Antimicrobial stewardship knowledge and perception among physicians and pharmacists at leading tertiary teaching hospitals in Zambia: implications for future policy and practice

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Abstract
Background: Antimicrobial stewardship (AMS) is a key strategy promoting rational antimicrobial use. In Zambia, information on health professionals' knowledge, attitude, and practice of AMS is limited. This study was undertaken to address this at Zambia's leading specialised teaching hospitals. Methods: Descriptive, cross-sectional study involving 137 physicians and 61 pharmacists. Results: AMS knowledge was relatively low among physicians (51%) and pharmacists (39%). Few physicians (9%) and pharmacists (20%) demonstrated sufficient knowledge of the basic principles of AMS. Physicians' and pharmacists' knowledge levels were significantly associated with years of practice, job position or practice rank, and previous AMS training. The majority (95%) perceived AMR as a current problem in their practise. Most physicians (92%) and pharmacists (86%) had not undertaken AMS training before. All indicated the need for context-specific educational interventions to promote AMS in Zambia. Conclusion: Despite positive perceptions, basic knowledge of AMS was relatively low. Context-specific educational interventions and capacity building are needed to address AMS gaps.

Keywords: Antimicrobial stewardship, knowledge, perceptions, physicians, pharmacists, Zambia

Introduction
Antimicrobial resistance (AMR) is a major public health concern increasing morbidity, mortality, and costs (1-5). The increasing inappropriate use of antibiotics driving AMR has led to international, regional and national initiatives to address this concern (6-10). AMR is one of the most important challenges facing healthcare systems worldwide (4, 6, 11, 12). If left unattended, an estimated 10 to 444 million people will die annually from AMR by 2050, appreciably reducing gross domestic product (GDP) among countries (3, 4, 10). Inappropriate use of antibiotics includes their inappropriate prescribing and dispensing (13-16). In low and middle-income countries (LMICs), antimicrobial use is increasing, yet in many cases antibiotic use is inappropriate or suboptimal, enhanced by the lack of adequate surveillance systems and governance (9, 12, 17-22). In addition, there is considerable self-purchasing of antibiotics among patients in LMICs often for viral infections such as upper respiratory tract infections (16, 23-27).

AMR poses a particular health risk in LMICs compared to higher income countries due to the double burden of communicable and non-communicable diseases (10, 28-30), including increased risk of life-threatening infectious diseases such as HIV, tuberculosis, pneumonia, and malaria (31-33). Consequently, it is imperative to improve the prescribing and dispensing of antimicrobials in LMICs. The instigation of antimicrobial stewardship (AMS) at health service delivery points particularly in hospitals is a recognised strategy to improve antimicrobial use and arrest growing AMR rates (34-39). However, recognising that AMS programmes are particularly challenging in LMICs due to health structure issues as well as lack of implementation of policies (40). AMS programmes though enable coordinated interventions designed to improve and measure appropriate use of antimicrobials through formulary development, promoting the optimal selection of antimicrobial drug regimens and their treatment duration, as well as promoting optimal routes of administration. AMS programmes are also known to improve the quality of patient care by reducing adverse events and improving patient outcomes (35, 37, 40). In addition, AMS programmes reduce AMR and the spread of infections caused by multidrug-resistant organisms (41). Already in 2003, Carling and colleagues (42) have documented the benefits of good AMS in hospital settings whereby a well implemented multidisciplinary AMS programme consistently demonstrated a decrease in the incidence of *Clostridioides difficile*–associated diarrhoea. Studies have also promoted key stakeholder groups in LMICs such as pharmacists to develop guidelines for AMS programmes (43) to improve subsequent antimicrobial use, especially in hospitals.

In Zambia, high rates of irrational antimicrobial prescribing and dispensing have been reported (44), with most antibiotics prescribed in hospitals without bacteriological tests (45) similar to a number of other LMICs (46-50). There are also high rates of self-purchasing of antibiotics without prescription in Zambia adding to AMR rates (24). However, to develop and provide potential initiatives to address irrational antimicrobial use in Zambia, there is a need to identify and address knowledge gaps including practice and behaviours of healthcare providers, which may be driving up AMR rates (51). We are aware through previous research by other scholars that there is variable knowledge of antibiotics and AMR among key stakeholder groups including physicians and pharmacists (52-63), with pharmacists typically being a member of AMS groups within hospitals (35, 64, 65). Lack of knowledge about antibiotic utilisation, AMR and AMS practice is a concern in the local setting. Knowledgeable physicians and pharmacists are crucial to the success of any AMS programme through developing and implementing appropriate antimicrobial strategies in their health facilities. Prior to this study, it was not known how existing knowledge of AMS and perceptions of AMR, or lack of it, could be influencing antimicrobial utilization in Zambia. This study was seen as important given the high burden of infectious diseases in Zambia including HIV/AIDS, tuberculosis, malaria, and pneumonia (24), as well as concerns about the lack of AMS programmes in a number of African countries (40, 66). Consequently, data on the existing knowledge and perceptions of AMS concepts among key health professionals was essential as a starting point to evaluate the need and nature for appropriate educational interventions to improve future antimicrobial utilisation in Zambia.

Consequently, as a first step, this study explored physicians' and pharmacists' knowledge and perceptions regarding AMS at leading tertiary teaching hospitals in Zambia.

Methods
Study Design and Sites
A cross-sectional study employing quantitative methods was undertaken.

The University Teaching Hospitals (UTH) in Lusaka Zambia, were chosen for this initial study. This was because UTH are Zambia's highest tertiary care referral public hospitals. They comprise a consortium of five specialised teaching hospitals namely: The Children's hospital; Mother and New-born hospital; Eye hospital; Adult hospital, and the Cancer Diseases hospital, respectively. The assumption was that if there were concerns regarding knowledge of AMS and AMR at this level of health care, these were likely to be greater at lower secondary care hospitals as well as primary healthcare centres in Zambia.

Physicians and pharmacists practising at UTH were the population of interest as they are key health professionals directly involved in prescribing and dispensing antimicrobials in the hospitals. Moreover, by practising at the respective university teaching hospitals, they are also involved in teaching and mentoring undergraduate students, which are tomorrow's health professionals.

Sample Size
The sample size of physicians and pharmacists were independently determined using Yamane's formula (67) where the total population of physicians at UTH stood at 210 and 85 pharmacists respectively at the time of the study. Using a confidence level of 95%, and a margin of error of 5%, the computed sample size was 137 physicians and 70 pharmacists, respectively.

Data Collection and Instruments
A structured self-administered questionnaire was used to collect data on the following aspects: (i) participants' demographics; (ii) general knowledge on AMS; (iii) knowledge of the goals, objectives, and development strategies of AMS; (iv) perceptions and attitudes about antimicrobial utilisation and AMR; and (v) the perceived need for AMS training. The questionnaire was adapted from similar studies undertaken by Abbo and colleagues (68, 69). The questionnaire was piloted for consistency, length, and relevance of the questions among five physicians and five intern pharmacists at the Levy Mwanawasa Hospital in Lusaka during February 2017 and further refined. A total of 2007 questionnaires were sent out and field data collection conducted from April to June 2017.

Data Analysis
Descriptive statistics were employed to analyse the data. Contingency tables were generated for frequencies and proportions of categorical variables. AMS knowledge scores were initially rated on a continuous scale out of 10. Subsequently, scores were categorized into three levels for ease of comparison and interpretation. These included: a 0 to 4 score as 'low', a 5 to 7 score as 'moderate' and an 8 to 10 score as 'high' knowledge level, respectively. Any associations between AMS knowledge and demographic variables were determined using the Freeman-Halton extension Fisher's exact test. For statistical inference, a p-value of less than 0.05 was accepted as a statistically significant association. Likert scores for the perception data were summed and grouped into 'agreed', 'unsure' and 'disagreed' categories, respectively. Numerical values of the 5-point Likert scale were grouped as follows: rating 1 and 2 = 'disagreed', 3 = 'unsure', and 4 and 5 = 'agreed'. Depending on the nature of the statement asked, responses in agreement or disagreement were categorized as positive and negative perceptions accordingly. Stata 13 software *(Stata Corp, College Station, TX, USA)* was used for statistical analysis.

Ethical Considerations
Written informed consent was obtained from each participant prior to enrolment in the study. Completion of the questionnaires was anonymous and data confidentially maintained. The study posed no known risk to participants. Ethical approval for this study was obtained from the University of Zambia, School of Medicine Research Ethics Committee (IRB00001131 of IORG0000774). Formal permission to collect data was obtained from the hospital management at each respective site accordingly.

Results
Participants Demographics
A total of 198 participants enrolled included, 137 physicians and 61 were pharmacists (95% response rate). Table 1 shows the demographic characteristics of the participants.

INSERT TABLE 1

Participants were mostly intern and resident physicians and pharmacists, and the majority of participants (55%) had less than five professional years of work experience (Table 1). There were a limited number of consultant-level physicians and clinical specialists in the sample, with few physicians (14%) and pharmacists having more than ten professional years of practice experience (14%). There was a relatively higher rate of refusal to participate in the study among senior ranked physicians and pharmacists than those in lower ranks. There were more participants from the Adult hospital which is currently the largest hospital among the UTH consortium and houses departments such as Internal Medicine, Surgery, Emergency and Critical Care, and the Adult Infectious Diseases Centre, respectively.

Antimicrobial Stewardship knowledge
Half (51%) of the physicians and 39% of the pharmacists indicated that they did not know what AMS was. Among those that indicated they knew what AMS was, only 9% of the physicians and 20% of the pharmacists demonstrated sufficient knowledge regarding the basic principles of AMS programmes.

Knowledge levels were significantly associated with practitioners' years of professional practice, position, or practice rank, and having undertaken previous AMS training (Table 2).

INSERT TABLE 2

Perceptions of Antimicrobial Use and Antimicrobial resistance (AMR)
Table 3 shows that the majority of participants had correct perceptions of and attitudes towards antimicrobial use and AMR in general. All participants (100%) agreed that inappropriate use of antimicrobials needs to be curbed, and the majority recognized AMR as a problem in their daily practice.

INSERT TABLE 3

Antimicrobial Stewardship training
Only 8% of the 137 physicians surveyed indicated they had previously undertaken AMS training programmes elsewhere, whilst only 11% out of 61 pharmacists indicated similarly. Nearly all participants (98%) stated that they were not aware of any active AMS programmes in place at the hospital sites at the time of the survey. All participants (100%) agreed that there was a need for active and contextually-relevant AMS programmes and capacity-building at UTH. Table 4 shows the participants' preferred modes of AMS training.

INSERT TABLE 4

Training workshops were the most preferred mode of AMS capacity building and professional development for the majority (>50%) of the participants, followed by on the job hands-on training. Short courses and self-paced online courses were least preferred (Table 4).

Discussion
This study explored physicians' and pharmacists' knowledge and perceptions of AMS at leading tertiary teaching hospitals in Zambia using a descriptive cross-sectional survey.

Antimicrobial Stewardship knowledge levels as well as general knowledge on AMR
We believe this is the first study to explore physicians' and pharmacists' knowledge and perceptions on AMS at leading university teaching hospitals in Zambia. Of concern was that this study found relatively low levels of conceptual knowledge on basic AMS principles and concepts assessed among physicians and pharmacists practicing at this consortium of leading referral teaching hospitals in Zambia. Overall, half (51%) of the physicians and 39% of the pharmacists at the teaching hospitals did not know about AMS (Table 2). It could be argued that these low levels of knowledge could be attributed to the fact that AMS was relatively a new concept coming to the fore in Zambia, which needs to be urgently addressed.

Notwithstanding the generally low conceptual knowledge of AMS, encouragingly a much higher proportion of participants perceived that irrational antimicrobial use should be curbed, that it is a problem in their current practice, and they should consider sensitivity patterns when using antimicrobials (Table 3). This suggests that some aspects of AMS are informally known and practiced but perhaps not conceptually understood and formalised. Lack of or limited implementation of Antimicrobial Stewardship Programmes (ASPs) due to limited resources among tertiary hospitals (70), as recently evidenced in Nigeria (66), could also explain the existing knowledge gap among physicians and pharmacists in Zambia. This is despite the concept of AMS programmes being an accepted global strategy to improve antimicrobial prescribing, especially in hospitals, to prevent AMR though recognising particular challenges in LMICs (39, 40, 71).

Similarly, inadequate knowledge about rational antimicrobial use is an issue that has been identified in other LMICs. Donkor and colleagues found that just under half of the students at tertiary level facilities in Ghana had poor knowledge about the irrational use of antibiotics (72). A lack of knowledge of antibiotics and resistance was highlighted among pharmacy students and physicians in India and Pakistan, with the majority of physicians admitting to no training on rational antibiotic use (63, 73, 74). Similarly, there were concerns about the level of knowledge of antibiotics and AMR among medical students in South Africa (75) as well as appreciable differences in the knowledge and perception of AMS programmes among final year pharmacy students in South Africa (62). The majority of

physicians and nurses in Ethiopia also lack knowledge about antimicrobials and AMR (60), with physicians in Saudi Arabia believing education and adherence to guidelines can reduce AMR rates in hospitals (61). There have also been concerns regarding antibiotic prescribing and knowledge about AMR among physicians in tertiary facilities in Ghana and Nigeria, with prescribing influenced by pharmaceutical company representatives in Nigeria (46, 76). This contrasts with Namibia where the majority of antibiotic prescribing in hospitals complied with national guidelines, although lower than the target rate of 95% (30).

The low levels of AMS knowledge in our study further highlight a gap that needs to be addressed through high impact educational interventions in the short-term among hospitals in Zambia as well as embedding AMS and associated programmes into health professionals' education curricula both at undergraduate and postgraduate levels. Going forward, AMS needs to be a priority among health professional's education programmes at all levels in Zambia as a sustainable measure given the current high rates of infectious diseases in Zambia. Burger and colleagues (62) in their study in South Africa also concluded that in order to help prevent AMR, efforts should be made to introduce concepts of AMS into the undergraduate pharmacy curricula to promote better use of antimicrobials and prevent AMR. This is being supported by newly developed guidelines on pharmacists' roles in AMS programmes in South Africa (43).

Whilst education is a pillar of any AMS strategy, we believe similarly to John and Fishman (77) that AMS educational programmes must be context specific and address local needs. This is important especially given the challenges of introducing AMS programmes among LMICs versus higher income countries, and reflects the complex nature of implementing AMS programmes in LMICs (40). There are also contextual variations regarding what constitutes an optimal educational programme on AMS in different country settings. For example, educational programmes on AMS can range from one-to-one instructions to formal approaches including workshops, lectures, staff conferences, clinical pharmacy consultations, and drug utilisation evaluations (77).

Our study revealed that the majority of physicians and pharmacists at UTH preferred formalized educational approaches such as structured training workshops on AMS whereas others preferred on the job hands-on training (Table 4). Further research is needed to explore how effective an educational intervention blending multidisciplinary learning through structured workshops, and on-the-job hands-on training methods, will be to improve knowledge about AMS as well as improving antibiotic prescribing in Zambia. These are projects for the future.

Perceptions of Antimicrobial Stewardship
Encouragingly, the majority of physicians and pharmacists in this study appreciated the importance of rational antimicrobial use and AMR (Table 3). There was also no difference in perceptions among physicians and pharmacists. Our findings complement those of Abbo and colleagues (68), who found positive perceptions among nurse practitioners and physicians in Florida, USA, regarding antibiotics and AMR. Similarly, our study found that physicians and pharmacists at UTH in Zambia were aware of and concerned about irrational antimicrobial use. Most participants agreed that inappropriate use of antimicrobials needs to be curbed and that rational use of antimicrobials can prevent AMR (Table 3).

There was however disagreement among some physicians and pharmacists on basing prescribing and the choice of antimicrobial on local antimicrobial policy and guidelines, which may reflect gaps in the levels of trust and confidence they have in existing policies and guidelines on antimicrobial use. This may also reflect a paramount need for health policymakers to regularly update and implement evidence-based antimicrobial policies and guidelines that health professionals will have confidence and trust adhering to. Trust in guidelines enhances their use (78).

Recent evidence also suggests antibiotic decision-making is a social process dependent on cultural and contextual factors. Cultural boundaries in health care and across specialties still limits the involvement of allied health professionals in stewardship interventions (70), which needs to be addressed going forward.

We believe the importance of such positive perceptions cannot be understated as behavioural changes among prescribers and dispensers of antimicrobials will be essential to enhance the prudent and rational use of antimicrobials in the future. Positive perceptions are essential to address variable adherence to guidelines and educational activities that currently exist across countries (30, 57, 79-

83). As a result of our findings, we believe concerted efforts and educational strategies are needed at UTH to reduce the unjustified high rate of antimicrobial prescribing reported by Mudenda and colleagues (44). Undoubtedly, strengthening AMS practices through capacity-building is an urgent need in Zambia. The recognition of the importance of preventing AMR must be complemented by AMS programmes that enhance knowledge building about the extent of activities needed, and behavioural change strategies instigated, to ensure AMS programmes are effectively implemented starting in tertiary level teaching hospitals. These are programmes and research projects for the future. Overall, Zambia stands to benefit in reducing current AMR rates if capacity is built not only among prescribers and dispensers of antimicrobials but among all health professionals and the public in general.

Implications for future policy and practice
The low knowledge levels and positive views regarding AMS among physicians and pharmacists in Zambia needs to be further improved using locally-driven, context-specific and needs-based educational interventions. For example, educators of health professionals need to consider incorporating AMS in the undergraduate training programmes as well as introducing Continuous Professional Development programmes (CPD) for health professionals once qualified that can help build capacity. Leveraging educational opportunities to improve knowledge and practice of AMS among healthcare providers is a key strategy to reduce AMR in Zambia. Whereas previous and current local strategies in Zambia have largely focused on raising awareness on AMR (84), evidence-based educational strategies to promote AMS practice and capacity have not yet been tried in Zambia.

Generally, we believe there is an imminent need for policy and practice to prioritise AMS at health service delivery points in Zambia. Implementation of a national multi-sector action plan for AMR (84) by the government of Zambia demonstrates efforts being made towards addressing this need. Developing high coverage and high impact educational interventions using evidence-based behaviour change models alongside, as well as strengthening institutional frameworks and tools that enable effective implementation of AMS practices, can go a long way to enable health professionals to prudently and rationally utilize antimicrobials, thereby averting the spread of AMR in Zambia. Evidence shows that well implemented and targeted educational interventions are key to reducing AMR in LMICs (62). Further evidence suggests that if well designed and implemented, AMS strategies result in considerable benefits not only to the health system but also to patients (42).

Limitations of the study
We acknowledge that only physicians and pharmacists at the five specialized tertiary hospitals that constitute UTH were surveyed in this study. The study sample considered only a component of the professionals that make up the health workforce in Zambia. Though our findings may not be generalized to all health professionals throughout Zambia, we remain confident that the findings were likely to be similar in other local healthcare facilities. It will be interesting to monitor how AMS knowledge and perceptions of other health workers other than physicians and pharmacists compare. This is potentially future work.

Due to limited resources, other tertiary teaching hospitals around Zambia were not surveyed. However, since the UTH represented the highest level of specialised tertiary care service delivery in Zambia's healthcare system, and the facilities being public university teaching hospitals, our findings emphasising the urgency to address identified AMS knowledge and practice gaps should be applicable to other hospital settings in Zambia. Inherently, the cross-sectional study design was unable to establish temporality of knowledge and perception variables, and was unable to track relative changes in these and other parameters. Despite these limitations, we however believe our study findings provide valuable baseline data for future comparative, longitudinal and time-series evaluations.

Conclusion

Despite overall positive perceptions, there was relatively low conceptual knowledge of AMS among physicians and pharmacists at leading tertiary specialized teaching hospitals in Zambia. The majority of health professionals have not undertaken AMS training before. These knowledge gaps may significantly affect the prudent and rational antimicrobial utilization in Zambia enhancing AMR rates. There is an urgent need for AMS training and capacity-building to address knowledge and practice

gaps in Zambia if the country is to make positive strides in improving rational antimicrobial use among all health professionals. The findings from this study will be used to design appropriate interventions and initiatives to optimize future AMS programmes throughout Zambia to improve antimicrobial use. These interventions are starting to be implemented and will be followed up in the future. This may lead the way for other LMICs, with similar challenges.

Acknowledgment
The authors acknowledge the technical assistance of Medicines Utilisation Research in Africa (MURIA) network and colleagues.

Declaration of Interest
All authors declare no conflicts of interest.

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Tables

Table 1: Demographic characteristics of participants

Characteristic	Physicians (n, %)	Pharmacists (n, %)
Sex		
Male	80 (58%)	26 (43%)
Female	57 (42%)	35 (57%)
Years of Practice		
<5 years	81 (59%)	28 (46%)
5 to 10 years	37 (27%)	24 (39%)
>10 years	19 (14%)	9 (15%)
Position/Practice Rank		
Intern	58 (42%)	28 (46%)
Resident	55 (40%)	21 (34%)
Senior	10 (7%)	9 (15%)
Consultant/Clinical Specialist	14 (10%)	3 (5%)
Hospital		
Adult hospital	98 (71%)	47 (77%)
Children's hospital	22 (16%)	5 (8%)
Mother and New-born hospital	17 (12%)	9 (15%)

Table 2: Physicians and pharmacists' knowledge on AMS concepts

	Physicians			Pharmacists		
	AMS Knowledge					
	None	Moderate	High	None	Moderate	High
Years of Practice						
≤5 years	56 (41%)	22 (16%)	3 (2%)	21 (34%)	17 (28%)	4 (7%)
>5 years	14 (10%)	33 (24%)	9 (7%)	3 (5%)	8 (13%)	8 (13%)
	*p < 0.0001*****			*p = 0.0042***		
Position/Practice Rank						
Junior Officer *(Intern/Resident)*	68 (50%)	39 (28%)	6 (4%)	23 (38%)	19 (31%)	7 (11%)
Senior Officer *(Senior/Clinical Specialist)*	2 (1%)	16 (12%)	6 (4%)	1 (2%)	6 (10%)	5 (8%)
	*p < 0.0001*****			*p = 0.018**		
Previous AMS training						
Have Ever Undertaken AMS Training	0 (0%)	7 (5%)	4 (3%)	0 (0%)	4 (7%)	3 (5%)
Never Undertaken AMS Training	70 (51%)	48 (35%)	8 (6%)	24 (39%)	21 (34%)	9 (15%)
	*p < 0.0001*** *			*p = 0.029**		

*Freeman-Halton extension Fisher's exact test

Table 3: Participants' perceptions and attitudes towards antimicrobial use and AMR

	Physicians *(n, %)*			Pharmacists *(n, %)*		
	Disagreed	Unsure	Agreed	Disagreed	Unsure	Agreed
Inappropriate use of antimicrobials needs to be curbed	0	0	137 (100%)	0	0	61 (100%)
Antimicrobial resistance is currently NOT a problem in my daily practice	129 (94%)	8 (6%)	0	59 (97%)	2 (3%)	0
I consider microbial sensitivity patterns when selecting antimicrobials for treatment of a patient	5 (4%)	17 (12%)	115 (84%)	2 (3%)	8 (13%)	51 (84%)
Rational use of antimicrobials can prevent antimicrobial resistance	1 (1%)	3 (2%)	133 (97%)	4 (7%)	0	57 (93%)
Choice of antimicrobial use should be based on laboratory/microbiology test results	15 (11%)	30 (22%)	92 (67%)	6 (10%)	8 (13%)	47 (77%)
Choice of antimicrobial to use must be based on hospital antimicrobial policy/guidelines	17 (12%)	18 (13%)	102 (74%)	2 (3%)	4 (7%)	55 (90%)
Choice of antimicrobial to use should be based on antimicrobial medicines available in the Pharmacy	16 (12%)	10 (7%)	111 (81%)	22 (36%)	7 (11%)	32 (52%)
Choice of antimicrobial used should be based on the severity of infection	0	4 (3%)	133 (97%)	0	5 (8%)	56 (92%)

Table 4: Participants' preferred mode of AMS training

Mode of AMS training preferred:	Physicians (n = 137)	Pharmacists (n = 61)
Training workshops	51%	54%
On the job hands-on training	24%	25%
Short course (4 – 6 weeks)	11%	16%
Self-paced online course	14%	5%