saúde
EM DEBATE

ESSAY

The One Health approach to face bacterial resistance to antibiotics in livestock production

A Saúde Única no enfrentamento da resistência bacteriana a antibióticos no âmbito da agropecuária

Rafael Almeida da Silva[1], Vera Lucia Luiza[1], Jorge Antonio Zepeda Bermudez[1], Maria Cristina Schneider[2]

DOI: 10.1590/2358-289820251449713I

ABSTRACT The bacterial resistance to antibiotics (AMR-Bacteria) is one of the main global health problems. In 2019 alone, it was estimated that 1.27 million people died due to complications from resistant bacterial diseases. The One Health approach is the primary strategy in addressing AMR-Bacteria. Thus, this essay aimed to reflect on the application of the One Health approach in addressing AMR-Bacteria within the scope of agriculture. AMR-Bacteria is partially related to the intensive production of animal-origin foods. One of the main challenges for implementing the approach is the lack of communication among stakeholders. The solution to this impasse involves transdisciplinary training to form research networks and develop surveillance tools. One Health presupposes negotiation to build sustainable public policies. The search for strategies to address AMR-Bacteria involves considering the balance between the economic issue of food production, the physical well-being of animals, and the effects on the environment. Those wishing to implement the approach must form teams, combine methods and techniques, and involve different stakeholders. Through the lens of One Health, one can better understand how human actions contribute to the spread of AMR-Bacteria.

KEYWORDS One Health. Drug resistance. Drug resistance, microbial. Livestock industry. Veterinary Medicine. Environment and public health.

RESUMO *A resistência bacteriana a antibióticos (AMR-Bacteria) é um dos principais problemas de saúde global. Somente no ano de 2019, estimou-se que 1,27 milhão de pessoas morreu devido a complicações por doenças bacterianas resistentes. A abordagem One Health é a principal estratégia no enfrentamento da AMR-Bacteria. Assim, este ensaio objetiva refletir sobre a aplicação da abordagem Saúde Única no enfrentamento da AMR-Bacteria no âmbito da agropecuária. A AMR-Bacteria está parcialmente relacionada à produção intensiva de alimentos de origem animal. Um dos principais desafios para implantação da abordagem é a falta de comunicação entre atores. A solução para esse impasse perpassa o treinamento transdisciplinar para a formação de redes de pesquisa e desenvolvimento de ferramentas de vigilância. A Saúde Única pressupõe a negociação para construir políticas públicas sustentáveis. A busca por estratégias para o enfrentamento de AMR-Bacteria perpassa levar em consideração o equilíbrio entre a questão econômica da produção de alimentos, o bem-estar físico dos animais e os efeitos para o meio ambiente. Aqueles que desejam pôr em prática a abordagem devem formar equipes, combinar métodos e técnicas e envolver diferentes atores. A partir do olhar da Saúde Única pode-se conhecer melhor como ações humanas contribuem com a disseminação de AMR-Bacteria.*

PALAVRAS-CHAVE *Saúde Única. Resistência microbiana a medicamentos. Indústria agropecuária. Medicina veterinária. Meio ambiente e saúde pública.*

[1] Fundação Oswaldo Cruz (Fiocruz), Escola Nacional de Saúde Pública Sergio Arouca (Ensp) – Rio de Janeiro (RJ), Brasil. *rafaelalmmeida@gmail.com*

[2] Georgetown University, Department of Global Health, School of Health – Washington, Estados Unidos da América.

Introduction

Bacterial antibiotic resistance is a particularity of antimicrobial resistance (AMR). AMR is a broad term and refers to the ability of all microorganisms, i.e., bacteria, fungi, viruses, and parasites, to resist antimicrobials, while bacterial resistance to antibiotics refers only to organisms pertaining to Monera kingdom[1]. In this work, the term 'AMR-Bacteria' is used to refer to bacterial resistance to antibiotics.

In 2019 alone, it was estimated that 1.27 million people died due to complications from resistant bacterial diseases[2]. Murray[2] ranked AMR-Bacteria as the third leading cause of death in humans, behind heart ischemia and stroke.

The One Health approach has been considered by the World Health Organization (WHO) as a fundamental strategy for coping with bacterial resistance due to the complexity of factors related to the increase in the problem, among them the excessive use of antibiotics in humans, livestock, and environment pollution[3].

The concept of One Health approach does not own a universal definition, coexisting several interpretations and perspectives on the term[4-6]. Its concept, dimensions, understanding, acceptability, and adoption continuously evolve[5] under the influence of challenges to health, science, and political, economic, and environmental priorities[7].

The definition applied here was proposed by One Health High Level Expert Panel (OHHLEP) carried on in 2021:

> The One Health is an integrated approach that aims to balance and optimize the health of people, animals, and ecosystems. It recognizes the close links and interdependence between the health of humans, animals, plants, and the broader environment (including the ecosystem). The approach mobilizes multiple sectors, disciplines, and communities of the various levels of the society to work together so to address threats to health and ecosystems, while addresses the collective need for clean water, energy, and air, safety and nutritious food, acting on climate changes and contributing to sustainable development[8].

OHHLEP has defined five key principles that make up the concept of One Health[8]:

1. equity across sectors and disciplines;

2. socio-political and multicultural parity, i.e. the doctrine that all people are equal and deserve equal rights and opportunities, and inclusion and engagement of communities and marginalized voices;

3. socioecological equilibrium that seeks a harmonious balance between human–animal–environment interaction and acknowledging the importance of biodiversity, access to sufficient natural space and resources, and the intrinsic value of all living things within the ecosystem;

4. stewardship and the responsibility of humans to change behaviour and adopt sustainable solutions that recognize the importance of animal welfare and the integrity of the whole ecosystem, thus securing the well-being of current and future generations; and

5. transdisciplinary and multisectoral collaboration, which includes all relevant disciplines, both modern and traditional forms of knowledge and a broad representative array of perspectives.

Despite the growing evidence in recent years as for the importance of various disciplines working together to further the understanding of challenges we are currently facing – among them pandemics, epidemics and AMR-Bacteria – it still remains a lot of difficulty in understanding how to act on a One Health approach. The lack of trans-disciplinarity between the areas of knowledge, collaboration among professionals and a basic

conceptual framework of what 'Health' would mean for the different species and the ecosystem are among the main reasons[9].

Material and methods

This essay aimed to review the development of One Health approach and its uses, as well as its application in the fight against AMR-Bacteria. It is divided into three parts, the first being a historical review of the One Health approach development; the second, a brief description of the areas of knowledge that One Health encompasses; and, finally, the practical application of the approach to coping with AMR-Bacteria.

Results and discussion

The history of the One Health approach development

The understanding of a relation between human beings, animals and the environment did not originate in a single human school of thought[5]. Its construction has evolved in different contexts involving health problems, scientific advances, and practices occurred throughout human history[7]. It is impossible to draw a linear structure of past events to the present concept of One Health[7].

The main premise of One Health – human, animal and environmental relationships – made part of the cultures and spiritual beliefs of several ancient civilizations. In the Western world, Hippocrates and Galen' (480 BC-367 BC) theory of humors assumed that human body was influenced by factors such as food, climate, ventilation, exercise, and sexual behavior[10].

Between 384 BC and 322 BC, Aristotle began researching on similarities and differences between humans and other animals[11,12]. In the seventeenth and eighteenth centuries, extensive vivisection experiments on animals were deepened for medical research and teaching in universities. During the same period, the physician Vicq d'Azyr investigated beyond comparative anatomy, developing a true form of comparative medicine[7]. Within the Americas, the Canadian William Osler furthered the concept of comparative medicine at the Montreal Colleges of Veterinary Medicine and McGill Medicine[5].

A series of discoveries occurred in the nineteenth century that would later contribute to the development of the One Health approach. In 1859, upon the publication of Darwin's theory of evolution, a number of researchers ventured to study the evolution of diseases in different animal species. Between the 1860s and 1870s, germ theories emerged, and different thoughts on germ theory appeared grounded on studies of disease spreading in animals[7].

Still in the nineteenth century, a new category of diseases emerged, leading Rudolf Virchow to create the concept of zoonoses[13]. The researcher stated that there are not and should not exist barriers between human and veterinary medicine. The object of study is different, but the knowledge obtained from studies created the grounds for the medicine as a hole[13].

Human and veterinary medicines experience important interfaces for understanding and coping with the transmission of diseases between species. However, it should be noted that their attributions do not overlap completely. A veterinarian does not carry specific knowledge to treat a human just as a physician cannot treat an animal.

William Osler (1849-1919), a Virchow' student, founded the Johns Hopkins Hospital in the United States in the nineteen century, creating the first Department of Pathology. Together with his teacher Virchow, Osler contributed to the description of the zoonoses terms so to indicate the relation between animals and humans with regard to the transmission of infectious diseases. His modern

work also contributed on cellular pathology and further the field of comparative pathology. William Osler is considered the founder of modern medicine and veterinary pathology and would later create the term 'One Medicine'. However, the term was not welcomed by the academic community[14].

The first schools of veterinary medicine were founded in Lyon (1762) and Alfort (1777), both located in France. Subsequently, veterinary schools spread throughout Europe, being the Montreal veterinary school founded in Canada in 1863[7].

The medical class contributed to the initial formation of veterinary education, making possible to conclude that veterinary schools were created from a pre-existing interest of physicians in studying animals. Thus, those professionals continued to improve their studies on animal health without, in fact, allowing for the creation of a new profession[7].

Until 1844, physicians controlled veterinary schools on the European continent. At the veterinary college in London, there was no formal separation between the professions: some physicians were also graduated as veterinarians, and both professionals could take classes at medical and veterinary schools. After that period, the veterinarians took control of the school and decided for the institutional separation between the two professions[7].

Another important institutional milestone was the development of the veterinary public health field (VPH). In 1947, the former Center for Disease Control – now the Center for Disease Control and Prevention (CDC) – created the Division of Veterinary Public Health at the Pan American Health Organization (PAHO), when the veterinary medicine discipline began to collaborate with human medicine in the control of zoonoses, focusing mainly on rabies (*Lyssavirus spp*) control[15]. During the first ten years of WHO' existence, the importance of HPV in the fight against zoonoses such as rabies, brucellosis, leptospirosis, bovine tuberculosis and others was already a subject[16].

In the mid-twentieth century, Calvin Schwabe revitalized the term One Medicine in his book Veterinary Medicine and Human Health, when he affirmed the need to treat, prevent and control infectious diseases in humans and animals[13]. Subsequently, the concept of one single world – One World – emerged in debates on international relations and in the formation of the United Nations Scientific and Cultural Organization (UNESCO)[17]. The concept was carried forward in the 1990s in the midst of the HIV pandemic[18].

The One Health approach emerged recently, in the twenty-first century, in response to the increasing environmental changes associated with the population growth and its production activities[5]. Activities such as the production of animal origin food represent a complex and profound interface between humans, animals and the environment, contributing to the emergence of diseases[19]. The approach is also a product of the coalition between public health agendas and stakeholders, having its roots in the various tendencies of veterinary thought and the practices of those professionals[7].

A symposium of the Wildlife Conservation Society took place in 2004. One of its results was the publication of the report 'Manhatam Principles on One World, One Health'[13,20,21]. The merger between One Medicine and One Medicine One Health (OWOH) agendas led to the creation of the term One Health[7], which began to be disseminated over time in international meetings, symposia, publications, university programs, research projects, and public health strategies[5].

The One Health approach is currently adopted by several institutions around the world. In 2007, the American Veterinary Medical Association (AVMA) created the One Health Initiative Task Force (OHITF) with the aim of facilitating cooperation and collaboration between academics from different institutions, government agencies, and industries to evaluate forms of treatment and prevention of communicable diseases[4].

Subsequently, the approach gained prominence and began to be recommended as a political strategy being adopted by the WHO, Food and Agriculture Organization of the United Nations (FAO), World Organisation for Animal Health (WOAH, founded as OIE) tripartite in the fight against avian influenza[13,22]. In 2009, the CDC created a One Health office so to keep contact with international organizations of animal health, support public health researchers, and exchange information with researchers from various disciplines and sectors[13].

After COVID-19, the need for the One Health approach became even more evident. In 2021, the High-Level Panel of Experts on One Health was created. It is a group of global experts selected by the FAO, the United Nations Environment Programme (UNEP), WOAH, WHO. Several new instruments have been created by the United Nations quadripartite organizations, including the Joint Action Plan on One Health (OHJPA)[23].

The expectation of this Plan would be to support prevention, prediction, detection and response to health threats and to improve the health of people, animals and the environment, as well as to contribute to sustainable development. The OHJPA is built on six interdependent lines of action that collectively contribute to achieving sustainable health and food systems, reducing global health threats, and improving ecosystem management.

The objective of Action line 5 is to control the silent pandemic of bacterial resistance (AMR-Bacteria). It can be suggested that most definitions of One Health mention a collaborative effort among multiple disciplines to achieve health for people, animals and the environment, not only for humans[4,6,8,24,25].

The One Health as an umbrella approach

Initially, the One Health approach emerges as a collaborative strategy between veterinary and human medicine limited to the control of zoonotic diseases. Human and veterinary medicine agree that global health is facing new challenges arising from a wide variety of interrelated diseases[9,15]. New challenges require different perspectives of interpretation, both to understand the emergence and spread of diseases and to develop and implement coping strategies.

One Health is a product of the twenty-first century and is part of research and political agendas developed collectively to respond to contemporary problems: food security, biosecurity, environmental pollution and scarcity of resources[26,27], in addition to re-emerging zoonotic epidemics and pandemics, neglected zoonotic diseases, and antimicrobial resistance[8,23].

One Health as a holistic, transdisciplinary approach, situated between the natural and social sciences, understands that the construction of knowledge to define the health problem and the development of coping strategies is achieved jointly by different stakeholders[28]. Currently, the approach is a large umbrella that encompasses several integrative approaches to health and its various interconnected components[28], such as planetary health, ecosystem health[8], global health and public health, animal health[29] and EcoHealth[30], whose researches on how social, economic and environmental activities impact the health of living beings[31].

Understood as a biocultural phenomenon that considers infectious diseases as products of social relations[32], One Health is based on the assumption that diseases should be analyzed from the dynamics between animals and humans within a shared environment[6,33], intending to identify the impact of that relation in a social, cultural, technological, economic and political context[32].

In the case of infectious diseases, the understanding of dynamics among humans, animals and the environment enables to measure the impact of changes caused by humans on the development and transmission of infectious diseases[30]. So, we can understand the risks of an infection by identifying the processes that result in its occurrence, the recurrence

of infectious agents and the spread among species, and extinction of their natural habitats[30].

Epidemics and pandemics throughout human history have shown the importance of the relation among human beings, animals, and the environment[34]. The bubonic plague in the Middle Ages and later in Latin America in 1899, the Severe Acute Respiratory Syndrome (SARS) in 2003, the avian influenza, the H5N1 in 2004, and, currently, the COVID-19[6]. These and other diseases show us that we live in a complex and interrelated system. A change in one location can impact on all living organisms. So, to avoid the deleterious consequences, we must learn to live in harmony[34].

Several studies have applied, in practice, the concept of One Health. For example, Kahn et al.[35] described the Nipah Virus dissemination process in Malaysia among bats, production pigs and humans. The authors stated that the clearing of fruit bat habitat to expand the pig production system caused vector bats to migrate in search of food to fruit trees near to pig farms production.

However, rabies was one of the first diseases whose control efforts were addressed by different disciplines. The National Rabies Program was created in Brazil in 1973 by means of an agreement between the Ministries of Health and Agriculture. Since its inception, it has developed integrated actions through access to free Post-Exposure Prophylaxis (PEP) for people at risk, canine vaccination campaigns, a joint integrated surveillance system involving human, domestic and wild animals, and risk awareness.

Recent study in Brazil focusing on One Health also demonstrated the reduction to zero cases of human rabies caused by dogs through the actions described above as the association of rabies cases with high temperatures, which is a concern with climate change[36]. Cleaveland et al.[37] also addressed the need for integration between professional and governmental institutions of human and animal health in the development of strategies to fight against rabies, including the sharing of information between sectors and the improvement of diagnostic laboratories for the disease[37]. The authors discussed the use of the One Health concept in the fight against rabies in dogs and humans.

Schneider et al.[38] aimed to understand the occurrence of leptospirosis in the central region of Rio Grande do Sul State. The results indicated a possible relation between rice, tobacco and cattle production systems, the environment as an ecoregion and the type of soil and social conditions with the number of leptospirosis cases in humans. The researchers concluded the evidence could be used in the elaboration of an intersectoral plan to face the problem.

The One Health and the fight against bacterial resistance to antibiotics

AMR-Bacteria is currently one of the main issues discussed on the One Health agenda and is intrinsically linked to zoonoses[39] and food security[21]. Anthropogenic activities contribute to the spread of AMR-Bacteria[39]. Among these activities grows the demand for food of animal origin, which is largely intensively produced and follows a globalized distribution chain system[40].

The intensification of animal production eases the transmission of diseases due to the increase in population and animal density[41]. In their work, Childs & Mackenzie[42] discuss the possibility that those animals play the role of intermediate hosts and amplifiers in the process of micro-organisms evolution that can be disseminated to humans directly or through contact with wild animals or other vectors, such as mosquitoes.

In the process of dissemination between species, bacteria can become more venomous and even develop new mechanisms of antibiotic resistance[43]. Newell et al.[40] mention that Campilobacter spp appears to have developed the ability to adapt itself to new hosts and becomes resistant to fluoroquinolone classes.

The selective pressure produced in bacteria and the development of resistance caused by the use of antibiotics are examples of how those microorganisms can develop in a short period of time[44].

Based on the concept of One Health, the study by McCubbin et al.[45] identified the commercialization of chloramphenicol for human use in animal production in Uganda. The consumption of meat containing residues of this antibiotic has a carcinogenic effect, and can promote aplastic, non-regenerative anemia in humans. As in other countries, the sale of this therapeutic class to farm animals is prohibited in Uganda. However, the work identified that individuals were acquiring the drug for animal use in pharmacies. The researchers account the misuse for the high levels of resistance (41-42%) to chloramphenicol in *Escherichia Coli* isolated from chicken meat.

The authors stated that the use of antibiotics in Uganda is not limited to species or sectors, being the main causes the lack of awareness about the adverse effects that the misuse of chloramphenicol can cause to human health, as well as the failure to implement regulatory policies. They recommended not only an awareness campaign with producers and pharmacists, but also a regulatory reinforcement, prohibiting the sale of antibiotics in pharmacies for application in the animal production sector.

It should be noted that the relation between human activities and AMR-Bacteria has not yet been fully elucidated[44]. Distinguishing the effects caused by anthropogenic activities and natural events remains a challenge[46]. It is not yet possible to measure the rate of AMR-Bacteria transfer from animals to humans, besides the fact that AMR-Bacteria diversity is not always interconnected with animal production[44].

Despite the gaps, it should be taken into account that the knowledge about the human-animal-environment relation over AMR-Bacteria continues to be built, and that the evidence collected so far shows that AMR-Bacteria is a multifactorial problem that requires the intervention of several sectors of the society. The solution to the problem goes beyond implementing actions in the agricultural sector, which does not mean that the sector should be innate before the challenge imposed by AMR-Bacteria. On the contrary, the accumulated knowledge is sufficient to implement coping strategies in the sector and contribute jointly with human medicine in tackling the problem.

Since the agricultural sector is a key link in the fight against AMR-Bacteria and other health problems, we must identify the barriers that prevent the integration of the sector with public health and other fields of knowledge.

Destoumieux-Garzón et al.[30] see as main challenge the lack of communication between different areas of knowledge: human medicine, veterinary, agronomic, environmental ecology, evolutionary sciences[30] and social sciences[47]. They also mention the lack of collaboration between stakeholders at different levels of the society such as scientists, government services, veterinarians and rural producers.

A possible solution to the obstacle would be the integration between the knowledge of those areas by means of the transdisciplinary training of different professionals and the creation of research networks at the national and international levels. Therefore, researchers would develop and share training programs, tools, and research protocols[30].

In addition to the creation of transdisciplinary research groups, the development of tools such as monitoring and surveillance systems are essential for the construction of an adequate support infrastructure for the practical implementation of the One Health approach[28]. The OHHLEP classified as critical the need for these databases[8]. The gap can be filled by means of implementing policies to collect data, secure financial resources, and provide data availability to researchers[30].

In the case of AMR-Bacteria, here limited to the field of animal production, monitoring and surveillance systems are essential for the

consumption of antibiotics; as well as for the incidence of AMR-Bacteria; for the control of antibiotic residues present in foods of animal origin; and for pharmacovigilance of antibiotics authorized for marketing.

Scientific literature recommends creating a broad and complex system that includes human and animal data[48]. Integrated models could be used to advance the emergence of zoonoses of public health importance[8]. Applied to AMR-Bacteria, that kind of System can be useful to improve the understanding of the resistance genes dissemination between humans and animals as a whole.

Min; Allen-Scott and Buntain[9] state that, as a transdisciplinary science, One Health should focus on the interaction among areas of knowledge and go beyond those boundaries, creating a new conceptual framework. The authors assert that a shared conceptual framework is essential to guide stakeholders in decision-making as to solve a specific problem[9]. Despite the potential positive effects bringing by One Health to the confrontation of public health problems, putting that approach into practice remains a challenge.

The construction of a common conceptual framework is part of the health meaning delimitation. To further health, decision-makers need a clear and well-defined understand about the concept to better reallocate the resources invested. However, there is a difficulty in finding a consensus on health meaning within One Health[29], since it deals with health of multiple species that can be evaluated not only at the individual, population and ecosystem levels[49], but also at the physical, mental, social and spiritual aspects of life. The question remains as to which of these criteria include in the concept of health in a One Health approach[29].

Lerner's critical analysis[50] discussed the possibility of using equilibrium theories as an understanding of health in the One Health approach, despite the difficulty of incorporating the ecosystem into the concept and having to consider the specificities of the different species within the animal kingdom.

Giraudoux, quoted by Destoumieux-Garzón[30], adds that it is necessary to explain the equilibrium desired for sustainable development and conservation of the planet, and that to answer the question it is essential to define and share indicators on the health of an entire ecosystem.

Lerner[50] also suggests two ways to create a universal concept of health for humans and animals. The first, 'top-down', starts from the concept of health already defined for humans and extends it to animals, and the second, 'bottom-up', tries to find a common basic level for defining health for humans and animals.

The relation established by humans with the various animal species can also be a factor to be considered in this discussion. While we treat pets as family members, other animals such as cattle, pigs and chickens are seen as a production good.

Taken this under perspective, would it be possible to include all the animals within a defined concept of health for human beings? Or even find a basic and common denominator of health for both?[50].

Questions exceed answers. So, in a way to leave the abstract field and land on the concrete one, this article proposes to adopt One Health not only as an interdisciplinary approach, but also as the concept of animal health to discuss and analyze the results. As this concept has not yet been clearly defined by the literature, here we adopt a broader view, which includes criteria such as the physical well-being of animals, their equilibrium with the environment[51], public health, and economic issues[52].

The economic factor is taken into account since the production purpose is to generate revenue, what can be harmed by an infectious outbreak provoking a loss in the herd productivity[52]. Animal welfare is also to be taken into consideration given that diseases can cause pain and suffering[53]. Still, stressful factors such as poor handling and housing conditions can predispose to infectious diseases[54]. Public health issues are central for the possibility

of zoonoses transmission to humans, as are the environmental effects for the impact that agriculture causes to the environment[52].

It is also assumed that these criteria are interdependent – and AMR-Bacteria is an example of this interdependence – since resistance is also a public health problem as impacts on production, on the environment and affects animal welfare[52].

In addition to an integration of stakeholders from different areas of knowledge, integrating stakeholders is also necessary at the various levels, e.g., producers, veterinarians, researchers, industry and government agencies. The Global Action Plan on Antimicrobial Resistance[55] is one of the several plans making part of the Joint Action Plan on One Health prepared by the United Nations quadripartite[23]. The plan provides an action framework and proposes activities that FAO, WHO, UNEP and WOAH have jointly designed to sustainably scale up the One Health approach. It aims to drive the change and transformation needed to mitigate the impact of current and future health challenges on the human-animal-plant-environment interface at the regional, national, and global levels.

AMR is one of the technical areas of joint external evaluation, which is a voluntary intersectional exercise involving national and international experts from different disciplines. It can be considered an example of how to work with the One Health approach, what many countries have already accomplished[56].

The first step towards the integration of human, animal and environmental health in Brazil was the materialization of the Interinstitutional Technical Committee on One Health. Its main objectives are to create the National Action Plan for One Health, to articulate multisectoral strategies with states and municipalities, and to support studies and research adopting the approach[57].

One-sided decisions are not effective and are viewed negatively by producers[58], who claim that public policies created by government agencies do not match the reality of the production environment[59], are bureaucratic, and lead to the loss of financial investment[58].

One Health presupposes that the construction of public policies to address health problems permeates negotiation and the continuous search for consensus among stakeholders[28]. The multilevel participation of stakeholders allows for the generation of new ideas, the identification of barriers, clarifying of information, and the promotion of concrete means for the construction of public policies that are acceptable, sustainable, and of common interest to both sectors of society, i.e., public health and agricultural sector[31].

That kind of approach requires negotiation skills and strategic planning[31]. In this regard, it is previously necessary to understand how human beings interact with animals[33] and the ecosystem[30], taking into account all the factors involved. The literature shows that there exist several driving forces related to the use of antibiotics in animal production, such as political, economic, psychological, cultural, beliefs[60], and personal values[61].

Contemporary health problems are not exclusively solved by means of technology development[47]. As an example, we cite the global anti-vaccine movement, by which the followers refused to be vaccinated against COVID-19. Applying this same line of reasoning to the AMR-Bacteria problem in the context of agriculture, it is possible to question why preventive measures such as biosecurity and animal welfare already developed are not being applied in the production environment to deliver a better quality of life for animals and, consequently, reduce the consumption of antibiotics applied in these animals?

The requirement here is not to refute the fundamental right of animals to be treated with medicines, because animal health is valued and it is understood that human health depends on the relation with other species and the environment. However, making use of Sainsbury words, quoted by Gunnarsson[51], who argues that animal health is not limited to the administration of medications: it also involves an

appropriate diet, an adequate and comfortable environment to meet the psychological needs of animals and protect them from predators and pathogenic microorganisms.

Conclusions

This essay does not intend to deplete the findings on the One Health approach, which is under continuous construction. Here, we tried to understand what its precepts are and how to apply it in a concrete way in studies on AMR-Bacteria and in the use of antibiotics in animals. Researchers wishing to put the approach into practice must create a transdisciplinary team, combine quantitative and qualitative methods, choose among data collection and analysis techniques, and involve stakeholders from different fields of knowledge and levels of society. As of One Health perspective, it is possible to better understand how human actions contribute to the dissemination of AMR-Bacteria and what are the driving forces that motivate producers and other stakeholders in the decision-making about the use of antibiotics in animal production.

Acknowledgments

We thank Professor Sian Clarke, from the London School of Hygiene and Medicine, for providing reflections and references and participating in the group of discussion that supported this text.

Collaborators

Silva RA (0000-0002-5049-9124)*: responsible for conception of the work, analysis and interpretation of the scientific literature; writing of the first draft of the article; all aspects of the work in ensuring the accuracy and completeness of any part of the work. Luiza VL (0000-0001-6245-7522)* and Bermudez JAZ (0000-0002-4657-0709)*: responsible for the relevant critical review of the intellectual content; and final approval of the version to be published. Schneider MC (0000-0001-8575-8002)*: responsible for the article writing; the relevant critical review of the intellectual content; and approval of the final version to be published. ■

References

1. World Health Organization. Antimicrobial resistance. Key Facts. WHO [Internet]; 2023 nov 21 [acesso em 2023 maio 30]. Disponível em: https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance

2. Murray AK. The Novel Coronavirus COVID-19 Outbreak: Global Implications for Antimicrobial Resistance. Front Microbiol. 2020;11:1020. DOI: https://doi.org/10.3389/fmicb.2020.01020

3. World Health Organization. Draft global action plan on antimicrobial resistance [Internet]. [local desconhecido]: WHO; 2014 [acesso em 2023 maio 30]. Disponível em: http://apps.who.int/gb/archive/

4. American Veterinary Medical Association. One health: a new professional imperative. One Health Initiative Task Force: Final Report [Internet]. [local desconhecido]: AVMA; 2008 [acesso em 2023 maio 30]. Disponível em: https://www.avma.org/sites/default/files/resources/onehealth_final.pdf

*Orcid (Open Researcher and Contributor ID).

5. Evans BR, Leighton FA. A history of One Health. Rev Sci Tech. 2014;33(2):413-20. DOI: https://doi.org/10.20506/rst.33.2.2298

6. Schneider MC, Munoz-Zanzi C, Min K-d, et al. "One Health" From Concept to Application in the Global World. In: Oxford Research Encyclopedia of Global Public Health. Oxford: Oxford University Press; 2019. DOI: https://doi.org/10.1093/acrefore/9780190632366.013.29

7. Bressalier M, Cassidy A, Woods A. One Health in History. In: Zinsstag J, Schelling E, Crump L, et al. The Theory and Practice of Integrated Health Approaches. Boston, MA, USA: CABI; 2021. v. 2 nd. p. 1-15.

8. Food and Agriculture Organization of the United Nations, World Organisation for Animal Health, United Nations Environment Programme. One Health High Level Expert Panel [Internet]. [local desconhecido]: FAO; 2021 [acesso em 2023 abr 15]. Disponível em: https://www.who.int/publications/m/item/one-health-high-level-expert-panel-annual-report-2021

9. Min B, Allen-Scott LK, Buntain B. Transdisciplinary research for complex One Health issues: a scoping review of key concepts. Prev Vet Med. 2013;112(3-4):222-229. DOI: https://doi.org/10.1016/j.prevetmed.2013.09.010

10. Wear A. Place, health, and disease: The airs, waters, places tradition in early modern England and North America. J Mediev Early Mod Stud. 2008;38(3):443-465. DOI: https://doi.org/10.1215/10829636-2008-003

11. Clutton-Brock J. Aristotle, the scale of nature, and modern attitudes to animals. Soc Res. 1995;62(3):421-440.

12. Kirk RGW, Worboys M. Medicine and Species: One Medicine, One History? Oxford: Oxford University Press; 2012.

13. Centers for Disease Control and Prevention. One health [Internet]. CDC, [local desconhecido]; 2016 [acesso em 2023 abr 15]. Disponível em: https://www.cdc.gov/onehealth/basics/history/

14. Schultz M. Rudolf virchow. Emerg Infect Dis. 2008;14(9):1480-1481. DOI: https://doi.org/10.3201/eid1409.086672

15. Schneider MC, Sciancalepore S, Polo P, et al. Saúde Única: onde a medicina humana, a medicina veterinária e as ciências ambientais se encontram. An Acad Nac Med. 2024;194(2):34-55. DOI: https://www.doi.org/10.52130/27639878-AANM2023v194n2p34-55

16. World Health Organization. The first ten years of the World Health Organization. World Health Organization. Geneve: WHO; 1958.

17. Sluga G. Unesco and the (one) world of Julian Huxley. J World Hist. 2010;21(3):393-418.

18. King NB. The Scale Politics of Emerging Diseases. Osiris. 2004;19:62-76.

19. Zinsstag J, Mackenzie JS, Jeggo M, et al. Mainstreaming one health. Ecohealth. 2012;9(2):107-110.

20. Cook RA, Karesh WB, Osofsky SA. The Manhattan Principles on 'OneWorld, One Health'. Conference summary [Internet]. New York, Bronx: Wildlife Conservation Society; 2004 [acesso em 2023 maio 30]. Disponível em: https://oneworldonehealth.org/sept2004/owoh_sept04.html

21. Gibbs EP. The evolution of One Health: a decade of progress and challenges for the future. Vet Rec. 2014;174(4):85-91. DOI: https://doi.org/10.1136/vr.g143

22. Food and Agriculture Organization of the United Nations, World Organisation for Animal Health, World Health Organization. The FAO-OIE-WHO Collaboration: Sharing responsibilities and coordinating global activities to address health risks at the animal-human-ecosystems interfaces. A tripartite concept note [Internet]. [local desconhecido]: FAO, OIE, WHO; 2010 [acesso em 2023 maio 30]. Disponível em: https://www.who.int/publications/m/item/the-fao--oie-who-collaboration

23. Food and Agriculture Organization of the United Nations, United Nations Environment Programme, World Health Organization, et al. One Health Joint Plan of Action (2022-2026): Working together for the health of humans, animals, plants and the environment. Rome: FAO, UNEP, WHO, WOAH; 2022. DOI: https://doi.org/10.4060/cc2289en

24. Kaplan B, Kahn LH, Monath TP. The brewing storm. Vet Ital. 2009;45(1):9-18.

25. King L. Combating the triple threat: The need for a One Health Approach. Microbiol Spectr. 2013;1(1). DOI: https://doi.org/10.1128/microbiolspec.oh-0012-2012

26. Cassidy A. One Medicine? Advocating (Inter) disciplinarity at the interfaces of animal health, human health, and the environment. In: Nowotny H, McBee D, Leahey E, et al. Investigating interdisciplinary collaboration: Theory and practice across disciplines. New Brunswick (NJ): Rutgers University Press; 2016.

27. Rushton S. Global Health Security: Security for whom? Security from what? Pol Stud. 2011;59(4):779-796. DOI: https://doi.org/10.1111/j.1467-9248.2011.00919.x

28. Rüegg SR, McMahon BJ, Häsler B, et al. A blueprint to evaluate One Health. Front Public Health. 2017;5:20. DOI: https://doi.org/10.3389/fpubh.2017.00020

29. Lerner H, Zinsstag J. Towards a Healthy Concept of Health. In: Zinsstag J, Schelling E, Crump L, et al. One Health: The theory and Practice of Integrated Health Approaches. Boston, MA, USA: CABI; 2021. p. 52-56. v. 2 nd.

30. Destoumieux-Garzón D, Mavingui P, Boetsch G, et al. The One Health Concept: 10 years old and a long road ahead. Front Vet Sci. 2018;5:14. DOI: https://doi.org/10.3389/fvets.2018.00014

31. Charron DF. Ecosystem approaches to health for a global sustainability agenda. Ecohealth. 2012;9(3):256-66. DOI: https://doi.org/10.1007/s10393-012-0791-5

32. Wolf M. Is there really such a thing as "one health"? Thinking about a more than human world from the perspective of cultural anthropology. Soc Sci Med. 2015;129:5-11. DOI: https://doi.org/10.1016/j.socscimed.2014.06.018

33. Wallace RG, Bergmann L, Kock R, et al. The dawn of Structural One Health: a new science tracking disease emergence along circuits of capital. Soc Sci Med. 2015;129:68-77. DOI: https://doi.org/10.1016/j.socscimed.2014.09.047

34. Schneider C, Oliveira MS. Saúde Única e a Pandemia de Covid-19. In: Buss PM, Fonseca LE. Diplomacia da saúde e Covid-19: reflexões a meio caminho. Rio de Janeiro: Ed. Fiocruz; 2020. p. 83-96.

35. Kahn HL, Monath TP, Bokma BH, et al. One Health, One Medicine. In: Aguirre AA, Ostfeld R, Daszak P, organizadores. New directions in conservation medicine: applied cases of ecological health. Oxford; New York: Oxford University Press; 2012.

36. Schneider MC, Min KD, Romijn PC, et al. Fifty Years of the National Rabies Control Program in Brazil under the One Health Perspective. Pathogens. 2023;12(11):1342. DOI: https://doi.org/10.3390/pathogens12111342

37. Cleaveland S, Lankester F, Townsend S, et al. Rabies control and elimination: a test case for One Health. Vet Rec. 2014;175(8):188-93. DOI: https://doi.org/10.1136/vr.g4996

38. Schneider MC, Najera P, Pereira MM, et al. Leptospirosis in Rio Grande do Sul, Brazil: An Ecosystem Approach in the Animal-Human Interface. PLoS Negl Trop Dis. 201512;9(11):e0004095. DOI: https://doi.org/10.1371/journal.pntd.0004095

39. Kim DW, Cha CJ. Antibiotic resistome from the One-Health perspective: understanding and controlling antimicrobial resistance transmission. Exp Mol Med. 2021;53(3):301-309. DOI: https://doi.org/10.1038/s12276-021-00569-z

40. Newell DG, Koopmans M, Verhoef L, et al. Food-borne diseases - the challenges of 20 years ago still persist while new ones continue to emerge. Int J Food Microbiol. 2010;139(supl1):S3-15. DOI: https://doi.org/10.1016/j.ijfoodmicro.2010.01.021

41. Graham JP, Leibler JH, Price LB, et al. The animal-human interface and infectious disease in industrial food animal production: rethinking biosecurity and biocontainment. Public Health Rep. 2008;123(3):282-99. DOI: https://doi.org/10.1177/003335490812300309

42. Childs JE, Richt JA, Mackenzie JS. Introduction: Conceptualizing and Partitioning the Emergence Process of Zoonotic Viruses from Wildlife to Humans. In: Childs JE, Mackenzie JS, Richt JA, organizadores. Wildlife and emerging zoonotic diseases: The biology, circumstances and consequences of cross-species transmission. Current Topics in Microbiology and Immunology. Berlin, Heidelberg: Springer Berlin; Heidelberg; 2007. p. 1-31.

43. Jones BA, Grace D, Kock R, et al. Zoonosis emergence linked to agricultural intensification and environmental change. Proc Natl Acad Sci. 2013;110(21):8399-8404. DOI: https://doi.org/10.1073/pnas.1208059110

44. Karesh WB, Dobson A, Lloyd-Smith JO, et al. Ecology of zoonoses: natural and unnatural histories. Lancet. 2012;380(9857):1936-45. DOI: https://doi.org/10.1016/s0140-6736(12)61678-x

45. McCubin KD, Ramatowski JW, Buregyeya E, et al. Unsafe "crossover-use" of chloramphenicol in Uganda: Importance of a One Health approach in antimicrobial resistance policy and regulatory action. J Antibiot. 2021;74(6):417-420. DOI: https://doi.org/10.1038/s41429-021-00416-3

46. Rapport DJ, Costanza R, McMichael AJ. Assessing ecosystem health. Trends Ecol Evol. 1998 Oct 1;13(10):397-402. DOI: https://doi.org/10.1016/s0169-5347(98)01449-9

47. Barnett T, Pfeiffer DU, Hoque MA. et al. Practising co-production and interdisciplinarity: Challenges and implications for one health research. Preventive Veterinary Medicine. 2020;177:104949. DOI: https://doi.org/10.1016/j.prevetmed.2020.104949

48. Haworth-Brockman M, Saxinger LM, Miazga-Rodriguez M, et al. One Health evaluation of antimicrobial use and resistance surveillance: A novel tool for evaluating integrated, One Health antimicrobial resistance and antimicrobial use surveillance programs. Front Public Health. 2021;9:693703. DOI: https://doi.org/10.3389/fpubh.2021.693703

49. Lerner H, Berg C. The concept of health in One Health and some practical implications for research and education: what is One Health? Infect Ecol Epidemiol. 2015;5:25300. DOI: https://doi.org/10.3402/iee.v5.25300

50. Lerner H. A critical analysis of definitions of health as balance in a One Health perspective. Med Health Care Philos. 2019 Sep;22(3):453-461. DOI: https://doi.org/10.1007/s11019-018-09884-1

51. Gunnarsson S. The conceptualisation of health and disease in veterinary medicine. Acta Vet Scand. 2006;48(1):20. DOI: https://doi.org/10.1186/1751-0147-48-20

52. Ducrot C, Bed'hom B, Béringue V, et al. Issues and special features of animal health research. Vet Res. 2011;42(1):96. DOI: https://doi.org/10.1186/1297-9716-42-96

53. Botreay R, Veissier I, Butterworth A, et al. Definition of criteria for overall assessment of animal welfare. Animal welfare. 2007;16(2):225-228.

54. Albernaz-Gonçalves R, Olmos Antillón G, Hötzel MJ. Linking Animal Welfare and Antibiotic Use in Pig Farming—A Review. Animals (Basel). 2022;12(2):216. DOI: https://doi.org/10.3390/ani12020216

55. World Health Organization. Global action plan on antimicrobial resistance [Internet]. Geneva: WHO; 2015 [acesso em 2023 maio 30]. Disponível em: https://www.who.int/publications/i/item/9789241509763

56. World Health Organization. Joint External Evaluation (JEE). Portal [Internet]. WHO [local desconhecido]; 2023 [acesso em 2023 maio 30]. Disponível em: https://extranet.who.int/sph/jee

57. Ekakoro JE, Caldwell M, Strand EB, et al. Perceptions of Tennessee cattle producers regarding the Veterinary Feed Directive. PLoS One. 2019;14(5):e0217773. DOI: https://doi.org/10.1371/journal.pone.0217773

58. Ministério da Saúde (BR). Lançamento do Comitê Uma Só Saúde marca nova era para a saúde pública no Brasil. Gov.br [Internet]; 2024 [acesso em 2023 maio 30]. Disponível em: https://www.gov.br/saude/pt-br/assuntos/noticias/2024/agosto/lancamento-do-comite-uma-so-saude-marca-nova-era-para-a-saude-publica-no-brasil

59. Garforth C. Livestock keepers' reasons for doing and not doing things which governments, vets and scientists would like them to do. Zoonoses Public Health. 2015;62(supl1):29-38. DOI: https://doi.org/10.1111/zph.12189

60. Chambers JA, Crumlish M, Comerford DA, et al. Antimicrobial resistance in humans and animals: Rapid review of psychological and behavioral determinants. Antibiotics (Basel). 2020;9(6):285. DOI: https://doi.org/10.3390/antibiotics9060285

61. Redding LE, Brooks C, Georgakakos CB, et al. Addressing Individual Values to Impact Prudent Antimicrobial Prescribing in Animal Agriculture. Front Vet Sci. 2020;7:297. DOI : https://doi.org/10.3389/fvets.2020.00297

Received on 08/08/2024
Approved on 11/11/2024
Conflict of interest: non-existent
Financial support: This work was carried on as part of a doctoral thesis in the Graduate Program in Public Health (PPGSP) of the Sergio Arouca National School of Public Health (ENSP), supported by a scholarship from the National Council for Scientific and Technological Development (CNPQ), and financed by PPGSP/ENSP

Editor in charge: Lenaura de Vasconcelos Costa Lobato