**Supplementary Tables**

Table SI – Antimicrobial Stewardship Programmes that have been implemented in ambulatory care across LMICs and their impact

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| **Author and Year** | **Intervention** | **Key Findings/ Impact** |
| Boonyasiri et al., 2014 [1] | * Principally educational initiatives among HCPs in Thailand
* The ASP included:
* Training HCPs on the rational use of antibiotics
* Introducing clinical practice guidelines with the potential for throat swabs (ARIs) and stool cultures (acute diarrhoea)
* Printed brochures for patients/ relatives in waiting rooms containing likely aetiology of the principal conditions as well the potential necessity/ harm of antibiotics for ARIs and acute diarrhoea
 | * The multifaceted programme resulted in:
* Limited prescribing of antibiotics for ARIs (13.0%) and for acute diarrhoea (19.1%)
* Clinical responses on day 3 after receiving care from the HCPs showed that more than 97% of the patients who received antibiotics/ those who did not receive antibiotics were cured or improved – confirming the soundness of the approach
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| Yip et al., 2014[2] | * Principally involving financial incentives:

In Ningxia Province, China, in a randomized study The study was undertaken to evaluate the impact of capitation with the introduction of pay-for-performance measures on subsequent antibiotic prescribing, health spending, outpatient visit volumes, and patient satisfaction | * There was approximately 15% reduction in antibiotic prescriptions following the implementation of pay-for-performance measures
* A small reduction in total spending per visit was also seen
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| Egger et al., 2017 [3] | * A comprehensive set of interventions were used to improve the management of 4 common conditions in PHCs in Kenya – including URTIs, UTIs, STIs and childhood diarrhoea
* Interventions included:
	+ Online educational programmes explaining the clinical guidelines for these 4 conditions
	+ 2-hour educational sessions
	+ Monthly feedback meetings
* Materials including posters and other material to remind prescribers
 | Key findings included:* Adherence to agreed clinical quality measures (CQM) increased from 41.4% to 77.1% for PHCs that took part in the intervention
* However, adherence dropped slightly from 26.5% to 21.8% among control PHCs over the 6-month study period. This was greatest for UTIs
* Adherence to CQMs significantly increased over the 6-month study period for the active intervention group
* The interventions were well received by those operating in the PHCs
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| Hoa et al., 2017 [4] | * Multi-faceted educational intervention over 7 months targeting HCPs' knowledge, practical competences and prescribing of antibiotics for patients with ARI in the intervention group
* No specific programmes in the control group.
 | * Knowledge regarding antibiotics improved in the intervention group for patients with ARIs by 28%, antibiotic use for mild ARIs by 15% and severe ARIs by 14%
* Practical competence for patients with mild ARIs improved in the intervention and control groups by 20% and 11% respectively
* Practice regarding the prescribing of antibiotics for mild ARIs improved by 28% in the intervention group
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| Korom et al., 2017 [5] | * Multiple interventions principally surrounding education in ambulatory care settings in Kenya
* The interventions included:
	+ Formal introduction surrounding a clinical practice guideline
	+ Introduction of peer-to-peer chart reviews
	+ Peer-reviewed publication describing local AMR patterns
* The interventions were undertaken by trained clinical officers
 | Key findings included:* Adherence to guideline-recommended antibiotics improved significantly - from 19% at baseline to 68% following all interventions (Χ2 = 150.7, p < 0.001)
* An outcome of composite quality scores improved significantly from an average of 2.16 to 3.00 on a 5-point scale (t = 6.58, p < 0.001)
* The interventions had different effects at different clinical sites - possibly reflecting differences in clinical officers and their activities
* Provider age was not a significant factor in subsequent changes in prescribing habits
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| Hamilton et al., 2018 [6] | * Principally educational initiatives in this ASP undertaken in Sierra Leone
* The ASP included the provision of an empirical antimicrobial guideline introduced via a number of different methods. These included:
	+ One-to-one feedback meetings with prescribers
	+ Announcements of the guidelines in general meetings
* Printed copies of the guideline were also made available in each outpatient room to help educate patients
 | Key findings included:* After the first cycle, the choice of appropriate antimicrobial in prescriptions improved to 85% and the correct antibiotic, dose and course-length to 53%
* Unfortunately, after 2 months the rates of appropriate prescribing reduced to 65% and 43%, respectively following lack of follow-up
* Implementing guidelines can be effective with improving appropriate antibiotic prescribing in ambulatory care; however, repeated measures are needed for sustainable changes
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| Kleczka et al., 2019 [7] | * Multiple components to this ASP among PHCs in the private sector in Kenya.
* Multiple interventions included:
	+ Rubber stamp templates for documenting the management of selected conditions, e.g., URTIs, UTIs, STIs and GIs
	+ Compilations of the relevant clinical practice guidelines for discussion/ adherence
	+ One low-budget Android smartphone to each facility
	+ Six continuing medical education (CME) sessions at each facility every month for 6 months to improve compliance
* Adherence to guidelines was determined using two measures – these included the appropriateness of the diagnosis and the appropriateness of prescribing based on current guidelines
 | Key findings included:* Antibiotics were prescribed in 94.3%±1.6% of the 889 patient encounters documented with templates including 97.3%±2.3% for URTI encounters, 94.2%±3.8% for UTI encounters, 91.6%±1.1% for STI encounters and 91.3%±1.4% for GI encounters
* Overall template documentation scores (69.5%±1.7%) were significantly higher post interventions
* The prescribing of nitrofurantoin in patient encounters increased from 9.2% to 29.9%; p<0.0001
* The prescribing of broad spectrum quinolones (ciprofloxacin – **W** and norfloxacin - **W**) decreased from 30.0% of encounters to 16.1% (p<0.05)
 |
| Tay et al., 2019 [8] | * Principally involving educational toolkits among HCPs in Malaysia
* These included:
	+ The production of a training module for HCPs on ARIs and acute diarrhoea
	+ One-hour educational sessions covering diagnostic criteria and treatment decision pathways
	+ Educational posters in Malay and English in the waiting area and consultation rooms
	+ Multimedia educational videos in the waiting areas
* Physician reminders
 | * Key findings include an appreciable reduction in antibiotic prescribing:
	+ Prescribing of antibiotics for ARIs down from 29.1% to 13.7% of patients seen in the clinics
	+ Prescribing of antibiotics for acute diarrhoea also down from 11.2% to 6.7%
 |
| Wei et al., 2019 [9] | * Principally education involving multiple interventions in China
* Interventions comprised:
	+ Clinical guidelines
	+ Monthly prescribing review meetings
	+ Training in doctor–patient communication skills

Provision of education materials for caregivers | * A 49% reduction in the prescribing of antibiotics for children with URTIs after 6 months in the intervention arm - having adjusted for patient and prescribing doctor covariates
* The reductions persisted after 18 months but at a lower rate (-36%)
* Key factors for sustaining the reduction in antibiotic prescribing included physicians’ improved knowledge and communication skills combined with prescription review meetings
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| Brinkmann et al., 2020 [10] | * Activities included assessing the effectiveness of implementation of ASPs among 10 PHCs in Namibia
* A SWOT analysis of each health care facility was conducted through interviewing infection control focal personnel at each facility in order to assess the level of compliance to good AMS practices and policies
 | * 90% of the focal persons were aware of systems and polices for good AMS practices
* The level of compliance at hospital-based PHCs was 30.8% compared to clinics (9.1%-36.4%)
* Principal challenges to implementing ASPs among PHCs in Namibia include:
	+ A lack of policies and systems specific to antimicrobial use
	+ Available financial and human resources
 |
| De Vries et al., 2022 [11] | * Multidisciplinary audit and feedback meetings once a month at 13 PHCs in South Africa
* 10 antibiotic prescriptions were randomly selected for a peer review audit by the team, assessed and scored for adherence to seven key measures including antibiotic choice according to the STG/ EML
* All measures had to be met for the prescription to be considered correct
* Concurrently, primary care pharmacists monitored monthly consumption for the six oral antibiotics most prescribed, e.g., amoxicillin **(A**), co-amoxiclav (**A**), penicillin (**A**), azithromycin (**W**), ciprofloxacin (**W**) and flucloxacillin (**A**) – defined daily doses (DDDs)/ 100 prescriptions dispensed
 | * Mean overall level of adherence to guidelines increased from 11% in July 2017 to 53% in June 2019
* However, prescribing adherence was significantly lower in the winter and spring, concurrent with higher antibiotic prescribing and consumption - may reflect inappropriate antibiotics for increased viral ARI months
* Mean of 19% correct prescriptions in the first 6 months (baseline) to a mean of 47% correct prescriptions in the last 6 months (*p*<0.001)
* Reduction of 12.9 DDDs between the pre- and post-intervention periods (*p*=0.0084) was documented - a 19.3% decrease in antibiotic consumption
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| Masetla et al., 2023 [12] | * The aim of the study was to provide antimicrobial stewardship (AMS) services to outpatients with chronic bone and joint infections presenting to an orthopaedic out-patient clinic in a hospital in South Africa
* 44 patients participated, with questionnaires to assess their understanding of their conditions and adherence to prescribed antibiotics
* Review of antibiotic prescriptions with prescribers contacted if concerns including adherence to current STG/EML
 | * 71 antibiotics were prescribed, with 62% from the ‘Watch’ group
* A total of 239 interventions were made including educating patients and clinicians
* The majority of interventions regarding patients were concerning knowledge of their condition and medication (n = 145, 61%)
* 65 interventions (27%) were made regarding educating patients on adherence to prescribed antibiotics and its importance to help resolve their condition
* The majority (96%) of the antibiotics were not prescribed according to the STG; however, interventions were only needed in 31% of prescribed antibiotics (n = 71) since the STG only recommends empiric therapy directed against Staphylococcus aureus
* The majority of the drug treatment interventions (n = 29) for the appropriate antibiotic selection (62%)
 |

NB: ARI: Acute respiratory Illness; \*AWaRe classification for Access (A) and Watch (W) antibiotics [13, 14]; URTI: Upper Respiratory Tract Infection; STG/ EML: Standard Treatment Guidelines/ Essential Medicine Lists

Table S2 (to be refined) Summary of ASPs and other activities to reduce inappropriate dispensing of antibiotics without a prescription across Africa and beyond

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| **Country and reference** | **Intervention and Aim** | **Impact of the Intervention** |
| Bangladesh [15] | * Drug sellers in Dhaka participated in 6 standardized role-playing scenarios
* An ARI guideline was developed following the role-play alongside a one-day educational course concerning appropriate management of ARIs
* The guidelines only recommended antibiotics for children with complicated ARI
 | Mixed results were seen:* In children, the dispensing of antibiotics for uncomplicated ARIs decreased (30% baseline vs. 21% post-intervention; p = 0.04)
* However, drug sellers were equally likely to dispense antibiotics for complicated ARIs and referrals to physicians for complicated ARIs decreased (70% baseline vs. 58% post-intervention; p = 0.03)
* For adults, dispensing of antibiotics without a prescription remained similar for uncomplicated ARI (48% baseline vs. 40% post-intervention; p = 0.1) but increased among those with complicated ARI (44% baseline vs. 78% post-intervention; p < 0.001)
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| Brazil [16, 17] | * In public pharmacies in Brazil, there have always been restrictions on the dispensing of antibiotics without a prescription and generally impossible for pharmacists to sell antibiotics without a prescription
* In 2010, the law was applied to private pharmacies
 | * Moura et al. (2015) found no difference in antibiotic utilisation among public pharmacies between 2008 and 2012
* However, in private pharmacists, Moura et al. (2015) documented a decrease in antibiotic use of 1.87 DDD/TID (p < 0.001) immediately after restrictions banning the sales of antibiotics without a prescription (from 2008 to 2012). The authors also found a greater decrease in the more developed regions as well as in the State Capitals
* Lopes-Junior et al. (2015) also found that sales of amoxicillin among private pharmacies fell by approximately 30% post legislation despite a general growth in the pharmaceutical market. The authors also found decreased sales of other popular antibiotics including tetracyclines (30.5% decrease), sulphonamides (28.5% decrease) and macrolides (25.0% decrease)
* Mattos et al. (2017) observed an increase in antibiotic utilisation from 2008 to 2011 (cephalosporins - 216.8%, quinolones - 170.9% and aminopenicillins - 140.9%), followed by a decrease in 2012 (cephalosporins – minus 19.4%, quinolones – minus 12.7% and aminopenicillins – minus 11.1%)
 |
| China [18] | * Multiple initiatives were introduced in Shaanxi Province in China to reduce the purchasing of antibiotics without a prescription given rising concerns. These included:
* Stricter regulations for dispensing antibiotics, and improving pharmacists’ education
* Stipulating there must be a qualified pharmacist’s present to dispense antibiotics
* Increased frequency of unannounced pharmacy inspections and punishments for abuse
 | * These multiple measures resulted in decreased antibiotic sales between 2011 and 2017
* There was decreased dispensing of antibiotics without a prescription for a 5-year-old child with diarrhoea between 2011 and 2017 - from 72.3% to 50.2% (p<0·0001) – simulated patients
* There was similar reduction for simulated patients with URTIs – down from 95.8% to 69.5% (p<0·0001)
 |
| Kenya [19-24] | * Activities included:
* Education among pharmacists linked to the Pharmacy Undergraduate programme at the University of Nairobi (UoN)
* Regular interaction with University staff and students regarding key issues surrounding antibiotics and AMR
* The University recently launching and implementing an AMS curriculum for undergraduate pharmacy students as part of its NAP to reduce AMR
 | * There was a low level of dispensing of antibiotics without a prescription (94.1% of antibiotics dispensed with a valid prescription) in the study of Mukokinya et al. (2018) among pharmacies allied to the UoN
* These contrasts with pharmacies not allied to the university and not superintended by pharmacists. In the study of Muloi et al (2019), 52% of surveyed pharmacists not allied to the University had sold antibiotics without a prescription
* In the study of Opanga et al. (2021) at the start of the COVID-19 pandemic, there was no purchasing of antimicrobials without a prescription among patients with actual or suspected COVID-19 among community pharmacies allied to the UoN. These community pharmacists typically recommended alternative treatments
* This compares with the study of Kimathi et al. (2022) who found that 23.4% of respondents had self-medicated with antibiotics during the pandemic, 60.6% at the onset of COVID-19 symptoms before confirmatory tests, with 51.5% self-medicating more than once
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| Mexico [25, 26] | * The government implemented a number policies in 2010 to enforce existing laws whereby antibiotics could only be dispensed to patients presenting with a prescription
* As part of the policies, antibiotic prescriptions had to be retained and registered in pharmacies, with fines imposed for non-compliance
 | * Antibiotic utilisation decreased by 22.9% (10.5 to 7.5 DDD/TID) between 2007 and 2012, with the trend accelerating after greater enforcement of the legislation
* There were significant changes in the dispensing of penicillins and sulfonamides: −0.86 DDD/TID (p<0.00) and −0.17 DDD/TID (p = 0.07) respectively
* There was also an appreciable seasonal reduction in the use of penicillins in Mexico after greater enforcement of the legislation
 |
| Namibia [27-30] | * Key activities included:
* Education among pharmacists starting in universities and continuing post qualification
* Implementation of regulations banning the purchasing of antibiotics without a prescription
* Activities of community pharmacies regularly monitored
 | * In a survey among 100 households in Namibia, typically cold/flu medication, paracetamol, and decongestants were used to treat adults or their children with ARIs including for common colds and influenza. There was no purchasing of antibiotics without a prescription
* There was a similar situation during the COVID-19 pandemic with no change in antibiotic utilization patterns early in the pandemic among 55 community pharmacies surveyed compared with other African countries including Nigeria
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| Nigeria [31]  | * Randomised trial to assess if access to C-reactive protein (CRP) test kits coupled with staff training on how to use these RTI management
* In private community pharmacies, pharmacists can reduce non-prescription antibiotic dispensing for RTIs
 | Antibiotic dispensing decreased by 15.66% (209/300 [intervention] vs 256/300 [control]) in the adjusted analysis |
| Republic of Srpska [32, 33] | * Activities included:
* Education of pharmacists regarding the appropriate management of diseases including ARIs together with the production of guidelines for the 42 most frequent diseases and conditions seen in everyday practice in community pharmacies in the Republic
* Greater enforcement of the regulations banning the dispensing of antibiotics without a prescription together with possible fines for violation of laws (Euro500–1500 for pharmacy directors and Euro500–750 for pharmacy technicians)
* Special attention given to the importance of adequate communication and skills among pharmacists starting in university and continuing post qualification
 | * The dispensing of antibiotics without a prescription decreased from 58% to 18.5% of pharmacies of pharmacies surveyed (simulated patients)
* OTC therapy to alleviate symptoms was offered in 72.3% of pharmacies in 2015 up from 67.2% in 2010
* OTC medication dispensed included throat and nasal sprays, decongestants, oral expectorants, analgesics and antihistamines
* Significantly fewer pharmacies dispensed an antibiotic without a prescription where OTC medicines were offered
* Encouragingly, the most common reason for not dispensing to simulated clients was that antibiotics cannot be dispensed without a prescription
 |
| Thailand, 2015 [34] | * Activities included:
* Principally education involving a multidisciplinary intervention among grocery stores in a rural province in Thailand
* Trained community leaders were used to reduce the extent of antibiotic availability in village grocery stores
 | * There were 87% fewer antibiotics available post-intervention compared with pre-intervention
* Grocery stores in the control group saw only an 8% reduction in antibiotic availability between the two time periods
 |
| Uganda, [35] | Four-part intervention to improve the management of paediatric febrile illness among drug sellers:* Training and work activities
* Provision of information, education, information and communication
* Supply activities including diagnostics and medicines
* Monthly support supervision via supervisors trained in either pharmacy or clinical medicine
 | * The intervention increased the appropriate treatment of children with uncomplicated malaria, pneumonia symptoms and non-bloody diarrhoea by 80.2% (95% CI 53.2–107.2), 65.5% (95% CI 51.6–79.4) and 31.4% (95% CI 1.6–61.2) respectively versus the pre-intervention period
* Adherence to guidelines during the intervention phase was high without causing excessive prescribing of antimicrobial medicines
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