Improving primary care antimicrobial stewardship by implementing a peer audit and feedback intervention in Cape Town community healthcare centres

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Background. The increasing prevalence of antibiotic resistance is a major threat to public health. Primary care, where 80% of antibiotics are consumed, is a pivotal setting to direct antimicrobial stewardship (AMS) efforts. However, the ideal model to improve antibiotic prescribing in primary care in low-resource settings is not known.

Objective. To implement a multidisciplinary audit and feedback AMS intervention with the aim to improve appropriate antibiotic prescribing at primary care level.

Methods. The intervention was implemented and monitored in 10 primary care centres of the Cape Town metropole between July 2017 and June 2019. The primary and secondary outcome measures were monthly adherence to a bundle of antibiotic quality process measures and monthly antibiotic consumption, respectively. Multidisciplinary audit and feedback meetings were initiated and integrated into facility clinical meetings. Two Excel tools were utilised to automatically calculate facility audit scores and consumption. Once a month, 10 antibiotic prescriptions were randomly selected for a peer review audit by the team. The prescriptions were audited for adherence to a bundle of seven antibiotic process measures using the standard treatment guidelines (STG) and Essential Medicines List (EML) as standard. Concurrently, primary care pharmacists monitored monthly antibiotic consumption by calculating defined daily doses (DDDs) per 100 prescriptions dispensed. Adherence and consumption feedback were regularly provided to the facilities. Learning collaboratives involving representative multidisciplinary teams were held twice-yearly. Pre-, baseline and post-intervention periods were defined as 6 months before, first 6 months and last 6 months of the study, respectively.

Results. The mean overall adherence increased from 19% (baseline) to 47% (post intervention) ($p<0.001$). Of the 2 077 prescriptions analysed, 33.7% had an antibiotic prescribed inappropriately. No diagnosis had been captured in patient notes, and the antibiotic chosen was not according to the STG and EML in 30.1% and 31.7% of cases, respectively. Seasonal variation was observed in prescribing adherence, with significantly lower adherence in winter and spring months (adjusted odds ratio 0.60). A reduction of 12.9 DDDs between the pre- and post-intervention periods ($p=0.0084$) was documented, which represented a 19.3% decrease in antibiotic consumption.

Conclusion. The study demonstrated that peer reviewed audit and feedback is an effective AMS intervention to improve antibiotic prescribing in primary care in a low-resource setting. The intervention, utilising existing resources and involving multidisciplinary engagement, may be incorporated into existing quality improvement processes at facility level, to ensure sustainable change.

In response to increases in antibiotic consumption[1] and to the rising prevalence of multidrug and extensive drug resistance among common bacterial infections in South Africa (SA), a One Health-based national strategic framework for antimicrobial resistance,[2] an implementation plan[3] and a mechanism for the governance of antimicrobial stewardship (AMS) at national, provincial, district and hospital levels[4] was developed by the National Department of Health. While the importance of improving outpatient antibiotic use is acknowledged, no comprehensive recommendations to curb the use in the primary healthcare setting have been made, owing to the lack of sufficient data to guide such efforts.[5] A targeted

application of AMS principles to the ambulatory setting has the potential to affect the most common indications for systemic antibiotic use, in that the majority (80%) of antibiotic use occurs in primary care, with acute respiratory-tract infections being the most common indication.[5,6]

AMS is defined as the systematic approach to optimising the appropriate use of antimicrobials to improve patient outcomes and limit emergence of resistant pathogens while ensuring patient safety.[4] However, the reasons driving the excessive prescription of antibiotics in the community are complex, and include constraints on consultation time, lack of appreciation of the impact on resistance, considerable

diagnostic uncertainty and perhaps equally importantly, perceived patient and parental/guardian pressures.[5,7,8] Therefore, multifaceted, multicomponent interventions with effect sizes of sufficient magnitude to potentially reduce the incidence of antibiotic-resistant bacteria are generally recommended for primary care.[5] Whereas educational interventions may be implemented on many levels after addressing local barriers to change, expecting adherence to antibiotic guidelines without concurrent interventions is of little value.

In fact, a recent survey of antibiotic prescribing practices in the Cape Town metropole confirmed 55% non-adherence to the standard treatment guidelines (STG) and Essential Medicines List (EML) for SA.[9] Undocumented antibiotic indication (30.5%) and inappropriate antibiotic dose (12.9%), choice (11.5%) and duration (9.5%) were the main reasons for non-adherence.[9] In addition, the problem in SA is confounded by lack of undergraduate AMS training, as final-year medical undergraduates have been found to be inadequately prepared for practice.[10] Crucial gaps in knowledge and poor understanding of AMS principles were recently demonstrated in a multisite survey in SA.[11]

Many different interventions have been implemented to improve antibiotic prescribing in primary care settings.[12] A Cochrane review concluded that C-reactive protein testing, shared decision-making between prescriber and client and procalcitonin-guided management reduce antibiotic prescribing for acute respiratory infections in general practice.[12] In one study, personalised prescription feedback did not have a significant effect in changing the antibiotic consumption between the intervention and control group,[13] but in primary care practices, accountable justification and peer comparison as behavioural interventions resulted in lower rates of inappropriate prescribing.[14]

A systematic review concluded that quality improvement (QI) methods are effective at reducing antibiotic use in ambulatory settings, but suggested further improving outcomes by active clinician education and targeted management of all acute infections rather than focusing on single conditions or single age groups of clients.[15] In the UK, stakeholder consultation, APEASE (i.e. affordability, practicability, effectiveness, acceptability, safety and equity) criteria were used to identify the highest-rated interventions to improve antibiotic prescribing. The top four were quality improvement, multidisciplinary peer learning, appointing AMS leads and auditing individual level prescribing.[16]

In the SA public sector, there is no standardised way of integrating AMS governance processes into primary care facility operations. At hospital level in the Western Cape Province, AMS committee activities have included antimicrobial prescription chart reviews and audits, AMS ward rounds, antimicrobial restriction policies and training.[17,18]

The ideal model to improve antibiotic prescribing in primary care in low-resource settings is not known. Utilising existing staff, we therefore designed and implemented a multidisciplinary AMS intervention involving an audit and feedback strategy, with the objective of improving appropriate prescribing of antibiotics at primary care level as defined in the STG and EML.[19] A peer review approach was chosen rather than a formal audit by outsiders, to increase ownership of the process by facilities and embed it in local quality improvement processes. It is hypothesised that such an intervention will result in improved prescribing patterns and adherence to evidence-based guidelines.

Methods

The multicentre AMS intervention was implemented in community health centres (CHCs) and community day centres (CDCs) of the Cape Town metropole between July 2017 and June 2019.

Ethical approval

Approval to conduct the study was granted by the Human Research Ethics Committee at the University of Cape Town, (ref. no. 290/2016), as well as Western Cape Government Health. For the purpose of the folder review, informed consent from patients was not required by the approval committees, as folder review was retrospective, data were anonymised before analysis and there was no direct patient contact.

Participants

Thirteen primary care facilities in the Cape Town metropole were initially invited to participate in the quality improvement implementation study. Ten facilities provided adherence and consumption data, and were included in the 24-month study period (July 2017 - June 2019). Characteristics of the facilities are shown in Table 1.

Interventions

Multidisciplinary audit and feedback meetings (consisting of pharmacists, doctors and nurse prescribers) were initiated and integrated into the facility clinical meetings. Once a month, at each of these facilities, 10 antibiotic prescriptions were randomly selected for a peer review audit by the team. These prescriptions were then assessed and scored for adherence to a bundle of seven measures, including antibiotic choice, dose, duration and frequency with the STG and EML[19] as standard, as shown in Table 2. All measures had to be met for the prescription to be considered correct, i.e. the all-or-nothing concept.

Concurrently, primary care pharmacists monitored monthly antibiotic consumption for the six oral antibiotics prescribed most frequently, i.e. amoxicillin, amoxicillin/clavulanic acid, azithromycin, ciprofloxacin, flucloxacillin and Penicillin VK.[9] Intravenous antibiotics were excluded. Monthly consumption data and the number of prescriptions dispensed were obtained from the electronic pharmacy information system. Consumption was calculated as defined daily doses (DDDs) per 100 prescriptions dispensed.[20]

Two tools (in Excel; Microsoft, USA), one for audit and one for measuring consumption, were developed. The audit tool was piloted by a family physician at a CDC during February - April 2017, prior to implementation in the rest of the participating CHCs.

Monthly, each facility provided feedback on the monthly folder review audit and consumption data to two project managers (one for adherence and one for consumption), using the two Excel tools that automatically calculated facility audit scores and DDDs per 100 prescriptions, respectively. The project managers collated the data from the various facilities 6-monthly, and provided comparative feedback to the pharmacists, who in turn provided verbal feedback in monthly clinical meetings.

Learning collaborations involving pharmacists and prescribers from participating facilities were held twice yearly, with the following aims: to facilitate collaborative learning among CHCs; to clarify requirements of AMS implementation; to brainstorm ideas to overcome obstacles to implementation; to share successes; to evaluate accuracy and consistency of data; and to provide comparative feedback on progress and improvements or otherwise. The feedback from the participating teams regarding successful components to achieve improvements in adherence to the antibiotic audit measures was collated.

Study outcomes

To enable measurement of process measures and sustainable improvement or otherwise, as well as consumption, pre-, baseline and post-intervention periods were defined as 6 months before the intervention, during the first 6 months of the intervention and the last 6 months of the intervention, respectively.

Table 1. Primary care facility characteristics							
		Multidisciplinary teams					
Facility	**Average monthly headcount**	**Total staff**	**Doctors**	**Clinical nurse practitioners**	**Pharmacists**	**Emergency centre**	**Midwife obstetric unit**	**Hours/day**
A	16 358	90	4	7	3	N	Y	8
B	11 531	120	4	10	3	N	N	8
C	32 113	144	12	18	4	Y	Y	24
D	21 337	135	8	7	3	Y	Y	24
E	16 052	120	4	8	3	Y	Y	8
F	39 585	206	13	17	7	Y	Y	24
G	22 636	180	10	12	4	N	Y	8
H	29 355	190	10	16	5	Y	Y	24
I	22 074	152	10	5	3	Y	Y	24
J	12 183	65	4	8	3	N	Y	8

Table 2. Antimicrobial prescribing process measures
Allergies documented
Diagnosis provided
Appropriate antibiotic prescribed according to guideline
Appropriate dose
Appropriate frequency
Appropriate duration
Valid prescription (prescriber name, signature and date)

Primary

The primary study outcome was monthly adherence to the bundle of antibiotic prescription quality process measures (Table 2). The percentage of correct prescriptions (out of 10) was reported as the performance for the month per facility, and compared over the study period. Facility percentages were combined to form a 'system' outcome measure and reported on an annotated run chart.

Secondary

The secondary outcome was monthly antibiotic consumption calculated in DDDs per 100 prescriptions (100 Rx) per month, as a pragmatic metric to assess trends in consumption over the study period.

Statistical analysis

Regression was carried out using R version 3.6.2 (The R Foundation, USA), to compare the adherence to the bundle of antibiotic prescription quality processes, comparing the first 6 months of the intervention to subsequent time periods in 6-month intervals for the duration of the study. Regression analysis was also carried out to explore the factors affecting the adherence to the bundle of antibiotic prescription quality process measures per facility. Unadjusted and adjusted analysis is presented for prescriber type, age of patient, season, physiological system and antimicrobial prescribed.

Stata/SE 14.0 (Stata Corp., USA) was used to generate paired t-tests and two-way scatter graphs to compare antibiotic consumption 6 months pre-intervention, with the last 6 months (post-intervention period) at facility level, over the same seasonal periods.

Results
Adherence to antibiotic process audit bundle

The response rate of facilities submitting monthly audits was 208/240 (86.6%), with 20% of facilities managing 100%. After 24 months of conducting the audit and feedback intervention with constant small adaptations, the mean overall level of adherence increased from 11% in July 2017 to 53% in June 2019 (Fig. 1), with a mean of 19% correct prescriptions in the first 6 months to a mean of 47% correct prescriptions in the last 6 months ($p<0.001$). A positive linear trend over time was documented, and the adherence improved by 2% each month, on average. When compared with the first 6 months, the odds of adherence to process measures for the last 6 months of the study period were 3.72 (95% confidence interval (CI) 2.85 - 4.88; $p<0.001$) (appendix https://www.samedical.org/file/1883).

Of the 2 077 prescriptions analysed, 33.7% (n=700) had an antibiotic that was prescribed incorrectly. Of these incorrect prescriptions, no diagnosis had been captured in patient notes in 30.1% (211/700), the antibiotic prescribed was different from what was recommended in the EML guidelines[19] in 31.7% (222/700), 6.1% (43/700) of prescriptions were incorrect as a result of differences between the EML[19] and Integrated Management of Childhood Illness 2014 guidelines[21] and only 0.3% (2/700) were incorrect owing to stockout of the EML-recommended drugs.

Univariable and multivariable logistic regression for adherence to the audit measures are shown in Table 3. Adherence to the audit measures differed between the facilities, and seasonal variation was observed in prescribing adherence, with significantly lower adherence in winter and spring months (adjusted odds ratio (aOR) 0.60; $p<0.01$) compared with summer and autumn months. Adherence to audit measures also differed by physiological system: prescriptions for sexually transmitted infections (aOR 1.83; p=0.05) and urology (aOR 1.49; p=0.20) were more likely to be adherent to audit measures. Antibiotic prescriptions for gastrointestinal tract infections (aOR 0.65; p=0.32) were less likely to adhere, although this was not found to be statistically significant. Comparing the top six antimicrobials prescribed, prescriptions involving flucloxacillin (aOR 3.10; $p<0.01$) and penicillin (aOR 2.62; $p<0.01$) were more likely to adhere to audit measures than prescriptions for other antimicrobials.

Consumption

Facility response rate for submission of monthly consumption data was 100%. The mean differences in antibiotic consumption between the pre- and post-intervention periods are shown in Table 4. A significant reduction of 12.9 DDD/100 Rx between the pre - and post-intervention period was documented, representing a 19.3% (95% CI: 6.3% - 32.3%) decrease in consumption. Except for amoxicillin/clavulanic acid and Penicillin VK, all other antibiotics showed a significant decrease in consumption. The greatest decreases in consumption were observed for amoxicillin, azithromycin and flucloxacillin. Overall,
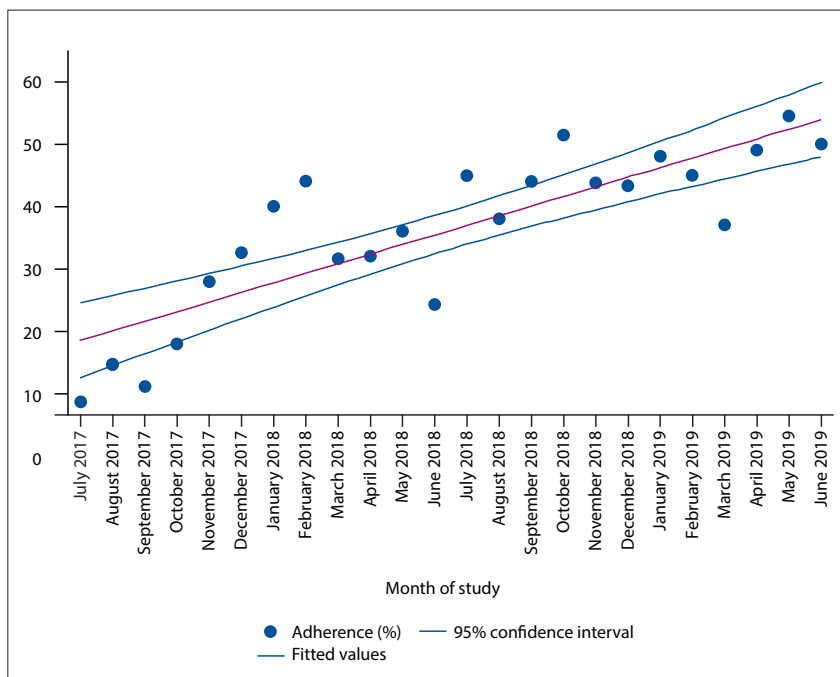
Fig. 1. Proportion of correct prescriptions for all facilities combined over the study period.

antibiotic consumption (DDDs/100 Rx) was higher during the winter months (June and July) than summer months (December and January). The overall antibiotic consumption per facility is depicted in appendix 2 (https://www.samedical.org/file/1884). A decrease in DDD/100 Rx was observed in the majority of facilities (80%). Only one facility showed an increase in overall consumption (13.19), with increases recorded for all antibiotics except ciprofloxacin.

The feedback from the participating teams during collaborative learning sessions regarding successful components to achieve improvements in adherence to the antibiotic audit measures are summarised in Table 5.

Discussion
Adherence to guidelines
In SA, AMS interventions at primary care have not been extensively reported, with more focus on hospital-based interventions at a tertiary hospitals,[22] private hospitals[23] and district hospitals.[18,24] Our study demonstrated that audit and feedback are an effective AMS intervention for primary care in a low-resource setting. While it is difficult for low- and middle-income countries to replicate resource-abundant stewardship models, utilisation of existing resources such as pharmacists and nurses is critical in implementing AMS.[25]

This pilot study illustrated that a quality improvement approach that involved peer review of prescribing practices, feedback and learning collaboratives resulted in a fivefold improvement in guideline adherence. The

results revealed sustainability, substantiated by continuous improvement over the 2-year period. Spikes of improvements after the learning collaborative meetings were observed, reflecting the importance of collaborative feedback.

Furthermore, there was no significant difference in prescribing adherence between nurses and doctors, or for prescribing for adults compared with children. However, prescribing adherence among facilities differed significantly, indicating that specific facilities could be targeted and provided with additional AMS support and guidance. Challenges in implementing AMS involved high staff turnover, resource constraints and competing priorities. Strong AMS leadership, understanding the value of AMS, regular feedback and support from mentors promoted implementation at facilities. Linking AMS to patient safety, i.e. recording allergies as a pivotal process measure, was another enabler for change.

Similar to the Gasson *et al.*[9] study, differences were found comparing physiological systems, with prescribing most adherent in sexually transmitted infections, dermatology and ear, nose and throat infections. Poor adherence was seen in respect of the respiratory tract infections (RTIs) and gastrointestinal infections. For urinary tract infections (UTIs), conflicting results were found between the Gasson *et al.*[9] study, which was the site of infection where prescribing was least adherent to the guidelines, and our study.

One plausible explanation may relate to a greater focus on UTI treatment, as a guideline change due to a medicine safety warning for fluoroquinolones occurred during the study period. Notably, this suggests that guidelines for specific infections could be targeted for improvement.

Prescribing adherence was significantly lower in winter and spring, concurrent with higher antibiotic consumption, which may reflect inappropriate antibiotics for increased viral RTI months. Seasonal variation in antibiotic prescribing is a global phenomenon.[26,27] In our study, increased inappropriate prescribing, especially of amoxicillin, contributed to the increased consumption.

Consumption
Overall, there was a significant 19.3% decrease in antibiotic consumption over the intervention period. Notably, the four facilities with the highest adherence also had the greatest decreases in antibiotic consumption. Consumption variation between facilities may be related to different factors, including patient populations. A previous survey of non-communicable disease profiles at most of the primary healthcare facilities recruited in our study documented major variations in the patient demographics and proportions of acute and chronic conditions.[28]

Role of learning collaboratives
During learning collaboratives, facilities identified key components of a successful implementation strategy that included formalising an AMS team that comprised of at least health facility pharmacists and family physicians to ensure that monthly audits take place. The folder peer review audit took 1 hour per month to perform, and facility staff reported that it was a useful process, and that prescribers learned by doing the audit and reviews themselves. In addition, comparing the antibiotic process measures against the EML and STG was found to be a good way to learn. A common challenge in implementing AMS processes in our study was the high turnover of prescribers, especially interns and community service doctors: therefore strategies that promote consistency, oversight or mentorship across facilities may be of value. In this regard, AMS activities should be integrated into the induction or orientation of all new prescribers who join a facility.

Other multimodal components for successful implementation that were identified during the collaborative learning meetings to improve adherence included

Table 3. Univariable and multivariable logistic regression for adherence to the audit measures

Facility	N (%)	Univariable analysis			Multivariable analysis		
		OR	95% CI	*p*-value	OR	95% CI	*p*-value
A	210 (10.1)	Ref			Ref		
B	180 (8.7)	0.97	0.65 - 1.45	0.90	0.93	0.58 - 1.50	0.77
C	230 (11.1)	0.26	0.17 - 0.40	<0.01	0.31	0.19 - 0.49	<0.01
D	210 (10.1)	0.76	0.52 - 1.12	0.17	0.63	0.41 - 0.97	0.04
E	209 (10.1)	0.58	0.39 - 0.86	0.01	0.58	0.37 - 0.92	0.02
F	170 (8.2)	0.44	0.28 - 0.67	<0.01	0.34	0.21 - 0.56	<0.01
G	230 (11.1)	0.32	0.21 - 0.48	<0.01	0.26	0.16 - 0.41	<0.01
H	239 (11.5)	0.44	0.30 - 0.65	<0.01	0.37	0.24 - 0.58	<0.01
I	170 (8.2)	0.53	0.35 - 0.80	<0.01	0.41	0.25 - 0.65	<0.01
J	229 (11.0)	0.98	0.67 - 1.42	0.90	0.99	0.68 - 1.52	0.82
Prescriber							
Clinical nurse practitioner	1010 (49.4)	Ref			Ref		
Doctor	1035 (50.6)	0.93	0.77 - 1.11	0.41	1.15	0.92 - 1.44	0.23
Age							
Child	151 (7.8)	Ref			Ref		
Adult	1924 (92.7)	1.16	0.82 - 1.67	0.40	0.87	0.58 - 1.32	0.51
Season							
Summer	579 (27.9)	Ref			Ref		
Autumn	569 (27.4)	0.91	0.72 - 1.15	0.44	0.95	0.73 - 1.24	0.71
Spring	480 (23.1)	0.61	0.47 - 0.78	<0.01	0.60	0.45 - 0.80	<0.01
Winter	449 (21.6)	0.57	0.44 - 0.74	<0.01	0.60	0.44 - 0.80	<0.01
Physiological system							
Dermatology	426 (24.1)	Ref			Ref		
ENT	354 (20.1)	0.97	0.73 - 1.29	0.84	1.46	0.91 - 2.37	0.12
Gastroenterology	47 (2.7)	0.37	0.18 - 0.73	<0.01	0.65	0.27 - 1.47	0.32
Multiple	7 (0.004)	0.49	0.07 - 2.29	0.39	0.44	0.02 - 3.05	0.44
Other	112 (6.3)	0.63	0.40 - 0.96	0.03	0.96	0.57 - 1.62	0.89
Respiratory	364 (20.6)	0.56	0.41 - 0.74	<0.01	1.13	0.71 - 1.81	0.60
STI	216 (12.2)	1.29	0.93 - 1.79	0.13	1.83	1.01 - 3.32	0.05
Urology	238 (13.5)	0.96	0.70 - 1.32	0.81	1.49	0.81 - 2.72	0.20
Antimicrobial							
Amoxycillin	628 (31.0)	Ref			Ref		
Azithromycin	87 (4.3)	1.11	0.67 - 1.81	0.68	1.27	0.72 - 2.21	0.40
Ciprofloxacin	226 (11.1)	1.82	1.32 - 2.51	<0.01	1.65	0.90 - 3.04	0.11
Co-amoxiclav	221 (10.9)	1.07	0.76 - 1.51	0.68	1.10	0.72 - 1.67	0.65
Flucloxacillin	359 (17.7)	2.74	2.09 - 3.60	<0.01	3.10	1.93 - 5.02	<0.01
Multiple	299 (11.3)	2.18	1.63 - 2.91	<0.01	1.74	1.00 - 3.04	0.05
Other	85 (4.2)	0.74	0.42 - 1.26	0.28	0.77	0.38 - 1.50	0.45
Penicillin	124 (6.1)	3.24	2.18 - 4.82	<0.01	2.62	1.64 - 4.23	<0.01

OR = odds ratio; CI = confidence interval; ENT = ear, nose and throat; STI = sexually transmitted infection.

Table 4. Mean change in antibiotic consumption pre- and post-intervention period for all facilities combined

Antibiotic	Mean diff (DDD/100 Rx)*	95% CI	*p*-value
All antibiotics combined	−12.9	−4.2 - −21.5	0.0084
Amoxycillin	−4.7	−0.4 - −9.0	0.0359
Azithromycin	−3.6	−1.58 - −5.57	0.0029
Ciprofloxacin	−1.72	−0.66 - −2.78	0.0051
Co-amoxiclav	0.5	−0.8 - 1.90	0.3793
Flucloxacillin	−3.35	−1.36 - −5.30	0.0042
Penicillin VK	−0.87	−0.64 - 0.81	0.7914

DDD = defined daily dose; CI = confidence interval.
*Mean diff (DDD/100Rx) = average consumption per month for the 6 months prior intervention (pre-intervention) less the average consumption per month for the last 6 months of the intervention period.

staff surveys to identify challenges and sharing resolutions, a '7-yes' criteria sticker on prescriptions to indicate adherence to all measures and immediate feedback to the prescriber for correction. Furthermore, posters on awareness of antimicrobial resistance, as well as medicine use evaluations to identify problem areas for specific antibiotics, etc., were other enablers for sustained improvement over the study period.

Limitations

The following limitations apply to our study. It was not compared with other primary care facilities in the Cape Town metropolitan area, where antibiotic audit and feedback are not standard of practice. Furthermore, we did not include outcome measures such as adverse events or repeat visits for the same infection (bacteriological or clinical failure), and neither did we follow up patients to calculate

Table 5. Learning collaborative: key components to enable successful implementation of an AMS audit and feedback intervention in primary care	
1	A well-defined, committed team comprising of at least a lead family physician and a community pharmacist should be constituted.
2	The review of folders is feasible, and should easily be incorporated into daily operations, while all team members should participate and rotate in the folder review process.
3	A specific feedback session should be incorporated into the work schedule, either nested in another meeting or a stand-alone meeting.
4	While it is ideal to involve as many staff as possible in the folder reviews, this may not be possible; all prescribers, however, should be invited to the feedback session.
5	Feedback should be done using several approaches, e.g. visual displays/posters (notices, graphs), written (short reports/summaries), WhatsApp/email and verbal (presentations/discussions).
6	A system of individual feedback to prescribers should be implemented. This is especially important for locum staff who are unable/unavailable to attend meetings.
7	AMS processes should be integrated into the induction/orientation of all new prescribers.
8	The audit tool should not only be used for measuring audit adherence and prescribing behaviour, but also for identification of gaps in the system, e.g. conflicting guidelines, the impact of out-of-stock antibiotics, lack of infection-specific guidelines, etc.
9	Other than the learning collaborative sessions, other opportunities for sharing and comparing of audit data, consumption data and interventions between facilities should be facilitated.
10	Less threatening tones and more acceptable and meaningful messages should be developed for prescribers, e.g. patient safety and limiting antibiotic resistance rather than cost containment.

infection-related hospital admission rates. While appropriate prescribing should improve patient outcomes, measuring patient-level outcomes of any AMS intervention is pivotal in future primacy care interventions.

In addition, we did not have the resources to provide individual monthly antibiotic adherence rates to every prescriber. Nevertheless, we believe the peer and institutional feedback led to continuous improvement in adherence over the study period. A systematic review[28] that included 140 randomised controlled trials showed that audit and feedback have small to moderate but important effects on health professionals' behaviour. Moreover, in this Cochrane review, the evidence informing its effectiveness for changing antibiotic prescribing behaviour within the primary care setting was sparse, with only four of the trials studying the effect of feedback on prescribing within primary care. Therefore the reasons for the decrease in consumption in our study are not entirely clear, and future studies in this setting should incorporate qualitative research approaches, including comparison of the effectiveness of different ways of providing feedback. Finally, the effect size of randomly selecting more folders monthly on the impact of this intervention is unknown.

Conclusion

The strength of this study is that it demonstrated that peer audit and feedback may be an effective AMS intervention in primary care in a low-resource setting. Prescriber adherence to guidelines improved during the study period, and antibiotic consumption decreased. It represents a feasible intervention that can seamlessly be incorporated into existing quality improvement processes at facility level, utilising existing staff. Improvement methodology supports this type of intervention, as it facilitates regular measurements, and peer-reviewed performance assessments with ongoing feedback. Support of the facility management and a multidisciplinary team approach is critical, with the pharmacist playing a key co-ordinating and interdisciplinary role.[29] A qualitative approach and analysis of barriers and enablers for further improvement are required prior to provincial-wide implementation.

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