

Education and management of antimicrobials amongst nurses in Africa—a situation analysis: an Infection Control Africa Network (ICAN)/BSAC online survey

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Objectives: To assess the current involvement of nurses in the use and management of antimicrobials and their training in antimicrobial stewardship (AMS) across Africa.

Methods: After a pilot study, an online questionnaire (SurveyMonkey) in both French and English was circulated via the Infection Control Africa Network (ICAN) mailing list to both members and non-members in Africa. The study was conducted from 26 May to 19 August 2016. Data were summarized in proportions and bar charts; proportions were compared using the χ^2 test. A multivariate logistic regression model was built to identify independent factors associated with the practice of AMS.

Results: While 96% of the 173 respondents were aware of the term 'AMS', 88.5% (146/165) undertook AMS tasks as part of their job; 91.9% (158/172) wanted to be more involved in AMS but 44.9% (71/158) reported there were barriers in doing so. AMS training was delivered to 36.7% (62/169) and 53.6% (90/168), respectively, during their undergraduate and postgraduate education. AMS training for healthcare workers in their institutions was reported by 50.3% (86/171), including training aimed at doctors (56.9%), pharmacists (76.7%), microbiologists (31.4%) and nurses (95.3%). However, 95.4% (164/172) of respondents asked for further education on AMS and the majority preferred AMS training to be part of the infection prevention curriculum (IPC) education. Three-quarters of institutions had an AMS initiative, but only ~41% reported having seen a national AMS guideline.

Conclusions: For Africa, we recommend AMS education at undergraduate level, AMS policies at institution and national levels and incorporating AMS training into the IPC for nurses.

Introduction

Antimicrobial resistance (AMR) is a recognized global threat, and it is widely accepted that antimicrobial stewardship (AMS) is one of the key strategies to combat AMR. Education of healthcare professionals is the mainstay to implement successful AMS programmes (ASPs).^{1–3} Ideally AMS is a multidisciplinary approach to combating AMR by appropriate selection and prescribing of antimicrobials, optimizing doses and duration, minimizing toxicity and side-effects and reducing the spread of all pathogens, especially resistant ones, by implementing robust infection prevention programmes. Inappropriate prescribing, which may be attributed in part to the lack of adequate undergraduate education, contributes to AMR.^{4–6,7} In fact, until recently AMS was not included in most undergraduate training in African medical and nursing schools,⁴ as

it is in some high-income countries.⁸ Published reports indicate that future prescribers of antimicrobials are less confident and prepared to deal with AMR^{4,6} and their need to be better trained in antimicrobial prescribing and stewardship is evident.^{4,8}

Usually, decision makers in AMS include infectious diseases physicians, pharmacists, infection control practitioners, microbiologists and administrative professionals (financial and regulatory support).¹ The IDSA provides a list of core members of a multidisciplinary AMS team, which includes an infectious diseases physician and a clinical pharmacist with training in infectious diseases, a clinical microbiologist, an information system specialist, an infection control professional and a hospital epidemiologist.⁹ In low-to-middle-income countries (LMICs) there is a paucity of clinicians and often the AMS team consists of a physician and a nurse, and rarely a pharmacist.

Often doctors work part-time sessions as consultants (specialist clinicians). Nurses, on the other hand, are involved in patients' continuum of care from admission to discharge (from the healthcare setting)—and increasingly they have an important role to play in AMS.

It is recognized that 70% of healthcare in Africa is delivered by nurses, especially in the rural health delivery centres; many of them already prescribe antimicrobial agents based on a syndromic approach, particularly for sexually transmitted diseases.¹⁰ While nurses are often expected to prescribe antimicrobials in their clinical practice, AMS is not covered in either their undergraduate or post-graduate training.³ The role of the nurse in AMS is becoming more critical, particularly in low-resource settings, and competencies or skills required by nurses to be included in ASPs are being developed.¹¹

In most African countries, nursing education provides a 3 year diploma as the entry level for practice, and in 2016 the WHO Regional Office for Africa published the 3 year regional prototype pre-service competency-based nursing curriculum.¹² This curriculum takes into account the primary healthcare approach and cross-sectoral actions to tackle the social determinants of health.¹² However, training of nurses in Africa varies from one country to another and in some places from one institution to another. The main difference between countries has been reported to be content-driven instead of competency-based education, and this is not always aligned to the local healthcare needs.¹³ Nurses have different qualifications at the end of the 3 year programme; some get a dual qualification as a nurse and a midwife, and others get a single one as a nurse or a midwife.¹³

In order to establish the role and potential interest in management of antimicrobials amongst nurses in Africa, the Infection Control Africa Network (ICAN) and the BSAC collaborated to develop and conduct an online survey in both English and French to record the current AMS systems, particularly regarding the role of nurses and their education and training to support these activities.

Materials and methods

A voluntary and anonymous online survey (SurveyMonkey) in both English and French was conducted using a questionnaire developed jointly by BSAC and ICAN. The survey was piloted before the final version was corrected and circulated. The survey was circulated to the ICAN mailing list of 998 e-mail addresses on the database, consisting of both the current members (505) and non-members (493) in Africa. ICAN is a multidisciplinary platform that includes experts in infection prevention and control (IPC), infectious diseases, infectious diseases epidemiology, clinical epidemiology and microbiology, just to name a few. It operates all over Africa, from Cape Town to Cairo, focusing on education/training in IPC and research, establishing and/or strengthening national IPC societies/programmes in Africa. The above-mentioned experts include clinicians and non-clinicians. ICAN works closely with national health ministries, international health organizations such as the WHO, US CDC, Médecins Sans Frontières (MSF) and the International Society for Infectious Diseases (ISID), to name a few. The period of survey was from 26 May 2016 to 19 August 2016. Data were collected on SurveyMonkey, which automatically summarizes responses using frequencies and percentages as appropriate. The denominator varied for each question depending upon the number of answers (no questions required mandatory answers). The survey was targeted at nurses; however, responses were also received from other categories of staff. The questionnaire was subdivided into sections as follows:

- Assessment of current awareness and participation in AMS programmes
- Access to formal education and training in AMS

- AMS training offered to employees by healthcare institutions
- Document the availability of national and regional programmes including AMS policies
- Express opinion on AMS generally and in their institutions

Data analysis was performed using STATA/IC 13.1 (College Station, TX, USA). Two comparison analyses were undertaken. The first comparison was between those respondents who were already involved with AMS as part of their job and those who were not, using the χ^2 test. The second analysis was a stratification of participants by origin 'from South Africa' versus 'not from South Africa', analysing AMS activities currently undertaken in each group. This was justified by the fact that South Africa represented half of the participants. Both univariate and multivariate logistic regression analyses were performed to determine independent factors associated with the practice of AMS among the respondents. The inclusion cut-off for the multivariate logistic regression was $P \leq 0.2$, using manual stepwise forward selection.

Results

Baseline characteristics of survey respondents

A total of 998 were polled, of whom 173 nurses (17.3%) volunteered to participate in the survey from both Anglophone ($n = 12$) and Francophone ($n = 3$) countries. It was noteworthy that South Africa returned 61.7% (103/167) of all replies, followed by Namibia (8.9%, 15/167), Zimbabwe (8.4%, 14/167), Kenya (4.8%, 8/167) and Sierra Leone (3.6%, 6/167); the remaining countries provided <3% of the total replies. Females represented 85.4% (146/171) of respondents. Eighty-seven percent (149/171) of participants were between the ages of 30 and 60 years while participants <30 or >60 years of age accounted for <7% each.

Respondents stated that their numbers of years post-qualification were as follows: 10–19, 28.4% (48/169); 20–29, 34.3% (58/169); 30–39, 15.9% (27/169); the remaining respondents stated they had <10 or >40 years post-qualification. Answers to the question on the highest educational qualification in nursing were as follows, in ascending order: diploma, 31% (53/171); degree in nursing, 23.9% (41/171); postgraduate diploma, 28.7% (49/171); completed a masters' programme, 9.4% (16/171); PhD, 1.2% (2/171); and a different qualification that was not recorded, 5.8% (10/171).

Current status of respondents in AMS

Ninety-six percent (166/173) of respondents were aware of the term 'antimicrobial stewardship'; 88.5% (146/165) performed at least one AMS-related task as part of their job. Among the tasks reported, 93.6% (160/171) taught IPC, 60.8% (104/171) taught about appropriate use of antimicrobials, 53.2% (91/171) led or took part in audits and data collection on antimicrobial usage, 49.1% (84/171) communicated laboratory reports daily to treating prescribers, 47.4% (81/171) reminded the prescriber to review the need for *in situ* medical devices (e.g. urinary catheters, central line) every day and 42.1% (72/171) were members of the committee making decisions about antimicrobial prescribing (Figure 1). About 92% (158/172) of participants would have liked to have been more involved in AMS, particularly in teaching IPC (117/157; 74.5%) and appropriate use of antimicrobials (116/157; 73.9%); 66.9% (105/157) would have liked to lead or take part in audits of antimicrobial use and 56.7% (89/157) would have liked to have taken part in developing antimicrobial prescribing policies and guidelines, while 12.1% (19/157) wanted to prescribe antimicrobials. Barriers

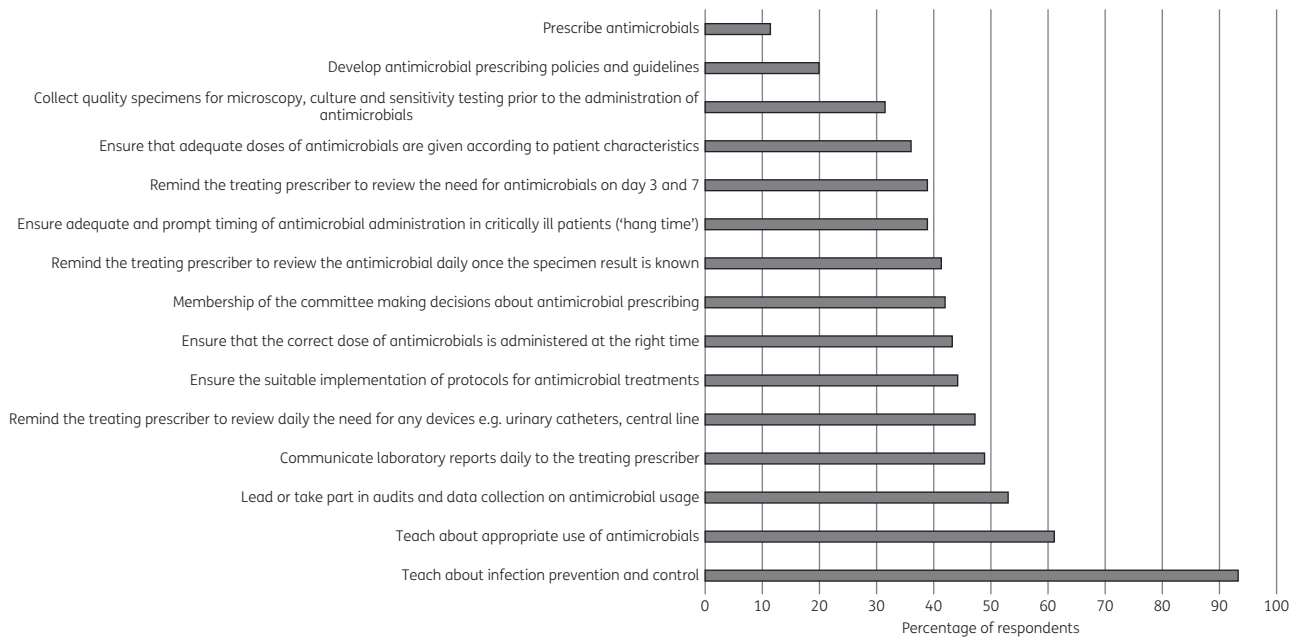


Figure 1. AMS tasks undertaken as part of the job. Some performed more than one type of task.

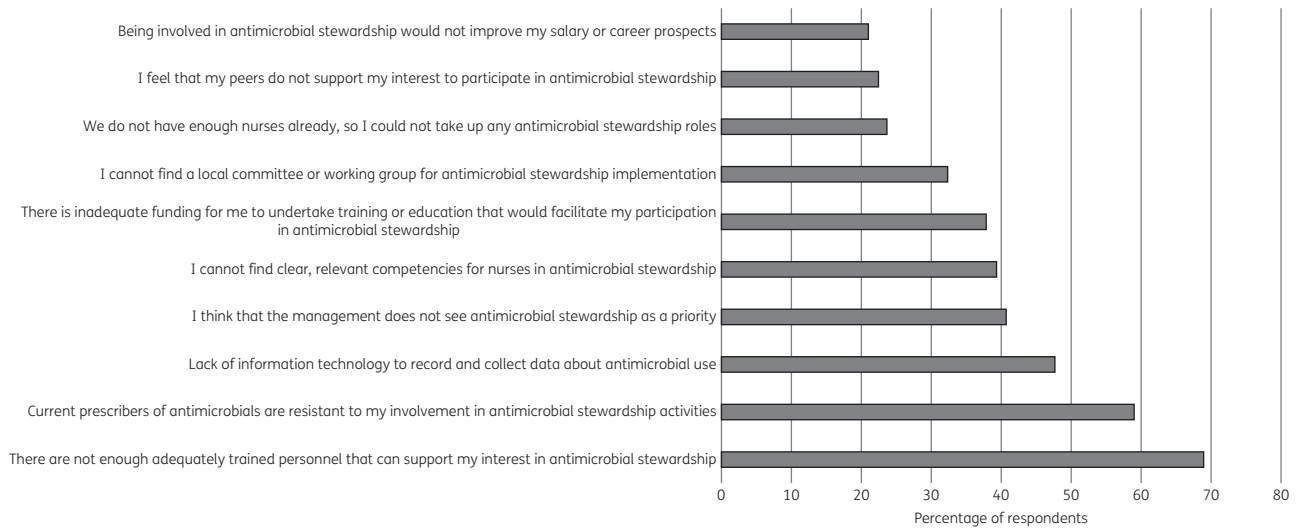


Figure 2. Barriers to AMS participation by nurses.

preventing participation in AMS were reported by 44.9% (71/158). The range of barriers identified is shown in Figure 2.

Personal education and training

During undergraduate training, 36.7% (62/169) reported they had received AMS teaching. More than 53% (90/168) received AMS education at postgraduate level in the form of continuous professional development (CPD) study days (63.3%), self-directed study from journal articles (46.6%) or online courses (31.1%). Some were formally trained at diploma level (23.3%), whereas 2.2% had AMS training at Masters level and 1.1% were exposed to AMS while studying for their PhD.

Outside formal education and training, respondents identified additional sources of AMS information as conference/scientific meetings (43%, 40/93) and hospital programmes (50.5%, 47/93); university/colleges were responsible for 36.6% (34/93) and professional organizations participated in education for 30.1% (28/93), while pharmaceutical companies were the source of information for 18.3% (17/93). The least information was delivered by national or regional government agencies (5.4%, 5/93).

Institutional employment education

Approximately 50.3% (86/171) of respondents reported that healthcare workers in their institution or organization received

Table 1. Baseline characteristics of survey respondents

Characteristics	Number (%)
Respondents (N = 167) by country	
Botswana	4 (2.4)
Burkina Faso	1 (0.6)
Cameroon	1 (0.6)
Democratic Republic of Congo (DRC)	3 (1.8)
Egypt	1 (0.6)
Kenya	8 (4.8)
Liberia	2 (1.2)
Namibia	15 (8.9)
Nigeria	4 (2.4)
Rwanda	2 (1.2)
Sierra Leone	6 (3.6)
South Africa	103 (61.7)
Swaziland	1 (0.6)
Senegal	2 (1.2)
Zimbabwe	14 (8.4)
Age, years (N = 171)	
20–29	10 (5.8)
30–60	150 (87.7)
≥60	11 (6.4)
Gender (N = 171)	
female	146 (85.4)
Number of years post-qualification (N = 169)	
0–4	7 (4.1)
5–9	18 (10.7)
10–19	48 (28.4)
20–29	58 (34.3)
30–39	27 (15.9)
>40	11 (6.5)
Highest educational qualification in nursing (N = 171)	
diploma in nursing	53 (31)
degree in nursing	41 (23.9)
postgraduate diploma	49 (28.7)
masters	16 (9.4)
doctorate (PhD)	2 (1.2)
other	10 (5.8)

training in AMS during their employment; however, access to such education was not equitable across the professions, for example nurses (95.3%, 82/86), pharmacists (76.7%, 66/86), doctors (56.9%, 49/86), microbiologists (31.4%, 27/86) and other categories (13.9%, 12/86).

Topics covered during employment education

A wide range of topics were covered in AMS or IPC education in the workplace and often more than one topic was covered by the training. The key topics included adopting necessary IPC measures related to preparation and administration of antimicrobials (90.8%, 79/87), ensuring adequate and prompt timing of antimicrobial administration in critically ill patients ('hang time') (93.1%, 81/87), ensuring appropriate duration of antimicrobial treatment (86.2%, 75/87) and ensuring that quality specimens for microscopy, culture

and susceptibility testing were collected while observing adequate IPC measures 88.5% (77/87).

Ways the AMS education was delivered during employment

The dominant methods of AMS teaching reported were 'on-the-job learning' (71.3%, 62/87) and 'face-to-face formal classes or presentations' (70.1%, 61/87). Mixed methods of teaching (e.g. e-learning and workshops) were reported by 33.3% (29/87), face-to-face 'hands-on' workshops by 26.4% (23/87), work-based teaching (e.g. workbooks or portfolios of evidence) by 29.9% (26/87) and web-based e-learning by 9.2% (8/87). The education was provided *ad hoc* in 52.3% (45/86) or once a year in 19.8% (17/86).

The providers of education were current employing organizations (63.9%, 55/86), conferences or scientific meetings (31.4%, 27/86), pharmaceutical (industry) companies (26.7%, 23/86), professional organizations (15.1%, 13/86) and national or regional government organizations (2.3%, 2/86).

Future training in AMS

Notably, 95.4% (164/172) of respondents said they would have liked further education/training in AMS. The preferred method for future training [based on a Likert scale ('strongly like')] was 'hands-on' workshop (53.8%, 77/143) and mixed methods (e.g. e-learning and workshops; 49.6% 68/137), followed by face-to-face classes or presentations 46.9% (67/143) and 'on-the-job' learning 46% (62/135). The least preferred methods for respondents to this survey were web-based or e-learning (38.2%, 47/123) delivered in isolation and work-based teaching, e.g. workbooks or portfolios of evidence (31%, 39/126). The topics of interest were developing improved infection management skills (91.9%, 149/162), better communication (91.4%, 148/162), education about managing infection better (87.7%, 142/162), data about important new infections (87.7%, 142/162), reasons for AMR (85.2%, 138/162) and laboratory diagnosis of infection (75.3%, 122/162). The majority of respondents said AMS training should be provided as part of infection prevention/control training (46.8%, 80/171) or as part of patient safety/quality improvement education or training (29.8%, 51/171) or independently (22.8%, 39/171).

Institution or organization level

More than 76% (130/170) of institutions or organizations had an initiative or interventions on antimicrobial prescribing or stewardship. More than 59% (101/169) of respondents reported that their institution had an antimicrobial prescribing policy and 69.1% (85/123) said they had seen one.

The ranges of topics included in the antimicrobial prescribing and stewardship policies were similar to those found in most AMS policies worldwide. The antimicrobial policy was made available during staff meetings (54.0%, 47/87) or via the intranet (44.8%, 39/87), e-mail (32.2%, 28/87) and booklets (24.1%, 21/87).

The lead person in charge of the AMS programme varied between healthcare facilities and countries based on background, interest or expertise. These were pharmacists (44.7%, 76/170), doctors (27.6%, 47/170), a group of hospital workers including doctors and pharmacists (19.4%, 33/170), a microbiologist (15.3%, 26/170) or a nurse (19.4%, 33/170).

In response to the question on which professional categories should be involved in AMS, the replies were doctors (95.9%, 165/172), pharmacists 95.3% (164/172), nurses 90.7% (156/172), infection control practitioners 91.9% (158/172), microbiologists 90.1% (155/172) and patients 49.4% (85/172).

Stewardship at the national level

National guidelines or standards for AMS were seen by 41.3% (71/172) of respondents. The presence of a national AMS committee was reported by 44.7% (76/170) and it was a multidisciplinary and multisectorial committee for AMS. Fifty-nine percent of respondents (101/171) recognized antimicrobial resistance in their country as a problem and they felt they were not able to control it.

Practice of AMS and bivariate comparisons

Those respondents who had received training in their institution would carry out AMS tasks ($P < 0.001$), belonged to institutions with an AMS initiative ($P < 0.001$) or had seen a policy on AMS ($P = 0.01$) (Table 2). It was noted that South African participants (Table 2) were more likely to be female, have a multidisciplinary and multisectorial committee and initiatives for AMS, trained in AMS at the workplace, seen a national or regional guideline or institutional policy for AMS, and have any postgraduate education in AMS. On the other hand, participants outside South Africa were more likely to have had AMS education during their undergraduate training, with a clear trend of interest in further education in AMS (100% of respondents) and the large majority would like to be more involved in AMS (98.4% of respondents) (Table 3).

Factors associated with the practice of AMS

In unadjusted analyses, the odds of practising AMS were three times higher in participants who had postgraduate education or training in AMS compared with those who had not (OR 3.3, 95% CI 1.1–9.8, $P = 0.03$), and were almost four times higher if the institution had any initiative or interventions on antimicrobial prescribing or stewardship (OR 3.9, 95% CI 1.4–10.6, $P = 0.008$). It was three times as high if respondents had seen the antimicrobial prescribing or stewardship policy (OR 3.5, 95% CI 0.9–12.2, $P = 0.05$) (Table 4).

In contrast, respondents who would have liked further education and/or training in AMS had a 93% decrease (OR 0.07, 95% CI 0.01–0.4, $P = 0.004$) in the odds of current practice of any AMS activity. In adjusted analyses, only one factor remained independently associated with the practice of AMS: interest in having further education in AMS had a decrease in the odds of practice of any AMS activity (adjusted OR 0.06, 95% CI 0.003–0.9, $P = 0.047$) (Table 4).

Discussion

In general our findings suggest that nurses are involved in AMS practice, with different levels of training and facilities or structures in Africa. The involvement of institutions and provision of AMS policy, education at the workplace and national/regional structures are associated with an increase in AMS practice. These results are more reflected in South Africa, where more than half of the participants came from. A subset analysis comparing respondents from

South Africa with those from the rest of participating African countries suggests two different interpretations. One demonstrates more robust AMS practice and related structures in South Africa compared with other countries in Africa, where there is a clear interest in further training in AMS and more involvement in its practice. The other is that the low rate of response from other African countries might be related to the sub-optimal knowledge about AMS, hence the interest in further education in AMS (all non-South African participants). In Africa, people are increasingly aware of IPC and recognize its importance in fighting healthcare-associated infections as well as outbreaks, hence the preference for including AMS training in IPC education.

In Africa, the critical and leadership role of the IPC nurse practitioner is recognized and has been highlighted as the first core component published in WHO's 2016 Core Component guidelines.¹⁴ Expanding the role of the clinical nurse to support stewardship activities, particularly in the rural health delivery areas and the community, where it already exists, is an opportunity to enhance AMS in this regard. Skilled healthcare workers are scarce in Africa and the traditional models for stewardship delivery may not be possible. IPC practitioners are currently involved in some policy-making decisions and many attend AMS committees and ward rounds. Stewardship requires adequate and robust structures, organization and processes to effect change. An understanding of all these components is critical to inform recommended systems changes for delivering good AMS practices through Africa that are sustainable.

Currently in Africa, nurses are already involved in AMS in their daily activities. More than 88.5% of participants practise at least one AMS task as part of their job, such as teaching IPC, appropriate use of antimicrobials, taking part in audits and data collection, and communicating laboratory reports daily to treating prescribers. Nurses would like to become more involved in the development of antimicrobial prescribing policies and guidelines, and prescribing antimicrobials as part of their clinical duties. These findings indicate a powerful message and a potential important game changer in the African context, and where nurses are prepared to become involved in the use and management of antimicrobials this could have a significant impact on AMS in Africa,¹⁵ but for this to happen, nurse executives need to actively support and participate and become instruments of change.¹⁶

During their undergraduate training, ~36% of nurses had some exposure to AMS education but much of this was not formally structured. Consequently >60% of nurses are not receiving AMS training at undergraduate level and more formal training in AMR needs to be incorporated in the curriculum for nursing students. A majority of respondents expressed an interest in further education in AMS and these findings are in line with the current body of evidence on AMS education and training.^{3,4,8} The foundations and principles of AMS should be taught at undergraduate level and more specialized training should be conducted at postgraduate level and in the workplace. Nurses are trained in good clinical practice and proper procedures in preparing and administering critical medication, and therefore the inclusion of nurses in AMS is both appropriate and opportune. At the community healthcare level, nurses are prescribers of antibiotics as part of a syndromic approach to treating sexually transmitted infections.¹⁰ It is logical that nurses be allowed to prescribe after the requisite training and

Table 2. Bivariate analysis comparing participants that do AMS versus those that do not

Characteristic	All, n/N (%)	Do AMS, n/N (%)	Do not do AMS, n/N (%)	P value
Female	141/163 (86.5)	126/145 (86.9)	15/18 (83.3)	0.9
Would you like to be more involved in AMS? Yes	150/164 (91.5)	134/145 (92.4)	16/19 (84.2)	0.7
Are there barriers preventing you from participating in AMS? Yes	67/150 (44.7)	60/134 (44.8)	7/16 (43.8)	<0.001
During your undergraduate education and training, did you learn about AMS? Yes	58/161 (36.0)	52/143 (36.4)	6/18 (33.3)	0.4
Since you qualified, have you had any postgraduate education or training in AMS? Yes	88/160 (55.0)	83/143 (58.0)	5/17 (29.4)	0.2
Do healthcare workers at your institution or organization receive education and training on AMS during their employment? Yes	84/163 (51.5)	82/145 (56.6)	2/18 (11.1)	<0.001
Would you like further education and/or training in AMS? Yes	156/164 (95.1)	140/146 (95.9)	16/18 (88.9)	0.09
Does your organization or institution have any initiative or interventions on antimicrobial prescribing or AMS? Yes	128/162 (79.0)	122/144 (84.7)	6/18 (33.3)	<0.001
Does your institution or organization have an antimicrobial prescribing policy? Yes	99/161 (61.5)	95/143 (66.4)	4/18 (22.2)	0.01
Have you seen the policy about antimicrobial prescribing and AMS? Yes	83/119 (69.8)	80/110 (72.7)	3/9 (33.3)	0.07
Have you seen a national or regional guideline or standard for AMS? Yes	69/164 (42.1)	65/145 (44.8)	4/19 (21.1)	0.08
Does your country have a multidisciplinary and multi-sectorial committee for AMS? Yes	74/163 (45.4)	70/144 (48.6)	4/19 (21.1)	0.1
What is your highest educational qualification in nursing?				
undergraduate	21/86 (24.4)	16/76 (21.1)	5/10 (50.0)	0.06
postgraduate	65/86 (75.6)	60/76 (78.9)	5/10 (50.0)	0.06

Table 3. Bivariate analysis comparing participants from South Africa with those not from South Africa

Characteristic	All, n/N (%)	From South Africa, n/N (%)	Not from South Africa n/N (%)	P value
Female	143/165 (86.7)	98/103 (95.2)	45/62 (72.6)	<0.001
Would you like to be more involved in AMS? Yes	153/166 (92.2)	91/103 (88.4)	62/63 (98.4)	0.06
Are there barriers preventing you from participating in AMS? Yes	67/153 (43.8)	37/91 (40.7)	30/62 (48.4)	0.2
During your undergraduate education and training, did you learn about AMS? Yes	61/163 (37.4)	34/102 (33.3)	27/61 (44.3)	0.04
Since you qualified, have you had any postgraduate education or training in AMS? Yes	86/162 (53.1)	62/102 (60.8)	24/60 (40.0)	0.04
Do healthcare workers at your institution or organization receive education and training in AMS during their employment? Yes	83/165 (50.3)	67/103 (65.1)	16/62 (25.8)	<0.001
Would you like further education and/or training on AMS? Yes	158/166 (95.2)	95/103 (92.2)	63/63 (100.0)	0.08
Does your organization or institution have any initiative or interventions on antimicrobial prescribing or AMS? Yes	126/164 (76.8)	93/102 (91.2)	33/62 (53.2)	<0.001
Does your institution or organization have an antimicrobial prescribing policy? Yes	99/163 (60.7)	71/101 (70.3)	28/62 (45.2)	0.01
Have you seen the policy about antimicrobial prescribing and stewardship? Yes	84/120 (70.0)	63/83 (75.9)	21/37 (56.8)	0.05
Have you seen a national or regional guideline or standard for AMS? Yes	71/166 (42.8)	56/103 (54.4)	15/63 (23.8)	0.001
Does your country have a multidisciplinary and multi-sectorial committee for AMS? Yes	74/164 (45.1)	55/102 (53.9)	19/62 (30.7)	0.002
What is your highest educational qualification in nursing?				
undergraduate	23/87 (26.4)	10/50 (20.0)	13/37 (35.1)	0.1
postgraduate	64/87 (73.6)	40/50 (80.0)	24/64 (37.5)	0.1

clinical support and mentorship. All such prescription in this process should be subject to quality review.

Changing the mindset of current prescribers to allow clinical nurse specialists to prescribe outwith sexual health in Africa has its challenges.¹⁴ Some barriers have been highlighted here and others go beyond education into a hierarchical power struggle over patient ownership. In order for change to occur there must be support within the existing infrastructure and behaviour change amongst both administrators and clinicians. Increasing evidence exists on the contextualization of barriers and facilitators of AMS initiative implementation, including the potential impact of

involving nurses.¹⁵ Besides education in AMS, clearly defined responsibilities and roles in AMS should be established for nurses to increase the cohesiveness and continuum of activities amongst multidisciplinary teams.^{15,17} Culture and resources as reported by Pakyz *et al.*¹⁸ highlight the importance of culture and hierarchy in Africa; communication, relationships and conflict management are key skills required for the successful implementation or practice of AMS. Prescribers' resistance to nurses' involvement in AMS activities may be related to the cultural background in Africa. Most prescribers are doctors, and the top-down hierarchical structure between doctors and nurses is still very strong. Discussion is taken

Table 4. Multivariate logistic regression model of factors associated with practice of AMS

Characteristic and reference group	Group	Unadjusted		Adjusted	
		OR (95% CI)	P value	OR (95% CI)	P value
Age (per 10 years increase) (reference, 20–29 years)		1.5 (0.9–2.5)	0.12*	2.0 (0.8–4.9)	0.11
Gender (reference, female)	male	0.8 (0.2–3.1)	0.76		
Are there barriers preventing you from participating in AMS? (reference, no)	yes	0.8 (0.3–2.0)	0.67		
During your undergraduate education and training, did you learn about AMS? (reference, no)	yes	0.7 (0.3–1.5)	0.36		
Since you qualified, have you had any postgraduate education or training in AMS? (reference, no)	yes	3.3 (1.1–9.8)	0.03*	4.4 (0.7–28.9)	0.12
Do healthcare workers at your institution or organization receive education and training on AMS during their employment? (reference, no)	yes	1.9 (0.8–4.4)	0.13*	0.6 (0.2–1.9)	0.35
How frequently is this education or training provided? (reference, not provided)	provided	0.6 (0.3–1.0)	0.09*	–	–
Would you like further education and/or training on AMS? (reference, no)	yes	0.07 (0.01–0.4)	0.004*	0.06 (0.003–0.9)	0.047
Does your organization or institution have any initiative or interventions on antimicrobial prescribing or AMS? (reference, no)	yes	3.9 (1.4–10.6)	0.008*	0.8 (0.1–5.7)	0.82
Have you seen the policy about antimicrobial prescribing and AMS? (reference, no)	yes	3.5 (0.9–12.2)	0.05*	2.3 (0.5–11.0)	0.3
Have you seen a national or regional guideline or standard for AMS? (reference, no)	yes	1.3 (0.6–2.9)	0.46		
Does your country have a multidisciplinary and multi-sectorial committee for AMS? (reference, no)	yes	1.1 (0.6–2.2)	0.7		
What is your highest educational qualification in nursing? (reference, undergraduate)	postgraduate	0.6 (0.3–1.2)	0.15*	–	–

Bold text is used for variables with a significant *P* value in adjusted logistic regression analysis. An asterisk indicates variables with *P* value <0.2 in unadjusted logistic regression analysis.

as confrontation, reminders are taken as insults.¹⁴ In health delivery institutions in Africa, there is little or no intra-organizational network to avoid confrontation between these two traditional hierarchical positions.

Our findings agree with the published literature showing that Africa suffers from insufficient resources, particularly when supporting AMS programmes with well-trained personnel, information technology, data analysis and reporting.^{4,11,19}

We identified four factors that were positively associated with the practice of AMS: (i) identifying barriers to the practice of AMS; (ii) having AMS training at the workplace or institution; (iii) having an institutional initiative or intervention on antimicrobial prescribing or stewardship; and (iv) having seen an antimicrobial prescribing or stewardship policy. These factors reflect a logical flow of interventions based on structure and substance. In contrast, one factor was independently associated with a decrease in practising AMS: reporting barriers to AMS practice (94% decrease).^{4,8} The lack of self-confidence in practising AMS activities due to inadequate training in AMS destroys any potential benefit of effective AMS, as was highlighted in the topics the respondents wanted to be included in the AMS training curriculum.

Our survey findings recommend that AMS education should become part of the IPC training programme or part of patient

safety/quality improvement (PS/QI) education. In fact, in Africa the training in IPC is highly relevant and much needed, as was evidenced by the last Ebola epidemic.²⁰ In response to the global AMR calamity, both IPC and Water Sanitation and Hygiene (WASH) have integrated AMR into their portfolio and support AMR programmes globally in different ways.¹⁴

While e-learning platforms are more cost-effective, the participants preferred face-to-face training and to engage in discussion and group work. As e-learning platforms are introduced gradually to Africa, mixed methods have a place in the teaching structures, particularly when covering vast distances across Africa. The ability of e-learning resources to complement and augment face-to-face teaching in the workplace has been illustrated in a randomized controlled trial (RCT).²¹ In this RCT, on teaching evidence-based medicine among postgraduates, the authors evaluated the educational effects of a clinically integrated e-learning course versus a traditional lecture-based course of equivalent content. The authors concluded that the e-learning platform was as effective as the traditional lecture-based course, less costly and well accepted.

The role of nurses is often not acknowledged and their value underestimated.^{1,15,22} To be more effective, nurses need to be recognized as an integrated part of the AMS team, get the appropriate training and have clear roles assigned to them.^{1,15}

Although this survey has the limitations of a web-based survey, as well as a relatively small representative sample of nurses in African hospitals, it does provide us with the first and largest pan-African insight into the challenges we face in relation to the role of nurses in AMS delivery and education. Many challenges are not dissimilar to those in other parts of the world. It is envisaged that these findings will inform and support both the WHO's desire to develop a global multi-professional curriculum and competencies for pre-service and post-service training in AMR and AMS and our desire to produce a range of traditional and e-learning educational resources that support this ambition. The global impact of the AMS Massive Open Online Course (MOOC), an e-learning resource that is free at the point of access, is such an example.²³

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Transparency declarations

None to declare.

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