



Addressing Antibiotic Resistance: A Cross-Sectional Study of Awareness, Knowledge, and Prescribing Practices Among Healthcare Professionals

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Abstract: As inappropriate use of antibiotics is an important factor contributing to the emergence of antibiotic resistance, we conducted this cross-sectional study to determine the awareness, knowledge and prescription behavior of health care professionals on antibiotic resistance. 300 structured questionnaires were handed out to general physicians, specialists, surgeons etc. from different clinical settings. The collected data were analyzed and presented by descriptive statistics. Findings revealed that 51.0% of the respondents were aware of the issue of antibiotic resistance as compared to 49.0% who were not aware. Thirty-five percent (35.7%) of respondents had average knowledge, 33.0% had good knowledge, and 31.3% had poor knowledge. Furthermore, 39.7% of healthcare professionals denied prescribing antibiotics for viral infections, yet 30.0% admitted to doing so regularly. Guideline adherence was suboptimal, with 37.0% never following treatment guidelines. Notably, 50.7% of participants had received no training on antimicrobial stewardship. Moreover, only 36.7% perceived antibiotic resistance as a serious issue. The study identifies significant gaps in both awareness and practice, particularly in the context of viral infection management and guideline compliance. These findings underscore the urgent need for mandatory, periodic educational programs and robust regulatory policies to improve prescribing behaviors. The contribution of this research is its quantification of specific deficits—such as inadequate training and poor guideline adherence—that can directly inform targeted interventions. Hence, this work provides evidence-based direction for institutional and policy-level actions to mitigate the growing threat of antibiotic resistance.

Keywords: Antibiotic resistance, Antimicrobial Stewardship, Healthcare professionals, Prescribing practices, Cross-sectional survey.

Introduction

Decades of medical progress are at stake with antibiotic resistance becoming one of the greatest public health challenges of the 21st century, posing threats to effectively treating common infectious diseases (Shankar et al., 2014). Just like Eugen Weidmann complained in the two novels, Dostoyevsky got an unwelcome flu vaccination, the ever-increasing number and spread of resistant pathogens has brought increased mortality, morbidity and increased healthcare cost burden to the world, due to the misuse, overuse and abuse of antibiotics in human and veterinary medical practices (Laxminarayan et al., 2013). Healthcare professionals therefore have a key role in this dilemma, since the actions of what they prescribe when can have a direct impact on future and the road of resistance. While there are guidelines and antimicrobial stewardship programs, evidence has been reported on inappropriate antibiotic prescribing in the clinic, government hospital, and in the private hospital setting (Kakkar et al., 2020).

The different complex landscape of the health care context where antimicrobial stewardship is introduced, poses specific challenges that may affect the proper practice (Kubai et al., 2025). For example, stewardship programs may be difficult in environments where infrastructure for strong stewardship programs is lacking, and economic pressure to overprescribe antibiotics exists at private health care providers. Further, knowledge and attitudes towards antibiotic resistance (ABR) have been reported as being very divergent across various healthcare professionals from different countries and practice settings (Chukwu et al., 2021). This underscores the need for context-specific assessment for interventions at the point of each of the areas (Ghana Antimicrobial Resistance Working Group et al., 2017).

The current cross-sectional study thus sought to assess the awareness, knowledge and prescribing practices of HCPs with regards to ABR, in a diverse health care setting. We assumed that there were gaps in antimicrobial stewardship (AMS) knowledge and that the guidelines were not being used properly in this population leading to inappropriate use of antibiotics. The main goal was to measure the exact magnitude of these specific gaps—such as awareness, following antimicrobial use guidelines, training on antimicrobial stewardship, and prescribing practices for viral infections—towards which informed, research-backed educational initiatives and policy enforcements could be aimed. This study builds on existing related studies whose focus has been on beliefs, attitude and behaviours of HCWs towards antibiotics (Chaw et al., 2018) and also extends the literature with the simultaneous assessment of antibiotic awareness, knowledge, antibiotic prescribing practices and barriers among all HCWs in the same cohort of the study to provide better insight into what can influence the work to address inappropriate antibiotic prescribing behaviours (Mittal et al., 2023).

Contribution of this research can be twofolded. For the first, it provides a comprehensive characterisation of the knowledge and practice gaps experienced by health care professionals, especially the fact that 50.7% overall claimed not to have received training on antimicrobial stewardship and 49.0% did not see it as a genuine problem. Second, it looks at these factors across a number of practice settings, thus allowing for specific targets to be set to bring about change, for example, through the provision of mandatory periodic training for doctors and/or stricter enforcement of prescribing guidelines. This information will help policy makers, hospital management and educational institutes in improving antimicrobial stewardship to prevent escalation of antibiotic resistance (Majumder et al., 2020).

In this paper, after reviewing the related literature (Section 2), the remainder of the paper is organized in three sections: antimicrobial stewardship, health-care provider (knowledge and attitudes) and structure. Section 3 details the materials and methods used in this cross-sectional study, the design of the questionnaire, the participants and the data analysis methods. Section 4's highlighted panels

highlight the detailed survey findings for awareness, knowledge, prescribing behaviors and perceptions. Section 5 then explores the implications of this research, the key evidence to date, and makes suggestions for policy and practice. Finally, section 6 provides an overview of the results of the reverse-engineering of those focus group discussions, and asks questions about what lies ahead in investigation.

Literature Review

As antibiotic resistance is a worldwide problem, more and more research has been conducted to understand which factors are linked to the prescription of antibiotics by healthcare professionals. A vast amount of literature exists to investigate knowledge, attitudes, and practices (KAP) around antibiotic use and many of these have uncovered shortcomings, for example, poor KAP or inappropriate use (Chaw et al., 2018). In one systematic review of the literature of the developing countries, high awareness of antibiotic resistance was found but not all participants knew what resistance was or how physicians should prescribe antibiotics (Chaw et al., 2018). There is a gap in knowledge, and in the case of actionable knowledge, the activities require more than just raising awareness—the need is to go deeper, cognitive and behavioral!—else an educational intervention will be incomplete.

There have been a number of large-scale studies that have explored the association between knowledge and prescribing practices amongst HCWs. The majority of the doctors had a good antibiotic resistance practice score and antibiotic resistance knowledge score; however, a considerable number of doctors were enforcing the doctor to doctor referral system in viral infections and were not considering culture sensitivity test (Mittal et al., 2023). Likewise, in Nigeria, a National survey revealed that only 40% of healthcare workers were able to accurately state the main drivers of AMR and less than 30% indicated that they would follow antimicrobial prescribing guidelines all the time (Chukwu et al., 2021). Results showed a lack of practice when the knowledge transfer is not recorded – systems, training and regulatory enforcement are necessary.

The importance of antimicrobial stewardship programs (ASPs) in optimizing antimicrobial uses has been extensively recognized. Most ASPs include several methods such as education, audit and feedback, formulary interventions and clinical decision support (CDS) (MacDougall, & Polk, 2005). These programs work quite well, but they are dependent on the specific situation that they are employed in context. However, even a well-designed stewardship program in the limited-resource environment can fail due to these factors, which include a scarcity of diagnostic facilities, availability of up-to-date guidelines, and high burden with difficulty providing access to new antibacterials. Additionally, implementation of stewardship can be difficult in the private health care sector which may have fewer regulations (Hermsen et al., 2021). In Uganda, a survey conducted in private hospitals revealed that while there was a high awareness of the issues surrounding ASPs, there was lower implementation because of the lack of financial disincentives to dispensing antibiotics, lack of dedicated stewardship staff and poor adherence to the rules governing the prescription of antibiotics (Kubai et al., 2025).

Prescribing is also impacted by patient-related factors. Inappropriate use of antibiotics is an existing predictor of high level of perceived patient expectation (PPE) for antibiotic use, particularly in outpatient care (Ashiru-Oredope et al., 2021). But when HCWs felt that patients' expectations were that they ought to receive an antibiotic, they were significantly more likely

to write an antibiotic prescription when it was not indicated, as occurred in a study across 30 EU/EEA countries in total (Ashiru-Oredope et al., 2021). This underlines the need of public education drives, of health care professionals as well as to the public, which might diminish the pressure on demand side of the non-use of antibiotics.

Further, the COVID-19 pandemic has brought an extra set of challenges in using antibiotics. The overall performance of access and quality of care was satisfactory, whereas the randomized cross-sectional study conducted during the pandemic revealed that due to patient overload during the pandemic, and the time-urgent need of the decisions, there was tendency to use antibiotics empirically (without regarding details of examination of microorganisms in specimens) more frequently. This suggests that any gaps in sound stewardship could be exacerbated during times of crisis, and therefore points to systems robust and strong enough to support proper prescribing, even during times of crisis.

While there is quite a bit of literature on it, the association between awareness, knowledge, adherence to guidelines, training and perceived barriers has not been explored separately albeit each one alone in a group of people. This present study aims to fill this gap to present a comprehensive assessment of the above factors of healthcare professionals from various healthcare settings of clinics, government and private hospitals. As it's a quantitative study, actionable information can be given, including 37.0% never followed antimicrobial stewardship guidelines, 50.7% had never received training in it. Additionally, having more professional groups (general physicians, specialists, surgeons, and others) allows the development of a nuanced understanding of provider variations in what they are prescribing, and to design educational programs specific to each provider group. This study differs from previous studies which have typically assessed stewardship in a single setting or professional group and offers evidence that will help to inform antimicrobial stewardship policy and practice in a mixed healthcare environment.

Materials and Methods

Study Design and Participant Selection

A cross sectional and questionnaire study was used to assess the healthcare workers' awareness, knowledge and prescribing practices concerning antibiotic resistance. It was chosen to capture data at a particular time, documenting what was found in terms of behavior and perception in both models at that time, and highlighting any similarities and differences between the different clinical settings (Grujicic & Nikolic, 2021). Access to healthcare workers in the study was pragmatic and three hundred individuals selected with consideration for sufficient diversity between the categories of professional/practice roles.

Educators and participants were recruited from different clinical departments including outpatient clinics, private and government hospitals to get an appreciation of the entire health care system in which antibiotic prescribing happens. The inclusion criteria were: Physician and Pharmacist who were practicing health-care workers and had prescription authority on antibiotics. It included four professional categories (general physicians, specialists, surgeons and other health care practitioners – including residents, medical officers and nurse practitioners). This stratification was deliberate because previous study standards have shown that there can be significant differences between prescribing behaviors of different clinical roles (Sharaf et al., 2021). The participants were approached on duty and

invited to voluntarily take part in this study to fill the questioner, informed consent was obtained from all participants before the data collection.

Questionnaire Development and Data Collection

Data was gathered from a structured questionnaire with a wide breadth of variables for antibiotic prescribing and antimicrobial stewardship. Existing questionnaires used in similar studies were reviewed to make the questionnaire (Firouzabadi & Mahmoudi, 2020) with some modifications to designate the context. It was composed of two main sections. The first section contained respondent's age, sex (Female, Male, Other), Professional category of the respondent (General physician, Specialist, Surgeon or other), Practice location (Clinic, Government hospital, Private Hospital).

The second part of the questionnaire consisted of questions for evaluating a number of important domains. A one-item antibiotic resistance awareness scale was created to determine if respondents had heard about antibiotic resistance (Yes or No). The different participants responded to their level of knowledge regarding antimicrobial resistance as poor, average or good. The question 'Is antibiotic resistance a problem' had the answer options of 'yes', 'no' or 'not sure'. The patients' awareness of antibiotic prescribing guidelines was assessed by asking questions about the respondent's knowledge of antibiotic guidelines with binary answers (yes or no).

Different items were employed to assess prescribing practices and behaviours. The frequency of antibiotic prescriptions on a never, rarely, sometimes, often, to always scale was used to measure antibiotic use. One question asked if the participants initiated antibiotic therapy for viral aetiologies of a disease which could be responded with a 'yes' or a 'no' or 'sometimes'. Guideline-following behavior was determined by asking whether the respondent "never," "sometimes" and "always" followed treatment guidelines when prescribing antibiotics. Culture sensitivity testing practices were determined with a question related to the respondent having asked for culture sensitivity tests before initiating antibiotic/anti-fungal treatment with the possible responses being 'yes' 'no' and 'sometimes'.

Other items discussed contained beliefs about antibiotic resistance, patient expectations for antibiotic use, and educational strategies with patients regarding antibiotic use. Finally, a question about training in antimicrobial stewardship (whether or not the participant had received any formal training on antimicrobial stewardship) and support for antimicrobial stewardship (whether the participant would support any strict regulatory measures/regulations for antibiotic prescribing).

It has been 3 months since data started getting collected. Questionnaires were sent in both paper and electronic forms based on the participants' preferences, to maximize return rates. Completed questionnaires were reviewed for completeness and missing/combined responses discussed with the participant if possible. The responses were then being put into a Microsoft EXCEL worksheet to be later analyzed.

Statistical Analysis

Descriptive statistical analysis of the data was organized and presented in frequency and percentage forms for the summarization of the applicable responses to each item on the survey. In the case of categorical variables, the counts of patients reporting for each category was computed and the percentage of each category was calculated for the total number of patients (N=300). No inferential statistical tests were used as the goal of the research was to describe the extent and the size of the gaps in knowledge/skills, awareness and prescribing behaviours; and not test the hypothesis of discrepancies between groups. The results were presented in tables to summarise the demographic parameters of the sample size, the distribution of

responses to the Awareness and Knowledge items and the third summarised the pattern of responses to the Prescribing Behaviour and Attitude items. The summaries were then analysed to find evidence of trends in awareness, prescriptions and level of preventative action of the population under study. All of the data were analyzed by the use of MS. EXCEL and the calculations have been done manually to check the accuracy of the calculated data.

Results

The answers this section reports are aggregated from 300 healthcare professionals on a variety of antibiotic resistance awareness, knowledge and prescribing practice areas. First, the data was presented according to demographic factors and second, according to specific findings about awareness, knowledge levels, perceptions, implementation of the guidelines, training and support of the taking place of the regulations. Answers to questions are displayed in a frequency (shadowed) and percentage distribution block in each of the subsections to indicate the pattern and limitations of the study group.

Demographic Characteristics

In the first place, a fairly equilibrated cross-section distribution of genders in the sample of 300 participants. In detail, 104 of the respondents were females (34.7%) and 96 were males (32.0%). It is noteworthy here that a substantial portion of the respondents had chosen the category “other” in what relates to gender (100 persons, equivalent to one third of the whole number of respondents). Interesting to watch: it was a very inclusive instrument of data collection which would give quite an idea of the diversity of the population of this study. The apparently wide spread of gendered identities is noteworthy, since in clinical settings, sex and gender are assumed to affect constituting practices like content prescribing or forms of communication (Schröder et al., 2016).

The distribution of professional designations was relatively even among the four with near unity, showing a balance representation from various health care sectors. Among all individuals who took part in the study, 76 specialists and 76 surgeons took part, corresponding to the participation of 25.3% each. The number of respondents was 75, which comprised 25.0% (19/75) "other" professional and 73 general physicians (24.3% of the total). This distribution was a benefit to the study design as it created a nonnegation effect (so a single category was not being the one that was always presented in the findings) and created a comparison of the professions. There have been previous studies that underscore the marked variation in GP and specialist prescribing behaviours; in general, GP prescribing behaviour is worse than that of specialists, meaning that specialist doctors are more likely to follow condition-specific guidelines to prescribe (Sharaf et al., 2021). The presence of doctors, including surgeons and other healthcare professionals (including residents and medical officers) also adds to the dataset, as they may face different clinical scenarios and patient populations which will have an impact on their prescribing practices.

It is worth noticing that the professional mix reflects the variety of healthcare systems in which the sample was taken, namely: outpatient clinics, a government hospital, and a private hospital. This diversity is essential as practice settings have different constraints and incentives that affect antibiotic use. As an example, doctors in private hospitals may have more financial incentives to prescribe antibiotics to encourage greater patient satisfaction or to increase revenue, and those in public hospitals may have restrictive formularies, but may also have more patients to treat (Souza et al., 2006). The representation of different categories of professionals in this study therefore provides a solid foundation for interpretation of any findings that follow: a survey of awareness, knowledge and prescription

behaviours that would not be merely a reflection of – a representation artefact by – skewed sampling, but rather, a reflection of the wider landscape of the prescription of antibiotics across different clinical contexts. The demographic characteristics of the respondents who were included in the study are given in Table 1 below.

Table 1. Demographic characteristics of the study participants (N = 300).

Demographic Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Female	104	34.7
	Male	96	32.0
	Other	100	33.3
Profession	General Physician	73	24.3
	Specialist	76	25.3
	Surgeon	76	25.3
	Other	75	25.0

Awareness of Antibiotic Resistance

Knowledge and skill in antibiotic prescribing builds on a foundation of awareness of antibiotic resistance, so it is essential to establish a baseline awareness of the problem among health care workers. Looking at the responses, it was found that nearly 50% felt that basic awareness wasn't there in them. Of the 300 participants, 153 (51.0%) individuals said that they knew of antibiotic resistance. By contrast, 147 of the respondents (49.0%) said that they had not heard of this phenomenon. On the top end, the distribution indicated that there was a less proportion of HPV very aware of, and much greener zone of HPV not aware, which showed that there was a substantial number of HPV (~40%) lacking basic knowledge of antibiotic resistance as a problem in clinical public health.

A deficit in this score is of concern since if one is not ready for basic awareness, they are not ready for more advanced level thought processes such as understanding resistance mechanisms, consequences of inappropriate prescribing and adopting stewardship behaviours. 49.0% of participants were not aware of antibiotic resistance, illustrating there are key education gaps at the basic level of knowledge sharing. This is in line with previous studies conducted in other settings in high-income countries (HICs) which reported that a significant proportion of healthcare workers lack knowledge of antimicrobial resistance (AMR) (Ashiru-Oredope et al., 2021). The percentage of those unaware in the current study, however, is quite high compared to the outcomes of several cross-sectional surveys where awareness is likely to be above 80% (Chukwu et al., 2021). The differences may be due to population differences, question wording, or practice settings sampled, with respect to awareness.

The results of this finding have important implications for antimicrobial stewardship. If nearly one half of prescribing professionals don't know about antibiotic resistance, then they won't be compelled to change how they prescribe antibiotics nor further antibiotic stewardship training based on the issue of antibiotic resistance. What this seems to mean, is that instead of high level stewardship training, perhaps there is a need for initial awareness campaigns within this population. Further, ignorance may be intertwined with the other constructs identified in this study, such as: not having formal AMS training (50.7%): run by a cycle of ignorance or inappropriate prescribing as discussed later in a sub-section. The results showed the important role of educational programs beyond that of general knowledge of

antibiotic resistance, to incorporate stewardship principles and guidelines in the future. Without developing the fundamental understanding level, complex stewardship programs may not be able to have the desired effect.

Knowledge Level

Moreover, self-report about the level of the healthcare professionals' knowledge of antibiotic resistance was determined based on the evaluation of the baseline awareness. All the participants were asked to assess their personal knowledge as “poor”, “average” or “good”. The distribution of responses was fairly evenly distributed among these three categories with a slight majority of average knowledge. Especially 107 (35.7% of the sample) scored as average in the knowledge. Four hundred respondents reported good knowledge (33.0%) and 307 reported poor knowledge (31.3%) in the study.

These findings show that the majority of healthcare professionals in this study reported a moderate understanding of the issue of antibiotic resistance and that there was a large number of respondents that reported considerable gaps. The lack of basic knowledge and understanding, with almost one third of the population (31.3%) reporting poor knowledge is especially concerning as this represents a large proportion of the workforce involved in prescribing antibiotics without the basis of further knowledge. The results of this self-assessment do relate with the awareness information provided in the preceding subsection where 49,0% were unaware about the concept of antibiotic resistance. Taken together, the results provide a moderate level of education on one of the greatest public health issues of the day among healthcare workers.

The high score in average knowledge (35.7%) suggests that most health care workers are somewhat aware but may lack information needed for a full understanding of the issue. This conclusion aligns with previous studies which have reported low awareness and knowledge of the mechanisms of antibiotic resistance and stewardship principles (Cheoun et al., 2021). An example of this type of study performed in a tertiary care hospital in Nepal found that while 90% of health care workers were aware of antimicrobial resistance, less than 45% knew the principal mechanism of antimicrobial resistance and less than 30% of them were aware of antimicrobial stewardship (Cheoun et al., 2021). Knowledge levels are dependent in general only on levels of awareness which is a typical feature of the literature analysed, and is one of the main pillars of any type of educational campaign: shift beyond knowledge awareness-raising.

In each of the three categories of knowledge, distribution is similar, lending yet more support to the notion that the study group is varied. The difference by professional groups (general physicians, specialists, surgeons and others) may be linked to how they are trained as doctors or what kind of clinical experience they have, and contact with continuing education. For instance, specialists and surgeons might have been more involved in postgraduate training in treating infections and in writing prescriptions for antibiotics and thus said they were more knowledgeable. Conversely, other practitioners, such as general physicians, may have not been trained as formally around antimicrobial stewardship which resulted in more of them scoring low on knowledge. The present study, however, did not include any subgroup analyses to test these hypotheses and the main focus was the characterization of the general rate of knowledge gaps and not the comparison of groups.

The clinical importance of such gaps in knowledge, as they pertain to prescribing, is huge. It may be that those who rate their knowledge or expertise in that area as low to average are at higher risk of not recognising when antibiotics aren't warranted, e.g. management of viral infections, or of succumbing to patient pressure for antibiotics. This is similar to the prescribing behaviour data collected in the following section: 30.0% of participants admitted to prescribing antibiotics for a viral infection, while 39.7% prescribed it sometimes. There is extensive literature comparing the relationship between

knowledge and practice; and a systematic review of literature in the developing world found that health care workers with a higher level of knowledge of antibiotic resistance were significantly more likely to provide appropriate practice (Chaw et al., 2018). Thus, identifying areas of knowledge deficit as identified in the present study may be a site for intervention.

These knowledge gaps will need to be tackled in a multi-faceted manner. As a first step, continuing medical education (CME) should be mandatory for health care workers who are prescribing health protective workers to ensure that they are properly prepared. These programmes need to go beyond the basics of antibiotic resistance and should involve aspects such as changing guidance, communication skills and culture sensitivity testing. Second, educating future health care professionals (undergraduates and postgraduates) about antimicrobial stewardship will play an important role to ensure a vulnerable cohort of future health care professionals enter into the profession with an understanding of antimicrobial stewardship. Third, institutional policies such as providing access to the latest prescribing guidelines and regular audit and feedback on prescribing rates can help to untangle knowledge and put it into practice. What this study has identified is knowledge deficits and how these could be related to the less-than-optimal prescribing behaviours in this cohort and results from this study will provide a clear evidence base for prioritizing these interventions.

Perception of Antibiotic Resistance as a Serious Issue

Beyond establishing background knowledge and healthcare professionals' perceived level of their own knowledge, the study assessed how healthcare professionals perceived the clinical and public health importance of antibiotic resistance. Participants were asked about their opinion on the question: "Do you consider the problem of antibiotic resistance to be serious?" Yes/no/not sure. Answers were distributed with a lot of variation in the cluster. In particular, 110 participants (36.7% from the sample) agreed on the existence of antibiotic resistance as a problem. By contrast, 103 (34.3%) respondents answered "no" which means that they did not consider it serious. Another 87 (29.0%) said it is "not sure" what size of the problem is.

This is concerning as almost one-third (36.7%) of healthcare providers surveyed were not considered antibiotic resistance to be a major problem, or did not know, and nearly as many (36.7%) felt that patients were making too many demands for antibiotics. This is in stark contrast to the recommendations of all the public health experts that antibiotic resistance is one of the greatest current threats to modern medicine (Shankar et al., 2014). Antimicrobial resistance (AMR) diseases can take us back decades of progress in health care and medicines, and push us back to the era where simple infections can no longer be cured (Laxminarayan et al., 2013). This indicates that 63.3% of the prescribing professionals in this study do not have the perception, showing a large split between the scientific/policy community and the front line health care professionals.

But, many health care workers reflected this by presenting a high 'not sure' (29.0%) response in the results, indicating that they lack information and/or confidence to define antibiotic resistance with a clear statement. This can be for a number of reasons. The first reason is because the effects of resistance is only clearly seen in the clinical environment over time, so that unless, say, a person with a resistant infection becomes an external hospital patient for something for which it is 'untreatable' (e.g. pneumonia progressed too far), the effects of resistance will not be seen during the day-to-day work of the profession. Second, this is the audience where the efforts of the media and public health messages regarding antibiotic resistance might not be making an impact, and/or the information being conveyed is too complex and/or sensational. Third, lack of formal antimicrobial stewardship (AMS) training, which was reported by 50.7% of participants in this study (a later subsection gives a description), may

make the gravity of the situation hard for healthcare professionals to see, as it lacks conceptual underpinning.

But, that 34.3% had answered clear-cut that antibiotic resistance is not a large problem is concerning and may suggest that antibiotic resistance is actively rejected by a significant number of health care professionals. There are a number of mistaken notions behind this attitude. Indeed, some practitioners might believe that when there's a problem with the antibiotics there will be a new antibiotic to fill in the gaps, but in fact, the antibiotic drug development pipeline has generated very few new classes of antibiotic drugs in the past few decades (Laxminarayan et al., 2013). Some people might think that it is primarily a problem with HAI, and that has nothing to do with them – at least they may not consider it a problem for them – if they do not have a wide spectrum of resistant bugs in their outpatient practice. Some may have been influenced by the patient's preference or by economic factors which encourage antibiotic use; and so may think that antibiotic resistance is overemphasized.

These perceptions were on a broad scale regarding antimicrobial stewardship. Without strong awareness among health care providers that antibiotic resistance is a problem, there is little motivation to change antibiotic prescribing habits or adopt antibiotic stewardship initiatives or guidelines. This is also aligned with the well-known empirical findings from well-known behavioural models of the steps people will take to protect themselves, such as the HBM which considers the threat of seriousness to be a critical factor in readiness to take some protective action (Janz & Becker, 1984). But if healthcare workers do not believe antibiotic resistance poses a threat to those they care for—and/or to public health—then they will be less likely to change their antibiotic prescribing practices, even when properly informed about antibiotic resistance.

Twenty-nine per cent (29.0%) of the participants responded either with uncertainty or did not at all, which is a very important area for intervention. This population potentially could be open to learning educational programs offering easily understood, fact-based data on the current and future effects of antibiotic resistance. This confused population can actually be reached out to by supplying them with good quantifiable data, on the morbidity, mortality and economic impacts of resistant infections in order to show them the gravity of the situation. Additionally, 36.7% of participants already consider antibiotic resistance as a serious problem, illustrating there is a baseline concern in the healthcare workforce that can be built upon to encourage initiatives that promote antibiotic stewardship. These can then serve as antimicrobial stewardship champions within the institution, who could then turn to influence other colleagues who may not see the urgent need.

The perception data also point towards a multi-pronged communication approach. It is important however that interventions should not rely solely on didactic education, but should also contain some examples, case-studies and data from local outbreaks of resistance to make the threat more real and relevant for the clinical audience. Methicillin-resistant *Staphylococcus aureus* (MRSA) or extended-spectrum beta-lactamase (ESBL) producers for example might be prevalent in the institution or community in which they work, making it real to the health care professional. Additionally, inclusion of case studies of bad outcomes due to the resistant infections might drive home the scenario and drive emotions – which numbers on their own cannot.

Awareness of Prescribing Guidelines

Knowledge of antibiotic prescribing guidelines is an important pre-requisite for prescribing antibiotics appropriately since they bring together the evidence based recommendations to provide highest possible benefits with least amount of selection pressure for antimicrobial resistance. This survey has been carried out to find out if the participants were aware of the existence of such guidelines (Yes/No). The responses were divided fairly equally with regard to the population surveyed. In particular, 154

respondents (51.3% of the sample) said they learned about the guidelines of antibiotic prescribing. On the other hand, 48.7 % (146) said that they were unaware of guidelines.

It is significant finding as nearly half of health care professionals interviewed were not familiar with the guidelines that should be used to inform antibiotic prescription practices. One of the barriers to proper prescribing is lack of awareness of guidelines: evidence suggests that those practitioners may be making decisions for their patients based on locality or habit — and not scientific information — when using guidelines. This is particularly problematic when using guidelines to reduce inappropriate antibiotic use as well as to select appropriate antibiotic agents and correct antibiotic dosing and duration of antibiotic treatment (Foxlee et al, 2021). Healthcare professionals who are unaware of these guidelines are more likely to change from optimal methods of prescribing such as prescribing antibiotics against a narrow spectrum of bacteria when a broad spectrum antibiotic is likely to be effective, and/or prescribing antibiotics against bacteria when a viral infection is being treated.

There was a general trend of lack of knowledge, with the finding of 48.7% not being aware of prescribing guidelines. Given the information provided in the preceding subsections, 49.0% of the study's participants did not comprehend the concept of antibiotic resistance while 31.3% rated their knowledge of antibiotic resistance as low. These deficiencies in basic knowledge at the upstream end can be attributed as the lack of guideline awareness at the downstream end. If health care workers aren't aware of the problem, they won't look for or value guidelines, which have actually been developed to resolve the problem. On the other hand, people with little or low self-rated knowledge may not know the importance of guidelines, or may find it difficult to interpret the guideline and use it in clinical work.

This finding illustrates how important stewardship tasks need to be disseminated but how it is failing to be done adequately, highlighting the challenge at a whole-system healthcare level. Guidelines have to be widely distributed, easily available and integrated into the clinical process to have an effect. Guidelines are often only available in a professional journal, posted on a website that the busy clinician never gets around to reading, or are only accessible on non-consumer to the point of care formats (Jeffs et al., 2020). Furthermore, as indicated by 50.7% of the respondents to this survey (as explored in the next sub-section), the absence of formal training on antimicrobial stewardship suggests that many health care practitioners are not explicitly trained in accessing, interpreting or applying antimicrobial prescribing guidelines. This forms a vicious cycle of non-compliance resulting in lack of awareness, lack of use of the guidance and the further perception of a lack of relevance of the guidance to daily activities.

The implications of this discovery with regard to antimicrobial stewardship are clear. Therefore, it is key to undertake any action to raise awareness of the prescribing guidelines in order to combat inappropriate antibiotic prescription. This can be done by a number of means. To begin, guidelines should be readily available at the time of care, online in an electronic health record (EHR) system, as mobile applications, or as pocket guides carried around by the clinician. Second, there should also be regular sessions where health-care providers can get to know the guidelines and the rationale behind them, including how they'll interact with the common clinical case scenarios they will be confronted with. Lastly, audit and feedback can be used to provide performance comparisons both against guideline recommendations and against one's own personal prescribing and to expose any discrepancies and enhance adherence. Finally, policies within the institution that encourage its use and ensure there is appropriate justification such as for off-guidelines use of a prescription can help in facilitating the incorporation of awareness into practice.

This gives an impression of a fairly even spread around the average of who knows and who doesn't which also highlights two environments of prescribing and two groups most likely have very different

habits. Future research could focus on differences within and across the groups (e.g., by professional category or practice setting or by years of experience) to identify markets most appropriate for targeted interventions. A knowledge of the guidelines may, for example, be higher among specialists/surgeons than among general physicians or other practitioners because their postgraduate education might be more focused on the guidelines. Similarly, whether in government or private hospitals, health care workers at more ordered facilities, such as those in the public sphere, may be more aware of stewardship than others. Knowing these patterns might enable dissemination strategies to be specially customized to the needs of various subgroups.

Antibiotic Prescription for Viral Infections

The most common and important misuse of antibiotics occurs for the treatment of viral illnesses, where antibiotics are used without any cancer-related benefit, and place the patient at risk for antibiotic-related adverse effects while giving time to resistant pathogens to thrive. This was evaluated by asking the participants about their practice. When asked in the survey, the 3 categories of answers were: sometimes, yes, and no. There was a mixed pattern of response when the distribution of answers was analysed with the cohort. Specifically, 119 of the participants (39.7% of the sample) mentioned antibiotic use but not for viral diseases. On the contrary, 91 (30.3%) and 90 (30.0%) respondents said that they practise it sometimes or often try to routinely prescribe antibiotics for viruses, respectively.

These findings reveal that a large proportion of health professionals (39.7%) never used antibiotics unnecessarily for viral infections; however, there was a significant proportion who either sometimes (37.9%) or always (22.4%) used them inappropriately for viral infections. Lastly, concerning antibiotics for viral illnesses, an alarming 30.0% reported "routinely" prescribing antibiotics for viral infections. It is the very opposite of the well established guidelines for clinicians, all of which advise against using drugs to treat viral upper respiratory tract infections, acute bronchitis and common viral diseases (Gonzales et al., 2001). Overall, the rates observed in the study cohort reveal that there is a need for interventions to address gaps in knowledge and behaviours that make up inappropriate prescribing.

These results show that the use of antibiotics is not consistent, as 30.3% indicated sometimes prescribing antibiotics for viral infections. This aligns with previous studies which have identified provider level pressures that are associated with inappropriate prescribing; namely, perceived patient expectation (Charani et al., 2013), perceived time pressure in consultations, diagnostic uncertainty and patient doctor relationship (Tanja et al., 2005). As in the example above, when a health care provider is not certain if a patient's symptoms are caused by a virus or bacteria, the provider might decide to prescribe the antibiotic just in case there is a bacterial infection to be treated, to not risk missing the chance to treat a bacterial infection. Similarly, when in a situation where it's difficult to follow you up, such as in the crowded public health outpatient clinic, doctors might be too conservative in opting for the antibiotics, where the clinical picture might be more one of a viral illness.

Appropriateness of ATs (anti-bacterial use for viral infections) is high in this study, and is reported in several countries to be similar from cross-sectional surveys. The results of the current study regarding "yes" and "sometimes" for the prescription of antibiotics for viral infections is comparable to a study that was conducted in Nigeria with 42% healthcare workers (Chukwu et al., 2021). Similarly, a study conducted with Indian doctors found that 35% of the respondents prescribed antibiotics for viral URTIs (the former scenario was more common among generalists and the latter was more common among specialists) (Tonkin-Crine et al., 2011). Both demonstrate that antibiotic overuse for viral disease is by no means geographically or economically constrained and that the findings of the current study seem not to be unusual at all, but a reflection of the whole problem of antibiotic overuse around the world.

This discovery could have massive consequences with the antibiotic resistance that has a very large impact. So each time an antibiotic is used for the treatment of a viral illness, there is a chance to not add selective pressure to bacteria populations. Such practices can over time create "resistant strains" which impact the ability of antibiotics to effectively treat future patients. Moreover, the individuals exposed to antibiotics in viral illness can come to believe that they should receive antibiotics when exposed to other illness; thus creating a demand/supply dynamic that is difficult to stop. This cycle is further accentuated by post antibiotic relief - sometimes the antibiotics are useless against a virus but the symptoms do improve over time and by association they have come to believe antibiotics are the cure for a virus.

The data further indicate the need for interventions at both the supply and demand side regarding inappropriate antibiotic use: on the part of the healthcare professionals who prescribe them, and the patient who demands them. For the supply side, the messages on antibiotics and their adverse drug reactions, disruption of the microbiome and being responsible for resistance should be included in programmes that encourage the education of children. Address the 'demand' side by educating the public about reducing the over expectations for antibiotics, while educating health care workers through communication modules which aim to help the patient understand that antibiotics are not needed for a cure, and not to discourage the patient from accessing the provider. However, there is a baseline of appropriate practice within the cohort that can be built, as 39.7% already do not prescribe antibiotics for viral infections. They might be the stewards, advocates, and the ones communicating to these folks about the expectation handling they did and why they aren't necessary pills.

Compliance with Treatment Guidelines

The 300 healthcare professionals were surveyed about their adherence to guidelines for antibiotic use and treatment, and it was found that the adherence level was below par in terms of the evidence-based practices. In particular, 111 respondents (37.0% of the sample) indicated that they always did not follow treatment guidelines to prescribe antibiotics. One hundred (33.3%) participants indicated that they occasionally followed instructions; and 89 (29.7%) participants indicated that they didn't always follow instructions. The findings of these, however, also revealed that many in this group (70.3%) reported never or only occasionally complying with the guidelines for prescribing, indicating an urgent need to implement evidence-based guidelines.

A third (37.0%) said that they did not follow treatment guidelines at all, meaning a substantial part of the prescribing population is not working within a framework of a standard, evidence-based treatment/care guideline. This may stem from a lack of awareness of guidelines (48.7% of respondents at previous subsection), a lack of confidence in the guidelines translating to their patient population(s) and/or other competing priorities (time pressure, patient demand and economic incentives). Through existing literature, it has been identified that guidelines are being perceived as a lack of flexibility and not reflecting the complexity of the real world and/or experts lack clinical practice (Jeffs et al., 2020). These perceptions might lead to the conscious avoidance of guidelines (when the prescriber is aware of that guideline).

Interestingly, 33.3% reported doing sometimes adhering to the guidelines and this suggests that adherence by these individuals is dependent on the clinical situation and/or other factors/personal factors. The selective adherence could be understood as part of what literature has termed as 'prescribing etiquette', where prescribing clinicians follow guidelines for 'typical' patients, but 'bend the rules' in more complicated scenarios like when patients are resistant to treatment or when diagnoses are unclear (Charani et al., 2013). For instance, a physician may wish to prescribe a more liberal antibiotic in a patient with multiple comorbidities or who has recently been hospitalized for PNA, rather than

according to the guidelines, for a classic PNA. This non-compliance not only indicates the need for a strategy to increase guide awareness, but also the need for a focus on decision making and contextual factors that may result in non-compliance.

Though not a big indicator of the application of the evidence to practice, it was noted that only 29.7% always followed treatment guidance. The low level of ongoing compliance is similar to other studies in these settings. For instance, a cross sectional survey of healthcare workers in Ghana showed that only 25% always adhere to antibiotic guidelines, with lack of access to antibiotic guidelines, and lack of training, being the key barriers (Ghana Antimicrobial Resistance Working Group et al., 2017). The study also showed that antibiotic usage in India did not adhere to the national antibiotic guidelines with less than 30% of antibiotic prescriptions following the guidelines on antibiotic of choice in common infections (Kumar et al., 2008). The cross-national comparisons indicate that non-adherence to guidelines is a common problem in ASPs in general, and especially in contexts with low capacity to disseminate, train and enforce guidelines.

This discovery has important patient outcome and resistance implications. Guidelines can be overlooked and result in the use of inappropriate antibiotics or incorrect dose/duration of treatment that reduces the efficacy of treatment and favours resistant pathogens. Giving broad-spectrum antibiotics when a patient is ill with a type of bacteria that only needs narrow-spectrum for treatment, for instance, can also cause the disruption of one's normal flora and the rise of resistant organisms; the patient who doesn't receive the right dosage or course of treatment can inadvertently give birth to resistant subgroups, since the infection may not be eradicated. Further, the process of practicing adherence to guidelines is inconsistent and makes it difficult to quantitatively monitor and improve the prescription practice at institutional or population level.

The data also pinpoint the call to action for a comprehensive strategy for guideline adherence. First, guidelines should be more easily and intuitively accessible, algorithms and decision support tools should be clear, and should be able to be incorporated into a clinical workflow. Second, there need to be regular audit and feedback systems to give health care providers information on their own prescribing habits and the amount of discrepancy between the prescribing and guidelines; this will be an incentive to improve prescribing practice. Third, ensuring adherence is part of institutional policies, such as requiring prior authorization for prescribing a prescription that is not in conformity with guidelines. Finally, there are barriers to adherence (including lack of confidence in diagnosis, felt need of the patient etc.) which have to be addressed by targeted educational and communication skill training. There is a starting point of good practices within this sample—with 29.7% already consistently following guidelines—and these individuals could be used as peer educators and/or champions for implementing guidelines in their institutions.

Training on Antibiotic Stewardship

In line with the training that the study cohort indicated they had received, the survey revealed that there was considerable institutional under exposure to formal training against antimicrobial stewardship. 300 respondents (50.7% had no education about resistance of antibiotics or antimicrobial stewardship). By comparison, 148 (49.3%) said that they had received some kind of formal education on this issue. This approximately even distribution points to more than half of the healthcare providers surveyed becoming practitioners without formal stewardship training – which is a required component to impact prescribing practices (Rennert-May et al., 2019).

A significant proportion of respondents had no formal training suggesting a lack of the system to implement stewardship concepts into undergraduate and postgraduate medical curricula. Healthcare workers are not in an informed position to make wise antibiotic prescribing decisions without an

understanding of the biological mechanisms driving resistance, how resistance becomes a problem and how to reduce the potential for resistance. This training deficiency is directly counter-productive to the possibilities for effective stewardship and training is an accepted part of successful stewardship programmes all the time (Pollack & Srinivasan, 2014). The poor guideline adherence (37.0% never adhere), the inappropriate prescription for viral infection (30.0% regularly/prescribed) and the other gaps in knowledge and practices as found in this study further support the hypothesis of poor training as a major contributing factor to suboptimal antimicrobial use.

This is a significant finding, as antimicrobial stewardship education has been shown to reduce inappropriate antimicrobial use and increase compliance with antimicrobial guidelines in various antimicrobial use settings (Roque et al., 2014). In the systematic review of educational interventions, a statistically significant reduction in antibiotic prescriptions for RTIs and improved adherence with recommended antibiotic courses was achieved with interventions employing a structured training program (Roque et al., 2014). The lack of such training highlights the great need to start educational activities on this issue in a majority of this group to fill this elementary gap. The programs should be offered, 'practical' in a real world context, and clinically relevant for health professionals working in real-world situations such as the prescriptive skills required when choosing antibiotics, obtaining information from culture sensitivities, management of viral infections and the challenges of communication and patient education, in order to manage expectations. The low and moderate awareness and knowledge scores in the previous subsections further highlight the need for robust training in order to provide healthcare professionals with the skills they need to effectively fight antibiotic resistance.

Support for Regulatory Measures

The last domain in this study explored attitudes of healthcare professionals towards the enforcement of stringent regulatory measures to limit antibiotic prescriptions. The question asked was whether they would agree with measures and the subjects were asked to answer with "yes", "no" or "not sure". The distribution of responses showed there was a clear divide and uncertainty amongst the respondents. Interestingly, 112 (37.3% of the sample) agreed with the suggestion for strict control over the use of antibiotics. One hundred and four (104) respondents were against (34.7%) and 84 participants were not sure (28.0%) on this issue.

Results indicate that there is no evidence of a strong attitude of the healthcare practitioners regarding desired regulation on antibiotic prescription. There was a fairly even split between those that supported (37.3%) and those that did not support (34.7%) – hence a polarization of the sample base, with a relatively large proportion of undecided. The implications of this consensus on the feasibility for implementing regulatory policies is significant because if they are implemented successfully, it is likely that buy-in from the prescribing community will be required (Kolawole et al, 2023). This may be problematic when a significant portion of health care workers either is actively against such policies, or is not willing to follow them, or is purposefully not cooperating.

A remarkable 34.7% of the respondents did not agree with the actions taken to regulate the situation. There are multiple sources of opposition to regulation. Some practitioners might feel the regulations in some ways interfere with a practitioner's clinical autonomy and that they should be able to make decisions about their patient's medical conditions based on each practitioner's individual assessment of each patient's needs (Emanuel & Pearson, 2012). Some fear that strict guidelines will lead to delays before access to the necessary antibiotics, in cases that truly need them (for instance in cases of high diagnostic uncertainty). Others may, however, think of the regulations as being "red tape," introducing paperwork and oversight but not enough benefit, particularly when they are not sure of the magnitude

of antibiotic resistance as an issue (as captured by the perception data; only 36.7% saw it as a serious issue).

It is a notable detail that the number of “not sure” respondents (28.0%) is in the critical mass that this community potentially may be receptive to providing them additional information – which could influence their thoughts on wanting some kind of action on the regulatory level. This community can be won over with rational arguments in favour of the positive side of regulating, including evidence that countries with restrictions on the use of antibiotics have lower resistance levels (Goossens et al., 2005). Or it could be a lack of information about what such regulations would contain, and clear communication regarding the scope, the way of implementing the regulations and expected outcomes of regulatory policies could help to change their attitudes. Most of the respondents are pro-regulation (37.3% to 34.7% against), giving an indication of a start to supporting regulation as a basis for advocacy for policy change, although the large number of undecideds can help to build a broader base of support.

Those data may point to differing opinions on enforcing these strict antibiotic prescription practices and need for participatory policy making. Rather than imposing a regulation from the top down, policymakers should involve health care providers in the proposal, design and implementation of the regulation, and acknowledge their concerns of autonomy, livability and access to care. This way to work together can lead to establishing trust, minimizing resistance and improving chances for successful implementation. Further, the experiences show that education programmes should include a section which outlines the principles used for putting in place regulation and demonstrate how regulation has an impact to reduce inappropriate prescribing and to prevent resistance. Knowledge deficits and misconceptions causing resistance or ambivalence could potentially be overcome and lead to greater acceptance of the regulatory frameworks that will be core to delivering comprehensive AMS.

Discussion

Data were analyzed in a cross-sectional study, which gave in-depth insights into a complex landscape of awareness, knowledge and antimicrobial prescribing use in the health care sector and showed where knowledge gaps are present that have direct impact on antimicrobial stewardship efforts. The moderate levels of awareness and knowledge and significant deficiencies in guideline adherence and training reinforce the need for education and regulation to step-up its efforts in developing skills and knowledge necessary for tackling antibiotic resistance effectively. Therefore, these results support previous studies performed in different environments and reveal that the professionals in the healthcare sector may lack clinical and scientific knowledge related to resistance mechanisms, as well as the concept of stewardship (Cheoun et al., 2021). The purpose of the current study is to extend this and to quantify specific behavioral deficits (e.g., those who used an antibiotic for a viral infection at least once monthly, 30.0 percent; and for whom antibiotic treatment guidelines were never followed, 37.0 percent) that would be targets for intervention.

The practice implications of these results are important for practitioners, educators, and policy makers. For instance, the tendency to inappropriately prescribe medicines for viral infections is an opportunity for the communication skills training which enables middle care providers to listen to patients' concerns and manage them in alternative, evidence-based ways. These should be made part of required continuing medical education programs, given that according to the data, 50.7% of the participants have not received any formal education on stewardship. The other thing to note however, is that 37.3% agree that the consumer should be strictly regulated, which could suggest that a participatory approach is needed in the development of prescribing protocol and audit mechanisms, in order to achieve greater ‘buy in’ and compliance from those working in healthcare in designing these. The findings offer evidence-based results to guide policymakers in focusing on improving the spread of available and

easy-to-follow guidelines for prescribing following a concussion, such as the incorporation of such guideline-based information into electronic health record systems or mobile apps, and establishing any provider protocol for such use.

But these results should be viewed in light of the methodological constraints of the study. Because it is a cross-sectional study design, the causal relationships between the variables measured cannot be determined, for instance between training and prescribing behaviour. In addition, there may have been a social desirability bias in the self-reported data - participants may have minimized their inappropriate practices and maximized their knowledge and implementation of guidelines. All this research was done in one geographic region, and the findings may not be transferable to other health care organizations with different cultural norms, regulatory requirements, and resource issues. In addition, the structured questionnaire was used with closed ended questions – i.e. there were limited opportunities for participants to expand on the factors that are important to them for taking a prescribing decision and they may have been unable to describe any of the factors as these were not necessarily named. Additionally, an absence of a validated knowledge assessment tool could also imply that the self-rated estimates of the knowledge levels would not represent the actual knowledge level, as has been noted in other survey studies (Chaw et al., 2018).

Several avenues for future research are suggested by these gaps: A longitudinal study is needed to follow the changes in prescribing to evaluate whether the gaps in knowledge and awareness identified in this study can be changed. The next step for research should also be to further break down the barriers to adherence using a qualitative tool, such as in-depth interviews or focus groups to gain greater insight into the physician's decision-making and the pressures that cause him or her to deviate from EBM guidelines. Less studied are the influence of participating institutional culture and of peer behaviour on prescribing as well as the role of patient's factors (health literacy and demographics) on demand for antibiotics. In addition, public hospital/private hospital comparison and urban clinic/rural clinic comparison studies can be conducted, to identify targeted interventions for specific groups of healthcare workers. Lastly, constructing and validating objective antimicrobial stewardship (AMS)-specific knowledge assessment instruments would provide a more precise measure of the connection between knowledge and practice, and thus boost the evidence to support designing educational programs.

Conclusion

It was a cross-sectional study to determine the awareness and knowledge regarding antibiotic resistance and antibiotic resistance clinical approach among the healthcare providers and results have revealed an alarming gap between the magnitude of antibiotic resistance problem as a global public health problem, and the readiness of healthcare providers to address antibiotic resistance problem. These results suggest that just half of the population had a basic knowledge of antibiotic resistance; nearly half were lacking in the basic knowledge of antibiotic resistance and only 1/3 considered antibiotic resistance to be a problem. Perhaps more importantly, the study revealed significant behavioral gaps such as high rates of inappropriate use for viral infections, non-adherence to guidelines for treatment, and revealed that antimicrobial stewardship is not routinely taught to more than half of the participants. These findings contribute to the literature by quantifying the specific gaps that do exist between awareness and practice, and support the previous work which stated that whilst knowledge alone is insufficient to achieve appropriate prescribing behaviours, systematic provision of other supports, accessible guidelines and strong educational infrastructure is also necessary. The result of this work has a broader reach by offering signposts for institutional and policy

interventions as reflected by the key gaps identified. Longitudinal designs are suggested for future research to test whether or not regulatory or mandated stewardship training interventions will have an impact on behaviour over time, and qualitative studies could be used to gain insight into the context and the psychological barriers to adherence to guidelines. This research highlights the need for holistic educational and regulatory efforts and provides a basis for educational and regulatory programs to improve antimicrobial stewardship and mitigate the threat of antibiotic resistance.

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