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Research Article

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Regulating Antimicrobial usage in Livestock Farming: Innovative and Interdisciplinary Solutions

Nathan Mugenyi[1*], Prize Ninsiima[2], Pauline Byakika-Kibwika[3], Rose Nanyonga Clarke[4]

[1]*Faculty of Medicine, Mbarara University of Science and Technology, Mbarara, Uganda*

[2] *School of Medicine, Uganda Christian University, Kampala, Uganda*

[3]*College of Health Sciences, Makerere University, Kampala, Uganda*

[4]*Clarke International University, Kampala, Uganda*

***Corresponding author**
Mugenyi Nathan, Faculty of Medicine, Mbarara University of Science and Technology, Mbarara, Uganda.

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Abstract
Antimicrobials have been used extensively in Livestock production. The overuse and misuse of antimicrobials has resulted in the development of drug resistant pathogens that is Antimicrobial Resistance (AMR). The emergence and spread of drug resistant pathogens have resulted into AMR and has continued to threaten our veterinary and health care systems. The most alarming situations include the rapid global spread of multi-and pan-resistant bacteria which have been referred to as "superbugs". These have caused infections that are un-treatable with the available medicines in our health care and veterinary settings. AMR is one of the top ten global health and development threats facing humans and animals according to the World Health Organization hence the need for urgent multisectoral action. Antimicrobials are medicines used for prophylaxis, treatment and prevention of infections in animals, humans and plants. They comprise of antibiotics, antiviral, antifungal and antiparasitics. Antibiotics are increasingly losing their effectiveness as drug-resistance spreads globally resulting into difficulty in treating infections, death of animals and humans. In this paper, we addressed some of the innovative solutions based on an interdisciplinary perspective. We discussed the fundamental concerns for defining policies and strategies to mitigate AMR in Livestock farming, structured a basis for AMR policies and strategies and the key actors in Antimicrobial decision systems.

Keywords: Antimicrobial Resistance, Antimicrobial Use, Livestock Production, System Actors.

Introduction

Concerns in usage of Antimicrobials on animal farms considerably rose due to the elevating prevalence of antimicrobial resistance and the way it has affected human health for a long period of time [1].

AMR is a growing global health threat, a naturally occurring molecular process that results from the ability of microorganisms to quickly adapt to changing conditions, develop mechanisms of survival in the presence of an antibiotic through mutations, change in configuration at the active site, drug inactivation and efflux mechanisms which render antibiotics less effective [2].

The existence of vital and un-common mutations which neutralize the action of antimicrobials is inevitable in dense microbial communities and the rapid generation times allow these mutations to easily become prevalent in growing communities [3]. Additionally, the ability of bacteria to exchange mobile genetic elements enhance their capacity to adapt and resist [3].

A myriad of factors have escalated the prevalence of AMR including un-regulated usage of medicines especially antibiotics in humans, livestock and agriculture as well as inadequate access to clean water, sanitation and hygiene. AMR is a natural phenomenon; its increasing prevalence is however not. It is rather due to anthropogenic factors such as the intensive clinical and agricultural use of antimicrobials globally, changes in human lifestyle (such as, increased urbanization, migration and travel), misconceptions and malpractices regarding antimicrobial usage (AMU) [4]. AMR is particularly concerning in Africa and its impact is becoming more apparent, with health care associated infections increasing, the ongoing high burden of communicable diseases, weak and fragmented public and veterinary health systems.

The rising prevalence is predicted to have a significant impact on global health and wealth by potentially causing up to 10 million deaths each year, at a cumulative cost of $100 trillion to global economic output by 2050 [3]. The World Bank Group estimated that reductions in annual global GDP due to AMR (ranging between 1.1 and 3.8%) may be comparable to the losses caused by the 2008–2009 financial crisis, with the difference that the economic damage would continue for decades and would mostly affect low and middle income countries (LMICs) [5].

The use of national action plans as an attempt to contain AMR with a One Health approach is time bound as it was estimated that by 2030, antimicrobial consumption associated with AMR would increase by 67% in livestock, by 33% in aquaculture and by 15, 32 or 202% in humans, depending on the scenario [6].

AMR surveillance, infection Prevention and control (IPC) and optimal antimicrobial prescription for use in both human and veterinary medicine are some of the ways to mitigate challenges caused by antimicrobial resistance [7]. Additionally, the institutionalization of Antimicrobial use (AMU) as well as the reduction of antimicrobial dependence is necessary in order to achieve a sustainable use of antimicrobials [4].

Antibiotics play a crucial role in livestock production since they are both therapeutic and economic assets as well [4]. The preventive application of antimicrobials for prophylaxis as well as metaphylaxis avoids economic risks and labor costs [4]. Antimicrobials are used as feed additives which improve animal growth, feed conversion and yield [8].

Technological innovations such as vaccination and alternatives to antimicrobials reduce reliance on antimicrobial use [4]. New technologies might not however be enough as addressed in Global action plans but rather not sufficiently developed in order to effectively replace antimicrobials [9]. Considerable investment in research and development will be needed so as to evaluate the efficiency of the new technologies meaning that these options will not be widely available in the coming years. However, such options may offer short-term solutions since we are engaged in an infectious arm's race with microbes that always find a way to accommodate and thrive in presence of new therapeutics [4].

The vision for AMR control is currently focused on technological and biomedical innovations where the benefits are short-lived due to over dependence on antibiotics [4]. Additionally, farmers may not adopt the new alternatives, as it was the case for the live oral Lawsonia vaccine in pigs, which was not widely used despite positive results [10].

The practice of new technologies by farmers can be influenced by numerous factors according to multidisciplinary studies, for example, environmental factors such as land use and land characteristics; personal features such as age, human capital or risk preferences; economic attributes such as market intervention by regulators and costs of acquiring the technology; extension services as well as cultural and social factors including social identity, social networks and peer group influence. It is therefore clear that farmers' behavior is embedded in both biophysical and social landscapes hence decision-making processes are complex and context dependent [10].Understanding farmers' behavior while considering the systemic complexity in which it is embedded is key since several frameworks and systemic approaches have been developed with the hope that this would help design research that represents farmer's behavior more realistically and that it would lead to the development of more effective sustainable agricultural policies [11].

In this regard, our objective is to add to an innovative interdisciplinary research agenda by providing a perspective structure on strategies for regulating antimicrobial usage[4]. This perspective was inspired by how the different multidisciplinary personnel can contribute to environmental policies [4].

We discuss how knowledge about farmers' behavior and where they operate can contribute to answering central concerns for the development of policies and strategies and can provide a clear structure of AMR interventions in livestock production along the value chains [12].

Objective

Antimicrobial resistance (AMR) is considered an external factor in livestock production as it is an undesired outcome of preventive and curative antimicrobial use [4]. Our objective is to provide an innovative approach based on interdisciplinary research to develop strategies and policies that aim to mitigate AMR [4].

Method

Fundamental concerns on which control policies, regulations and strategies for livestock production are mainly in the light of AMR [13]. We demonstrated the significance of systemic approach procedures to define every aspect to target by considering the difficulty in which the ultimate decision-maker is embedded [14]. We structured how voluntary behavioral change can be achieved via certain routes among farmers.

Strategies to Mitigate AMR in Livestock farming using Fundamental Concerns for Defining Policies

Externalities such as AMR in livestock and agricultural pollution, design of policies and control strategies for the latter might also be useful for the former [4]. We therefore applied three fundamental questions on which the design of policies and control strategies for agricultural environmental pollution is mainly centered, these are aimed to design new policies and strategies to mitigate AMR in livestock [13].

Antimicrobial Decision Systems Actors

Reduction of antimicrobial use and dependence in livestock production is dependent on the key actors in the antimicrobial decision systems. It is vital that farmers, as immediate users, and veterinarians, as antibiotics prescribers, alter their behavior [16].

Analysis of animal health systems along value chain approaches increased as it allows for the strengthening of the different actors involved, their roles and association between the different actors as well as how analyses influences practices [4]. Analytical frameworks have been structured to study big and complex systems as value chains are envisaged into the biological, economical, regulatory and social aspects [17].Agricultural Innovation Systems (AIS) have been developed under innovative procedures that comprises knowledge that all actors in an agricultural system demand as well as the interaction between these actors [16].Definition of functions and structures, that is, identification and classification of actors, of an AIS within the frame work may affect the contribution of actors to the fulfillment of the functions of the innovative systems [17].

Considering the value chain makes it more clear that other than farmers and veterinarians, other actors of the value chain can be targeted and engagaged [17]. Input suppliers such as feed mills could be subject to policies in the upstream part of the value chain through regulating the production of certain inputs like non-medicated feed to avoid cross-contamination with antimicrobial residues[4].Provision of information about antimicrobial usage during the production of animal products can be enhanced by labeling systems [18].

Educational and sensitization campaigns about AMR, antimicrobial stewardship or biosafety could be promoted for farmers, veterinarians and also advisors [19].industries support such as pharmaceutical plants support such campaigns.

Defining a Basis for AMR Policies and Strategies

Exploring different options that may provide an optimal basis for measuring impact that policies and strategies are intended to change is a basis for mitigating antimicrobial resistance [19]. an optimal base to formulate a regulation and measuring compliance and AMR relationship can be applied as they are correlated with AMR, enforceable and targetable in space and time [20].

Conclusion

Most strategies and policies that aim at regulating application and dependence on antimicrobials do not consider behavioral character of AMU and AMR [4]. We introduced an innovative approach that relies on interdisciplinary perspective to describe the antimicrobial decision system, provide adequate regulatory and intervention bases [23]. AMR policies and strategies are however investigated within different disciplines and not in a holistic and systemic way, which calls for advocating for more interdisciplinary work and discussions for further research [4].

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Conflicts of interest

There were no any conflicts of interest.

References

1. O'Neill, J. (2016). Tackling drug-resistant infections globally: final report and recommendations.
2. Abera, D., Desissa, F., & Endris, J. (2016). Mechanisms of development of antimicrobial resistance in bacteria: A review.
3. Frenoy, A., & Bonhoeffer, S. (2018). Death and population dynamics affect mutation rate estimates and evolvability under stress in bacteria. PLoS biology, 16(5), e2005056.
4. Baudoin, F., Hogeveen, H., & Wauters, E. (2021). Reducing antimicrobial use and dependence in livestock production systems: a social and economic sciences perspective on an interdisciplinary approach. Frontiers in Veterinary Science, 8, 584593.
5. Maki, G., & Zervos, M. (2021). Health care–acquired infections in low-and middle-income countries and the role of infection prevention and control. Infectious Disease Clinics, 35(3), 827-839.
6. Klepac Pogrmilovic, B., O'Sullivan, G., Milton, K., Biddle, S. J., Bauman, A., Bull, F., ... & Pedisic, Z. (2018). A global systematic scoping review of studies analysing indicators, development, and content of national-level physical activity and sedentary behaviour policies. International Journal of Behavioral Nutrition and Physical Activity, 15(1), 1-17.
7. Smith, M. A. (2005). Antibiotic resistance. Nursing Clinics, 40(1), 63-75.
8. Kirchhelle, C. (2018). Pharming animals: a global history of antibiotics in food production (1935–2017). Palgrave Communications, 4(1), 1-13.
9. World Health Organization. (2004). Food and agriculture organization of the United Nations. Vitamin and mineral requirements in human nutrition, 2, 17-299.
10. Andres, V. M., & Davies, R. H. (2015). Biosecurity measures to control Salmonella and other infectious agents in pig farms: a review. Comprehensive Reviews in Food Science and Food Safety, 14(4), 317-335.
11. Schlüter, M., Baeza, A., Dressler, G., Frank, K., Groeneveld, J., Jager, W., ... & Wijermans, N. (2017). A framework for mapping and comparing behavioural theories in models of social-ecological systems. Ecological economics, 131, 21-35.
12. Cash, D. W., Clark, W. C., Alcock, F., Dickson, N. M., Eckley, N., Guston, D. H., ... & Mitchell, R. B. (2003). Knowledge systems for sustainable development. Proceedings of the national academy of sciences, 100(14), 8086-8091.
13. Petetin, F., Bertoluci, G., & Bocquet, J. C. (2011). Decision-making in disruptive innovation projects: A value approach. In DS 68-1: Proceedings of the 18th International Conference on Engineering Design (ICED 11), Impacting Society through Engineering Design, Vol. 1: Design Processes, Lyngby/Copenhagen, Denmark, 15.-19.08. 2011.
14. Carley, M. (2013). Rational techniques in policy analysis: Policy studies institute. Elsevier.
15. Laxminarayan, R., Duse, A., Wattal, C., Zaidi, A. K., Wertheim, H. F., Sumpradit, N., ... & Cars, O. (2013). Antibiotic resistance—the need for global solutions. The Lancet infectious diseases, 13(12), 1057-1098.

16. Jones, P. J., Marier, E. A., Tranter, R. B., Wu, G., Watson, E., & Teale, C. J. (2015). Factors affecting dairy farmers' attitudes towards antimicrobial medicine usage in cattle in England and Wales. Preventive veterinary medicine, 121(1-2), 30-40.
17. Surana, A., Kumara*, S., Greaves, M., & Raghavan, U. N. (2005). Supply-chain networks: a complex adaptive systems perspective. International Journal of Production Research, 43(20), 4235-4265.
18. Bowman, M., Marshall, K. K., Kuchler, F., & Lynch, L. (2016). Raised without antibiotics: lessons from voluntary labeling of antibiotic use practices in the broiler industry. American Journal of Agricultural Economics, 98(2), 622-642.
19. Lekagul, A., Tangcharoensathien, V., Liverani, M., Mills, A., Rushton, J., & Yeung, S. (2021). Understanding antibiotic use for pig farming in Thailand: a qualitative study. Antimicrobial Resistance & Infection Control, 10(1), 1-11.
20. Anderson, M., Schulze, K., Cassini, A., Plachouras, D., & Mossialos, E. (2019). A governance framework for development and assessment of national action plans on antimicrobial resistance. The Lancet Infectious Diseases, 19(11), e371-e384.
21. Kok, G., Gottlieb, N. H., Peters, G. J. Y., Mullen, P. D., Parcel, G. S., Ruiter, R. A., ... & Bartholomew, L. K. (2016). A taxonomy of behaviour change methods: an intervention mapping approach. Health psychology review, 10(3), 297-312.
22. Castanon, J. I. R. (2007). History of the use of antibiotic as growth promoters in European poultry feeds. Poultry science, 86(11), 2466-2471.
23. Hedman, H. D., Vasco, K. A., & Zhang, L. (2020). A review of antimicrobial resistance in poultry farming within low-resource settings. Animals, 10(8), 1264.