DISSEMINATION OF ANTIBIOTIC-RESISTANT BACTERIA IN AQUATIC ENVIRONMENTS AND ITS IMPACTS ON PUBLIC HEALTH

DISSEMINAÇÃO DE BACTÉRIAS RESISTENTES A ANTIBIÓTICOS EM AMBIENTES AQUÁTICOS E SEUS IMPACTOS NA SAÚDE PÚBLICA

DISEMINACIÓN DE BACTERIAS RESISTENTES A LOS ANTIBIÓTICOS EN AMBIENTES ACUÁTICOS Y SUS IMPACTOS EN LA SALUD PÚBLICA

10.56238/IXSevenInternationalMultidisciplinaryCongress-001

José Mykael da Silva Santos[1], Lucas Assis Lourenço[2], Lucas Dantas Campêlo[3], Lucas Nathan Ferreira da Silva[4], Rawenhya Elamaissa Ferreira Rodrigues Amorim[5], Amanda Luísa Teixeira Leite[6], Bruno Henrique Resende Bezerra[7], Micaely Felix Lacerda[8], Victor Emannuel Dias Félix Paulino[9]

ABSTRACT

Bacterial resistance is a major public health concern, intensified by the presence of resistant microorganisms in aquatic environments. This qualitative study, based on a literature review, analyzed the dissemination of these bacteria in water. It was observed that sewage, hospital effluents, and antibiotic residues promote the selection and spread of resistance genes. Furthermore, human exposure to contaminated water may result in infections that are difficult to treat. It is concluded that integrated actions are necessary, including adequate sanitation and the rational use of antimicrobials, to mitigate this problem.

Keywords: Resistance Genes. Water Quality. Public Health.

RESUMO

A resistência bacteriana é uma importante preocupação de saúde pública, intensificada pela presença de microrganismos resistentes em ambientes aquáticos. Este estudo qualitativo, baseado em uma revisão da literatura, analisou a disseminação dessas bactérias na água. Observou-se que o esgoto, os efluentes hospitalares e os resíduos de antibióticos promovem a seleção e a disseminação de genes de resistência. Além disso, a exposição humana à

[1] Veterinary Doctor. Centro Universitário de Patos (UNIFIP). E-mail: josemykael@fiponline.edu.br
Orcid: https://orcid.org/0009-0006-1830-8494
[2] Veterinary Doctor. Centro Universitário de Patos (UNIFIP). E-mail: lucaslourenncofnsr@hotmail.com
Orcid: https://orcid.org/0009-0009-1745-6745
[3] Veterinary Medicine Student. Centro Universitário de Patos (UNIFIP).
E-mail: lucascampelo2703@icloud.com
[4] Veterinary Medicine Student. Centro Universitário de Patos (UNIFIP).
E-mail: lucassilva@medvet.fiponline.edu.br
[5] Veterinary Medicine Student. Centro Universitário de Patos (UNIFIP).
E-mail: rawenhyarodrigues1@medvet.fiponline.edu.br
[6] Veterinary Doctor. Centro Universitário de Patos (UNIFIP). E-mail: amanda34luisa@gmail.com
[7] Veterinary Doctor. Centro Universitário de Patos (UNIFIP). E-mail: brunohenrique_sbpb@hotmail.com
[8] Veterinary Doctor. Centro Universitário de Patos (UNIFIP). E-mail: lacerdamica@hotmail.com
[9] Veterinary Doctor. Centro Universitário de Patos (UNIFIP). E-mail: emanoelvictorfelix@gmail.com

água contaminada pode resultar em infecções de difícil tratamento. Conclui-se que são necessárias ações integradas, incluindo saneamento adequado e o uso racional de antimicrobianos, para mitigar esse problema.

Palavras-chave: Genes de Resistência. Qualidade da Água. Saúde Pública.

RESUMEN
La resistencia bacteriana es una importante preocupación de salud pública, intensificada por la presencia de microorganismos resistentes en ambientes acuáticos. Este estudio cualitativo, basado en una revisión de la literatura, analizó la diseminación de estas bacterias en el agua. Se observó que las aguas residuales, los efluentes hospitalarios y los residuos de antibióticos promueven la selección y la propagación de genes de resistencia. Además, la exposición humana al agua contaminada puede resultar en infecciones difíciles de tratar. Se concluye que son necesarias acciones integradas, incluyendo un saneamiento adecuado y el uso racional de antimicrobianos, para mitigar este problema.

Palabras clave: Genes de Resistencia. Calidad del Agua. Salud Pública.

1 INTRODUCTION

Bacterial resistance to antibiotics represents one of the greatest contemporary challenges to global public health, being associated with increased morbidity and mortality, as well as reduced therapeutic effectiveness of previously treatable infections. This phenomenon primarily results from the selective pressure exerted by the indiscriminate use of antimicrobials, favoring the survival and dissemination of resistant microorganisms (Troncoso; Alencar, 2020).

Traditionally associated with hospital settings, bacterial resistance is now also understood from an environmental perspective, especially in the context of aquatic environments. Rivers, lakes, reservoirs, and wastewater have been recognized as important reservoirs of resistant bacteria and resistance genes, acting as pathways for the dissemination of these microorganisms. In addition, water serves as a receptor for contaminants derived from human activities, including pharmaceutical residues, hospital effluents, and domestic sewage (Rodríguez; Quiceno, 2023).

In Brazil, there is a significant presence of resistant bacteria in aquatic environments, particularly Gram-negative species such as Aeromonas spp., frequently associated with water contamination. This scenario becomes even more concerning in regions with limited sanitation infrastructure, where water is directly used for consumption or productive activities (Nascimento; Araújo, 2014).

In this context, it is essential to understand the role of aquatic environments in the dissemination of bacterial resistance, as well as its impacts on human health, under the integrated perspective of the “One Health” approach, which considers the interdependence between human, animal, and environmental health.

2 METHODOLOGY

This is a qualitative literature review study conducted based on scientific articles published in national and international databases, such as SciELO, PubMed, Google Scholar, and indexed journals. The descriptors used included “bacterial resistance,” “aquatic environments,” “antibiotics,” and “public health,” along with their English equivalents. Inclusion criteria comprised full-text articles available in Portuguese, English, or Spanish that addressed the relationship between bacterial resistance and water. Duplicate studies or those not directly related to the topic were excluded. Data analysis was performed in a descriptive and interpretative manner, allowing the organization of information into thematic categories.

2.1 AQUATIC ENVIRONMENTS AS RESERVOIRS OF BACTERIAL RESISTANCE

Aquatic environments are recognized as natural habitats for a wide diversity of microorganisms, including potentially pathogenic bacteria. However, increasing contamination of these environments by anthropogenic residues has contributed to the rise in bacterial resistance. Water acts as an important medium for the accumulation and dissemination of resistant bacteria and resistance genes (Rodríguez; Quiceno, 2023).

There is a significant presence of resistant bacteria in freshwater, especially in areas impacted by human activities such as aquaculture and effluent discharge. These microorganisms exhibit resistance to several antimicrobials, including ampicillin, tetracycline, and sulfonamides (Nascimento; Araújo, 2014).

2.2 SOURCES OF WATER CONTAMINATION

Several sources contribute to the introduction of resistant bacteria into aquatic environments. Among the main ones are: untreated domestic sewage, which carries microorganisms from human microbiota; hospital effluents, rich in antibiotics and multidrug-resistant bacteria; indiscriminate use of antibiotics in medicine and agriculture, which promotes the selection of resistant strains; and pharmaceutical residues, often improperly discarded. These factors contribute to the continuous presence of antimicrobials in the environment, creating ideal conditions for the selection and maintenance of bacterial resistance (Rodríguez; Quiceno, 2023; Dickmann; Dalmagro, 2025).

2.3 MECHANISMS OF RESISTANCE AND DISSEMINATION

Bacterial resistance may occur through intrinsic or acquired mechanisms, including genetic mutations and horizontal gene transfer via elements such as plasmids and transposons. In aquatic environments, the proximity among different bacterial species favors this genetic exchange, enhancing the dissemination of resistance. Moreover, the presence of sublethal concentrations of antibiotics in water intensifies selective pressure, allowing resistant bacteria to survive and proliferate (Abrantes; Nogueira, 2021).

2.4 IMPACTS ON PUBLIC HEALTH

The dissemination of resistant bacteria in aquatic environments poses a significant risk to human health. Contact with contaminated water whether through consumption, recreation, or domestic use may lead to colonization or infection by resistant microorganisms. This situation complicates the treatment of infections, increases hospital stay duration, and raises healthcare costs. Additionally, there is a risk of community spread of these bacteria,

extending the problem beyond hospital settings. Antimicrobial resistance is already considered a global threat, with the potential to cause millions of deaths in the coming decades if effective measures are not implemented (Troncoso; Alencar, 2020).

3 LIMITATIONS IN WATER TREATMENT AND FUTURE PERSPECTIVES

Although water treatment plants play a fundamental role in removing contaminants, they are not always effective in completely eliminating resistant bacteria and resistance genes. This highlights the need to improve treatment technologies and water quality monitoring. In this context, the “One Health” approach emerges as an essential strategy, integrating environmental surveillance, antibiotic use control, and public policies aimed at improving sanitation (Rodríguez; Quiceno, 2023).

4 CONCLUSION

Bacterial resistance in aquatic environments is a complex and growing problem, directly related to human activities and inadequate waste management. Its impacts on public health are significant, requiring integrated actions involving the rational use of antibiotics, investments in basic sanitation, and the development of more efficient water treatment technologies. Therefore, the adoption of public policies and interdisciplinary strategies that consider the interrelationship between environmental, human, and animal health is essential for the effective control of bacterial resistance.

REFERENCES

Abrantes, J. A., & Nogueira, J. M. R. (2021). Bacterial resistance to antimicrobials: a review of the main species involved in infectious processes. Brazilian Journal of Clinical Analyses, 53(3), 219–223. Disponível em: https://www.researchgate.net/publication/359540957

Dickmann, L., & Dalmagro, A. P. (2025). Antimicrobial resistance from a One Health perspective: an integrative literature review. Amazônia: Science & Health, 13(4), 116–130. Disponível em: https://ojs.unirg.edu.br/index.php/2/article/view/6072

Nascimento, E. D., & Araújo, M. F. F. (2014). Antimicrobial resistance in bacteria isolated from aquatic environments in Brazil: a systematic review. Environment & Water Journal, 9(2), 239–249. Disponível em: https://www.scielo.br/j/ambiagua/a/r5rcKwtCt8jSFcNkmvzyv3J/

Rodríguez, E. A., & Quiceno, J. N. J. (2023). Antibiotic resistance in aquatic environments: origin and implications for public health. Faculty National Journal of Public Health, 41(3), 1–12. Disponível em: https://pesquisa.bvsalud.org/bvsms/resource/pt/biblio-1535274

Troncoso, A. T., & Alencar, G. A. B. C. (2020). Current perspectives on bacterial resistance: a literature review. Journal of the Faculty of Medicine of Teresópolis, 4(1), 22–31. Disponível em: https://revista.unifeso.edu.br/index.php/faculdadedemedicinadeteresopolis/article/view/2233