru-Oredope, D. Improving Access to Antimicrobial Prescribing Guidelines in 4 African Countries: Development and Pilot Implementation of an App and Cross-Sectional Assessment of Attitudes and Behaviour Survey of Healthcare Workers and Patients. *Antibiotics* **2020**, *9*, 555. [CrossRef] [PubMed]
200. Abubakar, U.; Syed Sulaiman, S.A.; Adesiyun, A.G. Impact of pharmacist-led antibiotic stewardship interventions on compliance with surgical antibiotic prophylaxis in obstetric and gynecologic surgeries in Nigeria. *PLoS ONE* **2019**, *14*, e0213395. [CrossRef] [PubMed]
201. Curtis, C.E.; Al Bahar, F.; Marriott, J.F. The effectiveness of computerised decision support on antibiotic use in hospitals: A systematic review. *PLoS ONE* **2017**, *12*, e0183062. [CrossRef] [PubMed]
202. Zahlanie, Y.; Mang, N.S.; Lin, K.; Hynan, L.S.; Prokesch, B.C. Improved Antibiotic Prescribing Practices for Respiratory Infections Through Use of Computerized Order Sets and Educational Sessions in Pediatric Clinics. *Open Forum Infect. Dis.* **2021**, *8*, ofaa601. [CrossRef]
203. Holstiege, J.; Mathes, T.; Pieper, D. Effects of computer-aided clinical decision support systems in improving antibiotic prescribing by primary care providers: A systematic review. *J. Am. Med. Inform. Assoc.* **2015**, *22*, 236–242. [CrossRef]
204. Sulis, G.; Sayood, S.; Katukoori, S.; Bollam, N.; George, I.; Yaeger, L.H.; Chavez, M.A.; Tetteh, E.; Yarrabelli, S.; Pulcini, C.; et al. Exposure to World Health Organization’s AWaRe antibiotics and isolation of multidrug resistant bacteria: A systematic review and meta-analysis. *Clin. Microbiol. Infect.* **2022**, *28*, 1193–1202. [CrossRef]
205. Charani, E.; Smith, I.; Skodvin, B.; Perozziello, A.; Lucet, J.C.; Lescure, F.X.; Birgand, G.; Poda, A.; Ahmad, R.; Singh, S.; et al. Investigating the cultural and contextual determinants of antimicrobial stewardship programmes across low-, middle- and high-income countries—A qualitative study. *PLoS ONE* **2019**, *14*, e0209847. [CrossRef]
206. Kakkar, A.K.; Shafiq, N.; Singh, G.; Ray, P.; Gautam, V.; Agarwal, R.; Muralidharan, J.; Arora, P. Antimicrobial Stewardship Programs in Resource Constrained Environments: Understanding and Addressing the Need of the Systems. *Front. Public Health* **2020**, *8*, 140. [CrossRef]
207. Pokharel, S.; Raut, S.; Adhikari, B. Tackling antimicrobial resistance in low-income and middle-income countries. *BMJ Glob. Health* **2019**, *4*, e002104. [CrossRef]
208. Björkhem-Bergman, L.; Andersén-Karlsson, E.; Laing, R.; Diogene, E.; Melien, O.; Jirlow, M.; Malmström, R.E.; Vogler, S.; Godman, B.; Gustafsson, L.L. Interface management of pharmacotherapy. Joint hospital and primary care drug recommendations. *Eur. J. Clin. Pharmacol.* **2013**, *69* (Suppl. S1), 73–78. [CrossRef]
209. Yoon, C.H.; Ritchie, S.R.; Duffy, E.J.; Thomas, M.G.; McBride, S.; Read, K.; Chen, R.; Humphrey, G. Impact of a smartphone app on prescriber adherence to antibiotic guidelines in adult patients with community acquired pneumonia or urinary tract infections. *PLoS ONE* **2019**, *14*, e0211157. [CrossRef]
210. Eriksen, J.; Gustafsson, L.L.; Ateva, K.; Bastholm-Rahmner, P.; Ovesjö, M.L.; Jirlow, M.; Juhasz-Haverinen, M.; Lärfars, G.; Malmström, R.E.; Wettermark, B.; et al. High adherence to the ‘Wise List’ treatment recommendations in Stockholm: A 15-year retrospective review of a multifaceted approach promoting rational use of medicines. *BMJ Open* **2017**, *7*, e014345. [CrossRef]
211. Gustafsson, L.L.; Wettermark, B.; Godman, B.; Andersén-Karlsson, E.; Bergman, U.; Hasselström, J.; Hensjö, L.-O.; Hjemdahl, P.; Jägre, I.; Julander, M.; et al. The ‘wise list’—a comprehensive concept to select, communicate and achieve adherence to recommendations of essential drugs in ambulatory care in Stockholm. *Basic Clin. Pharmacol. Toxicol.* **2011**, *108*, 224–233. [CrossRef]
212. Foxlee, N.D.; Townell, N.; Heney, C.; McIver, L.; Lau, C.L. Strategies Used for Implementing and Promoting Adherence to Antibiotic Guidelines in Low- and Lower-Middle-Income Countries: A Systematic Review. *Trop. Med. Infect. Dis.* **2021**, *6*, 166. [CrossRef]
213. Commonwealth Partnerships for Antimicrobial Stewardship Programme (CwPAMS). CwPAMS Antimicrobial Prescribing App—Antimicrobial Stewardship Mobile Application. Available online: <https://commonwealthpharmacy.org/cwpams-ams-app/> (accessed on 15 November 2022).
214. Mashaba, T.P.; Matlala, M.; Godman, B.; Meyer, J.C. Implementation and monitoring of decisions by pharmacy and therapeutics committees in South African public sector hospitals. *Expert Rev. Clin. Pharmacol.* **2019**, *12*, 159–168. [CrossRef]
215. Matlala, M.; Gous, A.G.S.; Meyer, J.C.; Godman, B. Formulary Management Activities and Practice Implications Among Public Sector Hospital Pharmaceutical and Therapeutics Committees in a South African Province. *Front. Pharmacol.* **2020**, *11*, 1267. [CrossRef]
216. Fadare, J.O.; Ogunleye, O.; Obiako, R.; Orubu, S.; Enwere, O.; Ajemigbitse, A.A.; Meyer, J.C.; Enato, E.; Masseur, A.; Godman, B.; et al. Drug and therapeutics committees in Nigeria: Evaluation of scope and functionality. *Expert Rev. Clin. Pharmacol.* **2018**, *11*, 1255–1262. [CrossRef]
217. Zulu, A.; Matafwali, S.K.; Banda, M.; Mudenda, S. Assessment of knowledge, attitude and practices on antibiotic resistance among undergraduate medical students in the school of medicine at the University of Zambia. *Int. J. Basic Clin. Pharmacol.* **2020**, *9*, 263–270. [CrossRef]

218. Nisabwe, L.; Brice, H.; Umuhire, M.C.; Gwira, O.; Harelimana, J.D.D.; Nzeyimana, Z.; Sebatunzi, O.R.; Rusingiza, E.K.; Hahirwa, I.; Muvunyi, C.M. Knowledge and attitudes towards antibiotic use and resistance among undergraduate healthcare students at University of Rwanda. *J. Pharm. Policy Pract.* **2020**, *13*, 7. [CrossRef]
219. Wasserman, S.; Potgieter, S.; Shoul, E.; Constant, D.; Stewart, A.; Mendelson, M.; Boyles, T.H. South African medical students' perceptions and knowledge about antibiotic resistance and appropriate prescribing: Are we providing adequate training to future prescribers? *S. Afr. Med. J.* **2017**, *107*, 405–410. [CrossRef] [PubMed]
220. Lubwama, M.; Onyuka, J.; Ayazika, K.T.; Ssetaba, L.J.; Siboko, J.; Daniel, O.; Mushi, M.F. Knowledge, attitudes, and perceptions about antibiotic use and antimicrobial resistance among final year undergraduate medical and pharmacy students at three universities in East Africa. *PLoS ONE* **2021**, *16*, e0251301. [CrossRef] [PubMed]
221. Etando, A.; Amu, A.A.; Haque, M.; Schellack, N.; Kurdi, A.; Alrasheedy, A.A.; Timoney, A.; Mwita, J.C.; Rwegerera, G.M.; Patrick, O.; et al. Challenges and Innovations Brought about by the COVID-19 Pandemic Regarding Medical and Pharmacy Education Especially in Africa and Implications for the Future. *Healthcare* **2021**, *9*, 1722. [CrossRef] [PubMed]
222. Sithole, T.; Mahlangu, G.; Walker, S.; Salek, S. Regulatory Authority Evaluation of the Effectiveness and Efficiency of the ZaZiBoNa Collaborative Medicines Registration Initiative: The Way Forward. *Front. Med.* **2022**, *9*, 898743. [CrossRef]
223. WHO. Launch of the Lomé Initiative. 2020. Available online: <https://www.who.int/dg/speeches/detail/launch-of-the-lom%C3%A9-initiative> (accessed on 14 November 2022).
224. Africa Centres for Disease Control and Prevention and Center for Disease Dynamics, Economics & Policy. African Antibiotic Treatment Guidelines for Common Bacterial Infections and Syndromes—Recommended Antibiotic Treatments in Adult Patients. 2021. Available online: https://africaguidelines.cddep.org/wp-content/uploads/2021/11/Quick-Reference-Guide_Adults_English.pdf (accessed on 15 November 2022).
225. GASPH. Global Antimicrobial Stewardship Partnership Hub. 2022. Available online: <https://global-asp-hub.com/> (accessed on 15 November 2022).
226. Lorencatto, F.; Charani, E.; Sevdalis, N.; Tarrant, C.; Davey, P. Driving sustainable change in antimicrobial prescribing practice: How can social and behavioural sciences help? *J. Antimicrob. Chemother.* **2018**, *73*, 2613–2624. [CrossRef]
227. Schellack, N.; Bronkhorst, E.; Coetzee, R.; Godman, B.; Gous, A.G.S.; Kolman, S.; Labuschagne, Q.; Malan, L.; Messina, A.P.; Naested, C.; et al. SASOCP position statement on the pharmacist's role in antibiotic stewardship 2018. *S. Afr. J. Infect. Dis.* **2018**, *33*, 28–35. [CrossRef]
228. Ogunleye, O.O.; Fadare, J.O.; Yinka-Ogunleye, A.F.; Anand Paramadhas, B.D.; Godman, B. Determinants of antibiotic prescribing among doctors in a Nigerian urban tertiary hospital. *Hosp. Pract.* **2019**, *47*, 53–58. [CrossRef]
229. Fadare, J.O.; Bankole, I.; Babatola, A.; Simeon Olatunya, O.; Aina, F.; Godman, B. Adherence to WHO Criteria on Drug Promotion Literature: An Exploratory Study from a Tertiary Healthcare Facility in South-West Nigeria. *Hosp. Pharm.* **2022**, 00185787221123217. [CrossRef]
230. Modisakeng, C.; Matlala, M.; Godman, B.; Meyer, J.C. Medicine shortages and challenges with the procurement process among public sector hospitals in South Africa; findings and implications. *BMC Health Serv. Res.* **2020**, *20*, 234. [CrossRef]
231. Fürst, J.; Čizman, M.; Mrak, J.; Kos, D.; Campbell, S.; Coenen, S.; Gustafsson, L.L.; Fürst, L.; Godman, B. The influence of a sustained multifaceted approach to improve antibiotic prescribing in Slovenia during the past decade: Findings and implications. *Expert Rev. Anti-Infect. Ther.* **2015**, *13*, 279–289. [CrossRef]
232. O'Neill, J. Tackling Drug-Resistant Infections Globally: Final Report and Recommendations. 2016. Available online: https://amr-review.org/sites/default/files/160518_Final%20paper_with%20cover.pdf (accessed on 14 November 2022).
233. Sartelli, M.; Hardcastle, T.C.; Catena, F.; Chichom-Mefire, A.; Coccolini, F.; Dhingra, S.; Haque, M.; Hodonou, A.; Iskandar, K.; Labricciosa, F.; et al. Antibiotic Use in Low and Middle-Income Countries and the Challenges of Antimicrobial Resistance in Surgery. *Antibiotics* **2020**, *9*, 497. [CrossRef]
234. Tadesse, B.T.; Ashley, E.A.; Ongarello, S.; Havumaki, J.; Wijegoonewardena, M.; González, I.J.; Dittrich, S. Antimicrobial resistance in Africa: A systematic review. *BMC Infect. Dis.* **2017**, *17*, 616. [CrossRef]
235. Bell, B.G.; Schellevis, F.; Stobberingh, E.; Goossens, H.; Pringle, M. A systematic review and meta-analysis of the effects of antibiotic consumption on antibiotic resistance. *BMC Infect. Dis.* **2014**, *14*, 13. [CrossRef]
236. Llor, C.; Bjerrum, L. Antimicrobial resistance: Risk associated with antibiotic overuse and initiatives to reduce the problem. *Ther. Adv. Drug Saf.* **2014**, *5*, 229–241. [CrossRef]
237. Collignon, P.; Beggs, J.J.; Walsh, T.R.; Gandra, S.; Laxminarayan, R. Anthropological and socioeconomic factors contributing to global antimicrobial resistance: A univariate and multivariable analysis. *Lancet Planet. Health* **2018**, *2*, e398–e405. [CrossRef]
238. WHO. WHO Methodology for Point Prevalence Survey on Antibiotic Use in Hospitals, Version 1.1. 2018. Available online: <https://www.who.int/publications/i/item/WHO-EMP-IAU-2018.01> (accessed on 14 November 2022).
239. Engler, D.; Meyer, J.C.; Schellack, N.; Kurdi, A.; Godman, B. Compliance with South Africa's Antimicrobial Resistance National Strategy Framework: Are we there yet? *J. Chemother.* **2021**, *33*, 21–31. [CrossRef]
240. de Wit, T.F.R.; Janssens, W.; Antwi, M.; Milimo, E.; Mutegi, N.; Marwa, H.; Ndili, N.; Owino, W.; Waiyaiya, E.; Garcia Roja, D.C.; et al. Digital health systems strengthening in Africa for rapid response to COVID-19. *Front. Health Serv.* **2022**, *2*, 2035–2043. [CrossRef]

241. Godman, B.; Grobler, C.; Van-De-Lisle, M.; Wale, J.; Barbosa, W.B.; Massele, A.; Opondo, P.; Petrova, G.; Tachkov, K.; Sefah, I.; et al. Pharmacotherapeutic interventions for bipolar disorder type II: Addressing multiple symptoms and approaches with a particular emphasis on strategies in lower and middle-income countries. *Expert Opin. Pharmacother.* **2019**, *20*, 2237–2255. [CrossRef]
242. Ogunleye, O.O.; Basu, D.; Mueller, D.; Sneddon, J.; Seaton, R.A.; Yinka-Ogunleye, A.F.; Wamboga, J.; Miljković, N.; Mwita, J.C.; Rwegerera, G.M.; et al. Response to the Novel Corona Virus (COVID-19) Pandemic Across Africa: Successes, Challenges, and Implications for the Future. *Front. Pharmacol.* **2020**, *11*, 1205. [CrossRef]
243. Godman, B.; Haque, M.; Abubakar, A.R.; Ogunleye, O.O.; Sani, I.H.; Sefah, I.; Kurdi, A.; Islam, S. Changes in Availability, Utilization, and Prices of Medicines and Protection Equipment for COVID-19 in an Urban Population of Northern Nigeria. *J. Res. Pharm. Pract.* **2021**, *10*, 17–22. [CrossRef]
244. Godman, B.; Basu, D.; Pillay, Y.; Mwita, J.C.; Rwegerera, G.M.; Paramadhas, B.D.A.; Tiroyakgosi, C.; Okwen, P.M.; Niba, L.L.; Nonvignon, J.; et al. Review of Ongoing Activities and Challenges to Improve the Care of Patients With Type 2 Diabetes Across Africa and the Implications for the Future. *Front. Pharmacol.* **2020**, *11*, 108. [CrossRef] [PubMed]
245. Godman, B.; Basu, D.; Pillay, Y.; Almeida, P.H.R.F.; Mwita, J.C.; Rwegerera, G.M.; Paramadhas, B.D.A.; Tiroyakgosi, C.; Patrick, O.; Niba, L.L.; et al. Ongoing and planned activities to improve the management of patients with Type 1 diabetes across Africa; implications for the future. *Hosp. Pract.* **2020**, *48*, 51–67. [CrossRef] [PubMed]
246. Gad, M.; Salem, A.; Oortwijn, W.; Hill, R.; Godman, B. Mapping of Current Obstacles for Rationalizing Use of Medicines (CORUM) in Europe: Current Situation and Potential Solutions. *Front. Pharmacol.* **2020**, *11*, 144. [CrossRef] [PubMed]
247. Saleem, Z.; Hassali, M.A.; Godman, B.; Versporten, A.; Hashmi, F.K.; Saeed, H.; Saleem, F.; Salman, M.; Rehman, I.U.; Khan, T.M. Point prevalence surveys of antimicrobial use: A systematic review and the implications. *Expert Rev. Anti-Infect. Ther.* **2020**, *18*, 897–910. [CrossRef] [PubMed]
248. WHO. Anatomical Therapeutic Chemical (ATC) Classification. 2021. Available online: <https://www.who.int/tools/atc-ddd-toolkit/atc-classification> (accessed on 10 November 2022).
249. Wettermark, B.; Godman, B.; Jacobsson, B.; Haaijer-Ruskamp, F.M. Soft regulations in pharmaceutical policy making: An overview of current approaches and their consequences. *Appl. Health Econ. Health Policy* **2009**, *7*, 137–147. [CrossRef]
250. Matsitse, T.B.; Helberg, E.; Meyer, J.C.; Godman, B.; Massele, A.; Schellack, N. Compliance with the primary health care treatment guidelines and the essential medicines list in the management of sexually transmitted infections in correctional centres in South Africa: Findings and implications. *Expert Rev. Anti-Infect. Ther.* **2017**, *15*, 963–972. [CrossRef]
251. Alrasheedy, A.A.; Alsalloum, M.A.; Almuqbil, F.A.; Almuzaini, M.A.; Aba Alkhalil, B.S.; Albishri, A.S.; Alharbi, F.F.; Alharbi, S.R.; Alodhayb, A.K.; Alfadl, A.A.; et al. The impact of law enforcement on dispensing antibiotics without prescription: A multi-methods study from Saudi Arabia. *Expert Rev. Anti-Infect. Ther.* **2020**, *18*, 87–97. [CrossRef]
252. Mendelson, M.; Brink, A.; Gouws, J.; Mbelle, N.; Naidoo, V.; Pople, T.; Schellack, N.; van Vuuren, M.; Rees, H.; Banoo, S.; et al. The One Health stewardship of colistin as an antibiotic of last resort for human health in South Africa. *Lancet Infect. Dis.* **2018**, *18*, e288–e294. [CrossRef]
253. Godman, B.; McCabe, H.; Leong, T.D.; Mueller, D.; Martin, A.P.; Hoxha, I.; Mwita, J.C.; Rwegerera, G.M.; Massele, A.; Costa, J.D.O.; et al. Fixed dose drug combinations—are they pharmaco-economically sound? Findings and implications especially for lower- and middle-income countries. *Expert Rev. Pharmacoecon. Outcomes Res.* **2020**, *20*, 1–26. [CrossRef]
254. Godman, B.; Wettermark, B.; van Woerkom, M.; Fraeyman, J.; Alvarez-Madrado, S.; Berg, C.; Bishop, I.; Bucsecs, A.; Campbell, S.; Finlayson, A.E.; et al. Multiple policies to enhance prescribing efficiency for established medicines in Europe with a particular focus on demand-side measures: Findings and future implications. *Front. Pharmacol.* **2014**, *5*, 106. [CrossRef]
255. WHO. Monitoring the Building Blocks of Health Systems: A Handbook of Indicators and Their Measurement Strategies. 2010. Available online: <https://apps.who.int/iris/bitstream/handle/10665/258734/9789241564052-eng.pdf> (accessed on 10 November 2022).
256. Campbell, S.M.; Roland, M.O.; Buetow, S.A. Defining quality of care. *Soc. Sci. Med.* **2000**, *51*, 1611–1625. [CrossRef]
257. NHS England and NHS Improvement. A Model for Measuring Quality Care. 2022. Available online: <https://www.england.nhs.uk/wp-content/uploads/2022/02/qsir-measuring-quality-care.pdf> (accessed on 10 November 2022).
258. van den Bosch, C.M.; Hulscher, M.E.; Natsch, S.; Wille, J.; Prins, J.M.; Geerlings, S.E. Applicability of generic quality indicators for appropriate antibiotic use in daily hospital practice: A cross-sectional point-prevalence multicenter study. *Clin. Microbiol. Infect.* **2016**, *22*, 888.e1–888.e9. [CrossRef]
259. van den Bosch, C.M.; Geerlings, S.E.; Natsch, S.; Prins, J.M.; Hulscher, M.E. Quality indicators to measure appropriate antibiotic use in hospitalized adults. *Clin. Infect. Dis.* **2015**, *60*, 281–291. [CrossRef]
260. Kallen, M.C.; Prins, J.M. A Systematic Review of Quality Indicators for Appropriate Antibiotic Use in Hospitalized Adult Patients. *Infect. Dis. Rep.* **2017**, *9*, 6821. [CrossRef]
261. Wambale, J.M.I.J.; Mathe, D.M.; Kavuo, S.K.; Kikuni, T. Point prevalence study of antibiotic use in hospitals in Butembo. *Int. J. Med. Med. Sci.* **2016**, *8*, 133–139.
262. Labi, A.K.; Obeng-Nkrumah, N.; Sunkwa-Mills, G.; Bediako-Bowan, A.; Akufo, C.; Bjerrum, S.; Owusu, E.; Enweronu-Laryea, C.; Opintan, J.A.; Kurtzhals, J.A.L.; et al. Antibiotic prescribing in paediatric inpatients in Ghana: A multi-centre point prevalence survey. *BMC Pediatr.* **2018**, *18*, 391. [CrossRef]
263. Garcia-Vello, P.; Brobbey, F.; Gonzalez-Zorn, B.; Setsoafia Saba, C.K. A cross-sectional study on antibiotic prescription in a teaching hospital in Ghana. *Pan Afr. Med. J.* **2020**, *35*, 12. [CrossRef]

264. Umeokonkwo, C.D.; Madubueze, U.C.; Onah, C.K.; Okedo-Alex, I.N.; Adeke, A.S.; Versporten, A.; Goossens, H.; Igwe-Okomiso, D.; Okeke, K.; Azuogu, B.N.; et al. Point prevalence survey of antimicrobial prescription in a tertiary hospital in South East Nigeria: A call for improved antibiotic stewardship. *J. Glob. Antimicrob. Resist.* **2019**, *17*, 291–295. [[CrossRef](#)]
265. Chioma, O. Rational Use of Antibiotics—A Point Prevalence Study Carried out at a Tertiary Hospital in South-South Nigeria. *Int. J. Trop. Dis. Health* **2020**, *41*, 39–47. [[CrossRef](#)]
266. Masich, A.M.; Vega, A.D.; Callahan, P.; Herbert, A.; Fwoloshi, S.; Zulu, P.M.; Chanda, D.; Chola, U.; Mulenga, L.; Hachaambwa, L.; et al. Antimicrobial usage at a large teaching hospital in Lusaka, Zambia. *PLoS ONE* **2020**, *15*, e0228555. [[CrossRef](#)]