Journal of Global Antimicrobial Resistance 25 (2021) 40–47

Contents lists available at ScienceDirect

Journal of Global Antimicrobial Resistance

journal homepage: www.elsevier.com/locate/jgar

Policy actors and human and animal health practitioners' perceptions of antimicrobial use and resistance in Tanzania: A qualitative study

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ARTICLE INFO

Article history:
Received 15 October 2020
Received in revised form 10 February 2021
Accepted 22 February 2021
Available online 1 March 2021

Keywords:
Antimicrobial use
Resistance
Policy actors
Practitioners
Perception
Tanzania

ABSTRACT

Objective: To explore and describe the perceptions of policy actors and practitioners on antimicrobial use and resistance in human and animal health in Tanzania.
Methods: This was an exploratory qualitative study, which involved semi-structured interviews with nine policy makers and 102 practitioners.
Results: Improved multisectoral collaboration and coordination among experts from the animal and human sectors, government will, improved infrastructures, existence of public awareness campaigns on appropriate use of antimicrobials and existence of antimicrobial stewardship were identified as strengths for the implementation of National Action Plan on Antimicrobial Resistance (NAP-AMR) in Tanzania. Despite these strengths, insufficient public awareness of AMR, limited community engagement and inadequate human resources were among the reported weaknesses. A number of opportunities for the implementation of NAP-AMR were also reported including the presence of integrated disease surveillance and response strategy in health sector and development of a coordinated surveillance system. Furthermore, the inadequate laboratory capacity and poor resource mobilization were identified as challenges facing the implementation of NAP-AMR.
Conclusion: The future policies of AMR need to capitalize on the identified strengths and opportunities as well as design interventions to improve public awareness of AMR and community engagement, deployment of adequate human resources and ensure adequate resource mobilization to meet AMR needs.

1. Background

Antimicrobial resistance (AMR) is now a public health, animal and ecosystem problem globally. Human activities, including agriculture, veterinary and human medicine practices, have been shown to contribute to the evolution and spread of AMR in the environment [1]. These activities include misuse and overuse of antimicrobials of variable quality and efficacy in humans and animals, improper storage and disposal of antimicrobials and preservatives for food and antibacterial agents in household products [2,3]. A recent systematic review has indicated that there are very high levels of antimicrobial use and AMR in animal production systems in Africa [4]. Regionally, high levels of antimicrobial use, related weak regulatory measures and poor AMR surveillance systems are of great concern to animals, the environment and human health. All these emphasize the call for an effective holistic and multisectoral collaboration (One Health) approach, including environmental, animal and public health sectors, to effectively mitigate this emerging threat.

Globally, several efforts have been made to combat AMR. In 1998, the World Health Assembly adopted a resolution requesting all member states to take action against AMR [5]. In 2011, the

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http://dx.doi.org/10.1016/j.jgar.2021.02.027

World Health Organization (WHO) issued a policy package aimed at increasing international attention to AMR as a growing public health threat [6]. The WHO policy package recommended several actions to be taken by governments to stimulate change and address AMR. These actions include committing to a comprehensive, financed national plan with accountability and civil society engagement, strengthening surveillance and laboratory capacity, ensuring uninterrupted access to essential medicines of assured quality, and regulating and promoting rational use of medicines [6].

The WHO member states were encouraged to develop National Action Plans (NAPs) for AMR by 2017 [7]. All these efforts reflect a global recognition and consensus that AMR poses a profound threat to human health. However, the effective implementation of NAPs faces some challenges, especially in low- and middle-income countries (LMICs) [5]. The challenges include: (i) lack of access to appropriate antimicrobial therapy; (ii) weak regulation around antimicrobial use in humans and animals; (iii) weak surveillance of antimicrobial use and resistance levels; (iv) lack of updated antimicrobial treatment guidelines; (v) lack of continuing medical/veterinary education on antimicrobial use for prescribers; (vi) a weak regulatory framework for the use of antimicrobials in animal production and aquaculture; (vii) tendencies of farmers treating their animals without consulting veterinarians; and (viii) livestock keepers who fail to observe the recommended therapeutic doses and withdrawal periods as well as frequently using incorrect routes of administration [4,8].

Recognizing that antimicrobials play a critical role in the treatment of diseases of farm animals and plants, the FAO developed the 2016–2020 AMR action plan to support the WHO-led Global Action Plan on Antimicrobial Resistance to assist countries to adopt and implement the multisector NAPs to combat AMR. The action plan highlights the critical requirements for involvement of public health and veterinary authorities, the food and agriculture sectors, financial planners, environmental specialists and consumers in the strategy [9]. However, there is a growing concern that resistance to antimicrobial drugs will reverse the achievements of food safety and animal health [10].

Several studies have demonstrated the magnitude of AMR in Tanzania. The prevalence of multidrug-resistant bacteria in clinical settings ranges from 25% to 50% [11,12]. A study on AMR among producers and non-producers of extended spectrum beta-lactamases in urinary isolates at a tertiary hospital in Tanzania found AMR in both *Escherichia coli* and *Klebsiella* species isolates [12]. Despite years of global concern and the development of a comprehensive action plan, AMR in Tanzania has continued to increase in human, animal and environmental sectors. A recent study reported that >70% of all samples from humans and food animals contained coliforms that were resistant to cefotaxime, tetracycline, sulfamethoxazole or ampicillin [13]. Despite these specific studies, there is limited information on AMR stewardship in Tanzania. This study was therefore designed to explore and describe the policy actors and human and animal health practitioners' perceptions of AMR in Tanzania.

2. Methods

2.1. Study design and settings

This qualitative study was conducted in the Ilala, Kibaha and Kilosa districts in Tanzania from June 2019 to February 2020. A qualitative study design was considered appropriate because conducting situational analysis on the AMR landscape requires an in-depth exploration of views from different key informants. Ilala district is in Dar es Salaam City, an urban area, densely populated, incorporating multiple activities such as informal housing, transport infrastructure, dump sites, agriculture, industrial commercial activities, fishing and sand mining [14]. It is highly polluted by effluents from Msimbazi river tributaries originating from different sources, leakage of effluent from waste dumps, abattoirs and domestic wastewater from septic tanks and pit latrines that are used by ca. 85% of the city population [15]. The area was appropriate for the study because its population is involved in a variety of activities, and because of the environmental contamination by effluent and other wastes from different sources, which can cause one-health AMR infections. Kibaha is characterized by large- and small-scale poultry [16] and fish farming [17] that is likely to use antimicrobials. Kilosa district has a large population of pastoralists keeping cattle who are known to treat their animals themselves, with frequent use of antimicrobials [18].

2.2. Selection of study participants

We used a purposive sampling strategy to draw the key informants from each group of actors from the national and health facility levels in Kilosa, Kibaha and Ilala districts. Policy makers at the national level were purposively selected from ministries responsible for public health, livestock, fisheries, food and agriculture. Other key informants were selected from the national regulatory authorities and agencies. These key informants were selected because of their role in the preparation and supervision of the implementation of the National Action Plan for Antimicrobial Resistance (NAP-AMR). At the facility level, we purposely selected key informants including laboratory technologists/technicians, livestock field officers, agro-vets, in-charges of healthcare facilities, pharmaceutical assistants and dispensers. An environmental officer from one of the districts was also interviewed.

2.3. Data collection

An interview with the key national policy actors was conducted during one of the Multi-Stakeholders Coordination Committee (MCC) on AMR meetings. The researchers made a presentation in the meeting, introducing the study goals, objectives and methodology to all MCC members. Individual consent was requested and granted by all members before the interview began. A mapping exercise was conducted by visiting all three districts to identify a list of potential key informants (practitioners) under the guidance of the district officials. Based on the list of key informants generated from the mapping exercise, we conducted in-depth interviews with key informants from the health, environment, livestock and fishing sectors from district and facility levels. Interviews with practitioners were conducted in Kiswahili, the national language, lasted 45–90 min and were run by 12 research assistants trained in qualitative research. All interviews were conducted face-to-face. Participants were able to choose the location of the interview, which usually took place at their workplace.

2.4. Data management and analysis

All interview transcripts were transcribed verbatim and translated from Kiswahili into English. To avoid loss of the original meaning, back translation was done for some of the transcripts. We used a thematic data analysis approach, which applies both inductive and deductive reasoning. Emerging themes across a sample of transcripts were identified and validated by all researchers before a line-by-line analysis was conducted by two researchers using NVivo 12 qualitative data analysis software (QSR International Pty Ltd. Version 12, 2018). The emerging themes were categorized into strengths, weaknesses, opportunities and challenges (SWOC) relevant to the AMR landscape in Tanzania.

3. Results

3.1. Study participants

This study involved a total of 111 semi-structured interviews. Of these, nine were policy actors who were members of the national Multi-Stakeholders Committee from the Food and Agriculture Organization of the United Nations Country Office (n = 1), Ministry of Health, Community Development, Gender, Elderly and Children (n = 6), Ministry of Livestock and Fisheries (n = 1) and Tanzania Medicines and Medical Devices Authority (n = 1). In addition, we interviewed an Environmental officer from Ilala Municipality (n = 1), a pharmacist from Kilosa District Hospital (n = 1) and a member of implementing partner (n = 1). For practitioners, the interviews involved 102 individuals who included laboratory technologists/technicians from public and private primary healthcare facilities (25), livestock field officers (12), agro-vets (15), in-charges of health facilities (23), pharmaceutical assistants (8) and dispensers (19). The study findings are presented based on four main categories from SWOC analysis and corresponding themes (Fig. 1).

3.2. Strengths

Four main factors were described by participants as strengths to the response to AMR in Tanzania. These were (i) improved multisectoral collaboration and coordination of AMR activities among experts from the animal and human health sectors, (ii) existence of political will for combatting AMR, (iii) existence of public awareness campaigns on appropriate use of antimicrobials and (iv) existence of antimicrobial stewardship. Key informants reported that improved multisectoral collaboration and coordination of AMR activities among experts from the human, animal and environmental health sectors is an important strength for combatting AMR in Tanzania. According to the national-level respondents, the One Health approach brings together different disciplines in all three key sectors, which requires multisectoral governance to support the coordination of AMR strategies. The key informants revealed that establishment of a MCC on AMR has been instrumental in coordinating various activities. Furthermore, it was reported that the existence of a technical working group on AMR has helped to provide coordinated technical guidance on AMR

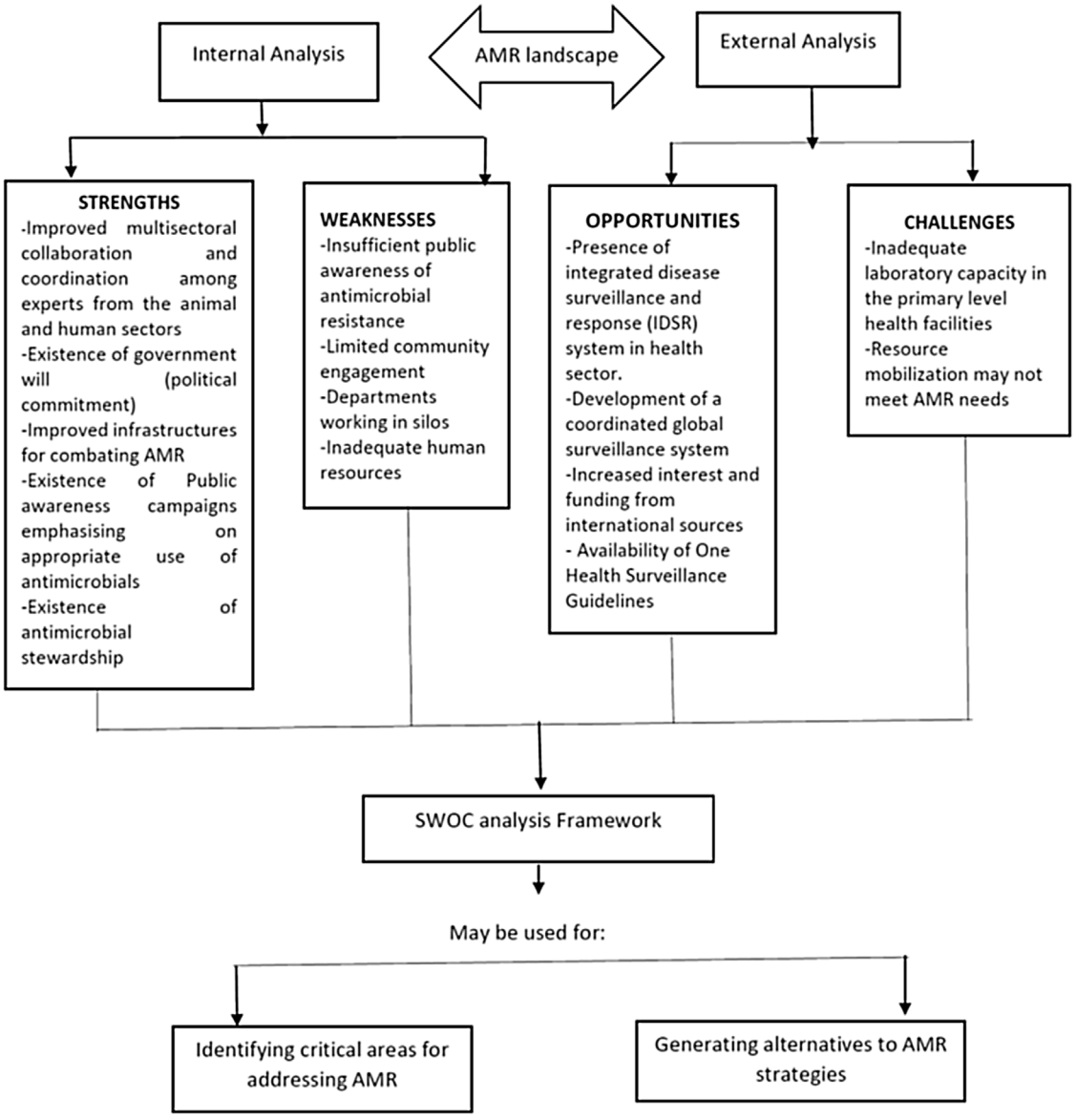

Fig. 1. Analysis of strengths, weaknesses, opportunities and challenges (SWOCs) in combating AMR in Tanzania.

interventions. For example, one respondent expressed: '*We have the technical working groups, which support coordination of various technical AMR activities*' (key informant (KI) 9: MCC member from FAO).

Some national-level respondents claimed that the Tanzanian government is committed to support the efforts toward combatting AMR. Political commitment and government leadership were reported as critical components to drive the AMR agenda in terms of coordination of its interventions and mobilization and allocation of resources: '*The strength that I currently see is a political will, the government has taken this (AMR) seriously; that is why now we have MCC sessions to coordinate everything that is happening in the country regarding antimicrobial resistance*' (KI 7: MCC member from Tanzania Medicines & Medical Devices Authority). Another key informant added: '*It is because of the government's commitment that the AMR will continue to be implemented*' (KII 8: MCC member from American Society of Microbiology — ASM).

Improved infrastructure was reported as one of the strengths necessary for combatting AMR. Study respondents reported that using a One Health approach through coordinated efforts from different stakeholders, including government and development partners, has facilitated an improvement in infrastructural development through mobilization of resources from different sectors. Interviewees suggested that through joint efforts some laboratories were renovated to enable them to provide support in microbiological and antibiotic sensitivity services, which in turn may help reduce the unnecessary use of antibiotics. One respondent emphasized that: '*The laboratories have been renovated to the extent they enable laboratory staff to provide correct test results which relate to the patient as well as by having communication between the laboratory staff and clinician to enable the later to prescribed appropriate medication*' (KI 7: MCC from TMDA).

Furthermore, some key informants reported that data management software has been established to capture national AMR data. Such software allows other national sites to generate data every month and feed them into the national system that aggregates the data nationwide. Several interviewees mentioned that development partners played a role in supporting establishment of AMR information system infrastructure, as emphasized by one of the key informants: '*We have supported procurement of computers; staff training in several sentinel sites; and conducted supervision. We have also supported provision of internet bundles for the system*' (KII 8: MCC member from ASM).

The findings from our key informants revealed that the existence of public awareness campaigns emphasizing sanitation and appropriate use of antimicrobials is an important strength in combatting AMR in Tanzania. It was noted that the MCC has been an active platform in raising awareness on the use of antimicrobial agents and AMR as testified by one of the key informants: '*In November 2019, we commemorated the World Antimicrobial Awareness Week, which had the key message on antibiotic resistance and irrational use of antibiotics. During that day there were T-shirts for AMR awareness, there were walks, outreach services and meetings in Dar es Salaam, Morogoro and Dodoma regions, all these aimed at creating awareness to the community about AMR*' (KI 9: MCC member from FAO). In addition, regulatory authorities such as the Tanzania Medicine and Medical Devices Authority (TMDA) work together with other stakeholders including students' associations to create awareness on AMR in communities and secondary schools: '*Community health education has increased from both the Ministries as well as from individuals. For example, we work together with Tanzania Pharmaceutical Students' Association to conduct AMR awareness campaigns*' (KI 7: MCC member from TMDA).

Study participants indicated that Tanzania has an effective antimicrobial stewardship programme, which is evidenced by the existence of a strong regulatory framework for medicines, availability of guidelines and existence of regulatory authorities such as the TMDA, all of which are focused on addressing AMR: '*We have standard treatment guidelines, showing which medicine is to be used for which disease. We have also developed antimicrobial stewardship guidelines, which will be released soon*' (KI 9: MCC member from TMDA). Another respondent stated: '*We have guidelines that have reached even the dispensary, which is the lowest level of our health delivery system. It requires anyone writing a prescription to comply with the guidelines to make sure that there is appropriate use of medicines to reduce microbial resistance*' (KI 4: MCC member from the Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC)).

In addition, the government through the MoHCDGEC had developed guidelines and standards on how to manage hospital waste effectively to prevent and control infections. In emphasizing this strength, one respondent said: '*We are now distributing guidelines and standards to make sure that hospital's waste is properly managed to prevent and control infections*' (KI 4: MoHCDGEC). Other stewardship programmes have been initiated to combat AMR. These include training of students pursuing nursing, laboratory, pharmacy and medicines on antimicrobial use and AMR, to enable them to educate communities about the issues: '*We have training programmes whereby nurses and clinicians are educated on AMR so that when they graduate, they know how to apply the knowledge in combatting AMR*' (KI 4: MCC from MoHCDGEC). Another participant reported that: '*The training programme is also provided to laboratory technicians to strengthen their capacity to be able to detect antimicrobial resistance*' (KII 8: MCC member ASM).

3.3. Weaknesses

The main weaknesses identified included insufficient public awareness on AMR, limited community engagement in AMR activities, weak sectoral or departmental cooperation and inadequate human resources. Our analysis identified insufficient public awareness as one of the main weaknesses in combatting AMR. Interviewees expressed the concern that even though there is an improved level of awareness of AMR, to a great extent there is insufficient awareness among some of the key stakeholders. For instance, in some regions, districts and communities, antimicrobial use and AMR awareness is limited, which affects any efforts made toward combatting it. One of the key informants said: '*I have never heard people talking about the impact of antimicrobial resistance to humans. I have never even seen it on the television. Many people are not aware of the issue of antibiotics resistance*' (KI 16: in-charge of dispensary).

According to some respondents from the facility level, there is a lack of understanding of how inappropriate use of medicines may result in AMR. One key informant cautioned that government officials and other stakeholders should continue creating awareness of AMR to avoid further disastrous effects on human and animal health: '*Those who are in the positions to make decisions have not yet seen how AMR affects our health or animal health, or will cost us more because more money will be spent on other drugs*' (KI 11: from Ministry of Livestock and Fisheries).

Limited community engagement was identified as another weakness in combatting AMR. The study respondents mentioned that for successful implementation of AMR interventions, community members who are key stakeholders must be engaged in the process. However, it was noted that community engagement in AMR programmes in many parts of the country is limited. One key informant underscored that: '*In the society, we can say there is still a challenge of ensuring effectively engagement of the community, because if we want to control AMR, the community must be fully engaged*' (KII 8: MMC member from ASM).

Interviewees were concerned with the fact that different departments from human, animal and environmental health sectors work in silos, which weakens the efforts to combat AMR. Although there is a One Health desk housed in the Prime Minister's office, the sectors have not coordinated their structures to work together. For instance, interviewees stated that the environment sector is not integrated with the human and animal health sectors in combatting AMR. One of the key informants expressed that: '*Each sector is working alone and at the end of the day you get duplication of efforts. Even in terms of administration, each one has his/her own leader, which is very challenging*' (KI 9: MCC member from FAO).

Inadequate human resources in all sectors involved in AMR was mentioned as another weakness. Execution of AMR activities is partly hindered by the shortage of staff, particularly in health facilities, as well as veterinary/livestock extension officers who are responsible for providing continuous education to dispensers and consumers of antibiotics. For instance, an observation of the number of staff working in the pharmacy unit at primary health facilities showed that most of the dispensing units had only one staff member present at any time, making it difficult to dispense drugs while providing education to patients on drug resistance. Given the shortage of staff, there is limited time to provide education about AMR to patients while others are waiting: '*When we have few clients, we may be able to have adequate time to discuss with the patient. Some patients don't understand when you give them instructions on the use of medicines so you have to repeat several times*' (KI 17: dispenser from health centre).

3.4. Opportunities

The establishment of the One Health desk, availability of Guidelines for Surveillance of Prioritised Zoonotic Diseases for Human and Animal Health of 2018, the development of a coordinated global surveillance system, and the increased interest and funding from international sources were identified as the important opportunities in mitigation of AMR in Tanzania. These guidelines were developed collaboratively between the MoHCDGEC Ministry of Livestock and Fisheries and Ministry of Natural Resources and Tourism. The guidelines provide direction for effective integrated surveillance and response to priority zoonoses in Tanzania. The guidelines summarize disease presentation in humans and animals, their documentation, analysis, interpretation and reporting. They also cover key aspects crucial for effective surveillance and monitoring and evaluation. These include community-based surveillance, sharing of data among sectors, dissemination of information and response. The guidelines describe the functions of surveillance and users at all levels: community, district, regional and national. Therefore, they can be used by all key sectors involved in AMR in conducting surveillance to strengthen the evidence base on AMR and help inform decision making and drive national actions.

Study participants reported the existence of a coordinated global surveillance system whereby WHO member states collect data on multidrug resistance and feed them into WHONET software. Study participants reported that different surveillance sites in Tanzania can collect data on AMR, feed them into WHONET and get national aggregated data on AMR, which can be used to inform decision and policy making on antimicrobial use: '*So, other national sites have been supported to generate data and feed them into a system (WHONET) on monthly basis*' (KI 9: FAO). Participants also reported on the availability of the FAO Assessment Tool for Laboratories and AMR Surveillance Systems (FAO-ATLASS) as another opportunity for addressing AMR in Tanzania. One participant acknowledged the existence of this tool and its usefulness in capturing AMR data that can be used to inform decision and policy making: "*The biggest programme that I have to mention is called ATLASS, which stands for Antimicrobial Laboratory Surveillance Systems in animals and agriculture, which can be used to improve country's surveillance data on AMR*' (KI 9: MCC member from FAO).

Study participants reported that efforts to combat AMR have increased interest and funding from local and international partners willing to invest in interventions targeting AMR in Tanzania. A development partner official reported that: "*An important component is on investments. A number of stakeholders are interested to invest and help to get rid of drug resistance in human, livestock and agriculture*' (KI Number 9, MCC member from FAO).

3.5. Challenges

Inadequate laboratory capacity at the primary healthcare facility level and financial resource mobilization for AMR programmes were the two most important challenges identified. Most of the interviewed laboratory staff reported that most facilities do not have enough capacity to perform cultures and antimicrobial susceptibility testing. Generally, inadequate laboratory capacity was reported as one of the challenges for combatting AMR as expressed by different key informants for this study: '*We offer services in different aspects including haematology tests, full blood picture, parasitology, blood smear tests, urine analysis, tuberculosis tests, but we don't carry out culture test for antibiotic sensitivity tests*' (KI 10: laboratory scientist, health centre in Dar es Salaam). Another respondent stated that: '*We don't have the guidelines for carrying our drug sensitivity and we don't do it here*' (KI 16: in-charge of laboratory, health centre in Kilosa).

Some of the study participants claimed that AMR has become a critical problem and a burden to the health system in terms of financial impacts. They explained that the cost of treatment for people who have a high level of antibiotic resistance is higher than those who are not infected by drug-resistant pathogens. Given this situation, respondents mentioned that the inability of government and other stakeholders to mobilize adequate financial resources to address AMR is a challenge that needs to be addressed jointly by all stakeholders: '*Mobilizing funds is a challenge because not all working groups have got fund for combatting AMR, so we are still looking for funds so that we can be able to carry out all AMR activities*' (KI 10: laboratory scientist, health centre in Dar es Salaam).

4. Discussion

This study used a qualitative approach to explore the AMR landscape in Tanzania, with semi-structured interviews from stakeholders at the national and primary health care facility levels. The themes presented illustrate that there are several strengths for combatting AMR: improved multisectoral collaboration and coordination among experts from the animal, human and environmental health sectors; existence of political commitment; improved infrastructures; existence of public awareness campaigns emphasizing appropriate use of antimicrobials; and existence of antimicrobial stewardship. As the fight against AMR requires efforts of various stakeholders from different sectors including human and animal health and the environment, improved multisectoral collaboration and coordination across these sectors as well as community engagement, were reported as important strengths and key for combatting AMR. The establishment of a MCC in Tanzania has been reported to play an instrumental role in coordinating various activities regarding AMR. A study in Guinea, Liberia and Sierra Leone reported similar findings indicating that in <3 years there has been a remarkable improvement in cross-sectoral coordination on the prevention,

detection and response to public health threats including AMR [19].

A study in Tanzania on building a functional national One Health platform reported that the country has a functioning and institutionalized multisectoral coordination mechanism with an effective institutional structure and the capacity to prevent, detect early and respond to health events [20].

In this study, political commitment and government leadership were reported as a strength driving the AMR agenda in terms of coordination of interventions and mobilization and allocation of resources. The placement of a One Health office at the Prime Minister's office is envisaged to facilitate the coordination of AMR activities from other ministries as all of them are answerable to the office. Bhatia et al. [21] insisted that as AMR is a complex, multisectoral public health problem, strong political commitment is important to ensure that there are national and international cross-sectoral coordination mechanisms that engage all key stakeholders. In Ethiopia, Kenya, the Philippines and Thailand, it has been shown that political commitment and leadership are critical strengths not only in driving the AMR agenda forward but also mobilizing and allocating resources for interventions appropriately [22]. Political will and support are recognized in different countries as instrumental tools in addressing AMR because it is a borderless threat, which requires global governance and political strategies to mitigate its emergence and spread [23,24]. However, contrary to our findings, it has also been reported that in high-income countries the greatest barriers for combatting AMR are lack of political support by the whole of government, excessive bureaucracy and weak implementation procedures, On the other hand, in LMICs political will is often frustrated by inadequate infrastructure and human resources, a lack of triangular cooperation and insufficient funding [25].

Findings from this study indicate that having in place improved infrastructures is a strength that different actors can use for combatting AMR. Study participants acknowledged that different stakeholders such as government and development partners have joined efforts, which facilitated mobilization of resources including funds and laboratory equipment, thereby strengthening laboratory capacities. Improved laboratory infrastructure in Tanzania was critically seen as an important strength, assisting confirmatory diagnosis and reducing unnecessary prescription of antimicrobials. Further, our work shows that public awareness campaigns that emphasize the appropriate use of antimicrobials are essential for community buy-in to combat AMR. Awareness creation campaigns have been put in place for key stakeholders such as pharmacists, laboratory staff and, to a lesser extent, communities. As in Tanzania, Thailand also acknowledged that community awareness is an important strength for combatting AMR, leading to the national government adopting a participatory approach that engaged with multisectoral stakeholders [26].

Antimicrobial stewardship was acknowledged to be an important strength for combatting AMR in this study. Tanzania has put in place antimicrobial stewardship interventions including development of strong regulatory framework for medicines, guidelines and a regulatory authority [27]. Analysis indicated that a number of stewardship programmes have been established to improve rational use of antimicrobials both in the human and livestock sectors. These programmes include increasing investments in a medicines regulatory authority and pharmacy council, in laboratory services, and strengthening management teams at all levels of service delivery, including medicines and therapeutics committees; as well as strengthening advocacy on rational use of antimicrobials [27].

Apart from opportunities offered by the One Health approach in tackling AMR, this study has identified a number of weaknesses in how Tanzania is addressing the AMR threat. There is limited awareness on AMR among some of the key stakeholders in different regions, districts and community members. Similar findings were reported in Singapore where there was low awareness of AMR among physicians, farmers and others within the environmental health sector [28]. Mani et al. [29] noted that it is not possible to make antibiotic resistance prominent on the policy agenda and attract support from key stakeholders including civil society organizations if there is limited public awareness on AMR. Limited awareness on AMR in Tanzania is likely to be a result of the nature of campaigns that stakeholders have used. These include the development and dissemination of campaign materials through channels such as print, television, radio, internet, and social media, which have some limitations in countries such as Tanzania in which the majority of people cannot easily access AMR information through those channels. Factors influencing accessibility of information in Tanzania include literacy levels, income, reliability of information infrastructure, availability of electricity and the cost of information and communication technologies [30].

Related to insufficient public awareness on AMR, this study reported limited community engagement as one of the weaknesses in combatting AMR. This limited engagement is because most of the AMR interventions apply a top–down approach whereby the experts and policy makers in the human, animal and environmental health sectors are involved in the design of AMR interventions without engaging community members in the process, thus limiting the effectiveness of any intervention. In Tanzania, lack of community engagement in AMR interventions is substantiated by the existence of unregulated marketing of antimicrobials and widespread use of antimicrobials as growth promoters in livestock [15,16,31].

Human, animal and environmental health sectors working in silos was reported as another weakness in combatting AMR. Across sectors, cooperation has been complicated by fragmented animal, public and environmental health systems, leading to reduced flexibility of actors and their organizations, and resulting in resource duplication and delays [32]. Although promoting collaboration between multiple stakeholders is an important aspect of the One Health approach, there are challenges in ensuring meaningful and equal participation from diverse actors in multiple domains and at multiple levels, insufficient policy prioritization and funding, and the lack of One Health-related educational and training programmes [33].

Shortages of staff, particularly in the human and animal health sectors, was discussed as a weakness in combatting AMR. Our key informants reported that there is inadequate human workforce in both human and animal healthcare delivery systems, which are responsible for providing continuous education to consumers of antimicrobials. Similar findings have been reported elsewhere [34]. Inadequate laboratory capacity at primary level was also mentioned as another challenge for combatting AMR. Other studies on antimicrobial stewardship in Tanzania [27] and Pakistan [35] have also reported that low capacity of the laboratories in the primary health facilities limits their ability to combat AMR.

This study identified guidelines that provide direction for effective integrated surveillance and response to priority zoonoses in Tanzania. The guidelines also include information on community-based surveillance, sharing of data among sectors, dissemination of information and response. Therefore, they can be used by all key sectors involved in AMR in conducting AMR surveillance to strengthen the evidence base on AMR and help inform decision making and drive national actions. The establishment of the Africa Centers for Disease Control and Prevention's Antimicrobial Resistance and Surveillance Network was also recognized as an opportunity for standardizing the approach to AMR surveillance and attempt to attain good-quality data [36]. In addition, the existence of a coordinated global surveillance system like

WHONET has also been listed as one way in which countries such as Tanzania can generate national aggregated data on AMR for informing policy and decision making on antimicrobial use [37].

Increased interest and funding from local and international partners for combatting AMR provide further opportunity for Tanzania to address the AMR challenges. A number of stakeholders, through investments in innovation, have contributed to an increased effort in investing in different AMR priority areas including research and development [38]. The World Bank is also financing improvements in disease surveillance and laboratory strengthening in multiple countries to consolidate the core functions of human and animal public health systems to combat global public health threats including AMR [39]. Despite the fact that this study reported an increased interest in funding AMR-related activities, this is also a challenge because the level of funding from international sources may not necessarily meet local needs and is unlikely to be sustainable. In spite of mounting evidence on the impact of AMR and multiple calls for action and interventions to combat AMR, funding has remained inadequate at all levels, making it difficult for various nations to address this problem [40].

The strengths of this paper are that it is one of the first qualitative studies to explore in detail the perceptions of policy makers and practitioners on the strengths, weaknesses, opportunities and challenges of implementing AMR NAPs, and that the interpretation of the findings is grounded in interviewees' or respondents' contributions. Social desirability bias was a limitation of this research in which some members had a tendency to present reality in line with what they believe to be socially acceptable. However, this limitation was mitigated during data collection, whereby researchers clearly introduced the study objectives and established rapport with the participants.

In summary, this study has identified several areas that should be addressed in future policies on AMR. These include among others: enhancement of public awareness of AMR and community engagement, deployment of adequate human resources to combat AMR, upgrading of laboratory capacity at primary-level health facilities and ensuring adequate resource mobilization to meet AMR needs.

Funding

This study was funded by a Joint DFID/ESRC/MRC/Welcome Trust Health Systems Foundation, which is administered by the Medical Research Council (MRC) UK. Grant (Ref. MR/S012796/1). Article processing charges were covered by the World Bank supported Eastern and Southern Africa Centers of Excellence for Infectious Diseases of Humans and Animals (SACIDS-ACE). Project Grant P151847.

Conflict of interest

None declared.

Ethical approval

Permission to conduct interviews with MCC members was sought and granted by the chairperson of the MCC on AMR. All study participants provided their informed consent for inclusion before they participated in the study. The Medical Research Coordinating Committee of the Tanzania National Institute for Medical Research approved the protocol (Ref No. NIMR/HQ/R.8a/Vol IX/3147).

Acknowledgements

We extend our thanks to the regional and district authorities including the respective regional administrative secretary, district executive directors, district medical and veterinary officers, district project focal persons and ward leaders for their support and facilitation of the study implementation. We are grateful to all members of the Multi-Stakeholders Coordination Committee for their enthusiasm and participation in this study. We acknowledge the support received from our research assistants during the course of data collection. They were Isolide Massawe, David Kiwera, Fausta Mgaya, Fortunata Nyeringo, Gilbert Mwageni, Jackson Kisamo, Jesca Michael, John Ng'imba, Joyce Kasuamila, Magao Mhando, Pendo Mtui and Shoko Kashenge.

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