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The impact of antibiotics on the environment and human body

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Abstract. Antibiotics, as a typical new pollutant in environmental media, have important implications for the treatment of water sources, soil, livestock, and humans. This article summarizes the effects of antibiotics on sewage, water sources, soil, water circulation, and plankton in the water, as well as the underlying reasons, by analyzing and summarizing other papers. It also provides analysis and solutions for antibiotics. Not only that, this article also reviews the reasons for the excessive use of antibiotics in clinical treatment and the impact of antibiotic resistance on clinical treatment. It also reviews the emergence and treatment of antibiotic resistance in the human body. Through the above plan, this article summarizes the impact of antibiotics on the environment and the human body.

Keywords: Antibiotic, Environment, Clinical Antibiotic Treatment, Antibiotic Resistance.

1. Introduction

Antibiotics, as a new pollutant, are the main environmental destination of antibiotics in watershed water environments. There are various types of antibiotics, with low concentrations in aquatic environments and matrix interference, which can cause separation and enrichment problems. At the same time, there are also high concentrations of antibiotics in sewage. Meanwhile, plankton are very sensitive to environmental changes. Antibiotics in water also have an impact on plankton.

The abuse of antibiotics continuously releases them into the environment, and most antibiotics have strong polarity, hydrophilicity, and weak volatility. They can easily diffuse through various environmental media in soil, water bodies, and sediments, resulting in pollution of livestock, poultry, aquatic products, water bodies, and soil. In addition, antibiotics can promote the generation, transmission, and formation of antibiotic-resistant bacterial communities in organisms, thereby posing a threat to the ecological safety of the water environment and human health. Antibiotics in the aquatic environment mainly come from domestic sewage, wastewater from animal husbandry and aquaculture, industrial wastewater from pharmaceutical enterprises, and medical wastewater from hospitals [1].

Antibiotics are widely used in the treatment of human diseases, animal husbandry, and aquaculture, leading to the accumulation of antibiotics in the environment. Although antibiotics have a short half-life, due to the increase in antibiotic usage and low bioavailability, the risk of antibiotic contamination of the environment also increases. Due to the difference from other pollutants in the water environment, antibiotics can directly act on microorganisms, leading to a decrease in the biological treatment efficiency of sewage treatment plants. This not only affects the content of pollutants in the environment, leading to serious environmental pollution events but also induces the generation of drug-resistant bacteria when a large number of antibiotics are discharged into the water body, which can pose a threat

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to human and animal health in severe cases. The concentration of antibiotics in different sewage treatment plants varies depending on the environment and geographical region they are located [2].

2. Existence and Risk of Antibiotics

Antibiotics in aquatic environments exhibit characteristics such as a wide detection range, multiple detection types, and significant differences in abundance. Multiple types of antibiotics are commonly detected in rivers, mainly including macrolides, tetracyclines, sulfonamides, fluoroquinolones, and so on β- There are dozens of specific types of lactams. Among them, China generally has a high level of antibiotics for cyclic esters, tetracyclines, and sulfonamides. The abundance of antibiotics in the aquatic environment is also related to their chemical properties, such as β- The dosage of lactam antibiotics is relatively high, ranking second among all antibiotics, but they are more easily hydrolyzed. Drug resistance genes in watershed water environments may be transmitted to the human body through exposure pathways such as drinking water and swimming, resulting in potential health hazards. Studies have found identical strains of bacteria carrying the same resistance genes in the human gut and drinking water, providing direct evidence for the transmission of resistance genes to humans in watershed water environments. Antibiotics can promote the spread of resistance genes in a single medium or even across media [3].

There are problems with the current application of chemical risk assessment methods to antibiotics. The risk assessment of traditional chemical pollutants is mainly based on the persistence, bioaccumulation, and toxicity of pollutants. However, compared to other pollutants, the persistence, aquatic toxicity, and bioaccumulation of antibiotics are relatively low. Correspondingly, the risk threshold (predicted ineffective concentration) evaluated by the P-B-T method is generally at the mg/L level, which is significantly higher than the actual abundance of antibiotics in the watershed water environment (ng/L)~ μ G/L). So, we need an innovative method that takes bacterial resistance as the core assessment module, studies the dose-effect relationship between antibiotic exposure and bacterial resistance at different levels such as genes, cells, populations, and communities, and establishes a multi-indicator risk assessment system for antibiotics in a watershed water environment [3]. Phytoplankton is an important primary producer in aquatic ecosystems and plays an important role in maintaining the stability of aquatic ecosystems. Antibiotics can be absorbed by phytoplankton, affecting their physiological and morphological characteristics, and further altering the rate of algal population proliferation. Firstly, antibiotics can inhibit the photosynthesis of algae cells by interfering with the synthesis of proteins and chlorophyll a. Secondly, antibiotics can also affect the synthesis of chlorophyll-a in algal cells, producing a "low promotion and high inhibition" effect on photosynthesis in algal cells. In addition, antibiotics can also interfere with the energy metabolism process of algae cells, affecting their carbohydrate content. As primary consumers of the aquatic food chain, zooplankton often feed on bacteria, debris, and phytoplankton, and are preyed upon by upper trophic species. They play a crucial role in the material cycle and energy transfer processes of the ecosystem. Under the influence of antibiotics, the physiological, behavioral, filtration efficiency, and life history characteristics of zooplankton may be affected, ultimately affecting the population and community characteristics of zooplankton [4].

Due to the excessive use of antibiotics in medicine, aquaculture, agriculture and other fields in human society, antibiotic resistance is rapidly spreading globally, posing a huge crisis to ecological environment security and human health. This section discusses the biological transmission of antibiotic resistance in the ecological environment and the related factors of antibiotic resistance transmission in environmental transmission. Antibiotic resistance is a natural phenomenon encoded by microbial resistance genes and is a product of billions of years of microbial evolution. The mechanisms of antibiotic resistance can be classified into four categories: limiting antibiotic uptake, modifying antibiotic targets, causing antibiotic inactivation, and antibiotic efflux [5].

High concentrations of antibiotics in hospital clinical disease treatment provide excellent conditions for the development of drug resistance, making hospitals another storage and transmission hotspot. Agricultural antibiotics are used to promote plant growth and control crop diseases and pests, increasing antibiotic resistance in agricultural soil and becoming a hot topic for the spread and storage of antibiotic resistance in the environment [5].

3. The Effect of Antibiotic Residues in Soil on Nitrogen Biotransformation

The residual antibiotics in the soil can interfere with and alter the composition, structure, and function of soil microbial communities, thereby affecting the microbial-driven geochemical cycling process and threatening the safety of soil ecosystems. The continuous accumulation of antibiotics in the soil has varying degrees of impact on nitrogen conversion processes such as nitrogen fixation, nitrification, and denitrification [6].

3.1. Effect of Antibiotics on Soil Nitrogen Transformation

After antibiotic veterinary drugs or feed additives enter livestock, most unmetabolized antibiotics will enter the soil environment in large quantities through livestock excreta. In agricultural ecosystems, antibiotics mainly enter the soil through manure; In grassland ecosystems, antibiotics in the soil environment mainly come from the feces and urine of grazing livestock. The residue of antibiotics in the soil environment can affect soil microorganisms, thereby affecting the nitrogen conversion process driven by microorganisms. Among them, the most studied effects are on biological nitrogen fixation, nitrification, and denitrification [6].

3.2. Impact of Antibiotics on Biological Nitrogen Fixation

In soil ecosystems, there are generally multiple antibiotics present at the same time, and the effects of different antibiotics on nitrogen fixation are not consistent. However, as the cultivation experiment progresses, the metabolites produced by antibiotic decomposition accumulate toxins. For example, the natural decomposition of oxytetracycline is very strong, resulting in the production of a more toxic metabolite - differential oxytetracycline. In summary, the interference of antibiotics in soil on nitrogen fixation is influenced by factors such as antibiotic concentration, antibiotic type, and exposure time, and the pattern is not clear [6].

3.3. Effect of Antibiotics on Soil Nitrification

Due to the inhibitory effect of antibiotics on bacteria, antibiotics at most experimental concentrations inhibit soil nitrification driven by bacteria. In addition, a large number of studies have found that the effect of antibiotics on nitrification has a characteristic of "low promotion and high inhibition". Overall, antibiotics in the soil can inhibit nitrification at experimental concentrations, but the inhibitory effect is not constant. There is a phenomenon of "low promoting high inhibiting" as the concentration of antibiotics in the soil changes [6].

3.4. Analysis of the Mechanism of Antibiotics Affecting Soil Nitrogen Transformation

Antibiotics differentially inhibit the growth of soil microorganisms in the soil, thereby affecting the composition of soil microbial communities and microbial-mediated soil processes, leading to changes in soil ecological functions. Different antibiotics have different mechanisms for inhibiting microbial growth, such as macrolides and tetracyclines, which can prevent protein synthesis and prevent bacteria from synthesizing nutrients [6].

4. The use and treatment of antibiotics in the human body

Antibiotics are a type of substance that can disrupt cell development and exert antibacterial and bactericidal effects. In recent years, with the progress and development of medical technology, new types of antibiotic drugs have been continuously increasing, which has increased the risk of antibiotic abuse, leading to a series of serious problems such as increased bacterial resistance, increased adverse reactions, and waste of drug resources, endangering the physical and mental health of patients [7].

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4.1. Human Health Risks of Antibiotics

The excessive use or even abuse of antibiotics leads to the growth of drug-resistant bacteria and even multidrug-resistant bacteria, reducing the current efficacy of antibiotics, increasing the risk of infection or inflammation, and may even endanger human life Antibiotics may lead to various adverse health outcomes such as drug resistance, obesity/overweight, abnormal blood sugar, nephrotoxicity, neurological diseases, allergic diseases, etc. First, antibiotic resentence Lack of safety awareness and imperfect management systems in performance rewards can lead to unreasonable antibiotic prescriptions in hospitals or outpatient clinics, further leading to the overuse or even abuse of antibiotics Especially in the context of the current prevalence of COVID-19, antibiotics are frequently used in patients with COVID-19 infection, and the use of antibiotics in the general population is also on the rise, which is also one of the important reasons for the increase in the incidence of drug-resistant bacterial infections in our population in recent years In addition, antibiotics in food and the environment can enter the human body through the food chain, leading to the accumulation of antibiotics in the body. Second, nervous system disease. The imbalance of gut microbiota caused by antibiotics can further cause neurological diseases such as depression, anxiety, insomnia, etc Studies have shown that repeated administration of ciprofloxacin in rats can lead to neurological toxicity, with changes in brain neurotransmitter levels and oxidative stress being potential mechanisms for ciprofloxacin induced neurotoxicity. The correlation between antibiotic exposure and neurological diseases has also been confirmed in epidemiological studies [7].

4.2. Exposure Characteristics of Antibiotics in the Human Body

Antibiotics accumulate in the human body through environmental exposure and food chain transmission. In addition to being excreted in the form of prototypes or conjugates, some of them are also metabolized in the human body, which has not been considered in previous studies on external exposure., Among them, the intake of animal-derived foods is the main exposure pathway [7].

4.3. Current Clinical Application Status of Antibiotics

Chloramphenicol was the first broad-spectrum antibiotic obtained by American scientists in 1948. During this period, clinical research on antibiotics became purposeful, and industrial production also began at the same time. A large number of antibiotic manufacturing industries were constructed. The continuous progress in antibiotic research has accelerated the pace of modern medicine to its peak with the continuous deepening of clinical research on antibiotics, the target audience has also continued to increase. Antibiotics such as anti-tumour and antigenic insecticides that affect humans, livestock, and agriculture have all appeared in the sight of the general public [8].

4.4. Analysis of the Mechanism of Action of Antibiotics

The antibacterial mechanism of antibiotics mainly involves interfering with important biochemical processes in cells, thereby inhibiting cell growth and division, and ultimately achieving the effect of killing pathogenic bacteria. The main component of the cell wall is mucin, and various antibiotics in clinical practice can affect the biological formation of mucin in bacterial cell walls, which in turn damages the synthesis process of bacterial cell walls. Antibiotics can also affect the formation of bacterial proteins because the target of antibiotics that hinder protein formation is ribosomes, which are composed of many different combinations of ribosomal DNA. Therefore, antibiotics can affect topoisomerases by preventing DNA formation [8].

4.5. Current Situation and Harm of Antibiotic Abuse

At present, antibiotics are widely used. When patients experience symptoms such as headache, fever, and cough, the first drugs used are mostly antibiotics, which leads to the abuse of antibiotics. At present, there are deficiencies in the management of antibiotics in many countries. The abuse of antibiotics will inevitably lead to an increase in the resistance of pathogenic bacteria, resulting in the production of more super bacteria. If this situation continues to worsen, it may lead to the inability to find suitable antibiotics

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for treatment and effective control of various pathogenic bacteria cannot be achieved. The main factors affecting antibiotic abuse in hospitals are social factors, hospital factors, patient factors, and other factors. Among them, the lack of effective publicity and education accounts for 64.00%, the prescription of treatment experience accounts for 58.14%, and patients lack a correct understanding of antibiotic use accounts for 76.25%. These are the key factors affecting antibiotic abuse [9].

4.6. Reasons for Antibiotic Abuse

The first social reason is the lack of effective publicity and education. Secondly, false propaganda against antibiotics. The first reason for the hospital is insufficient management. Secondly, use antibiotics and other medications based on treatment experience. Thirdly, medical institutions lack a sense of social responsibility and lack awareness of antibiotic use. Fourthly, medication is unreasonable. The first reason for the patient is that they lack a correct understanding of the use of antibiotics. Secondly, medication is not standardized. Thirdly, the blind demands of patients [9].

5. The generation and treatment of antibiotic resistance in the human body

5.1. The Way Antibiotics Produced in the Human Body

Downregulate the number of porins to decrease the Input amount of medicine. First of all, chemical moiety inactivates through an Antibiotic-modifying enzyme. Secondly, blinding drugs to non-target proteins by medicating the target site. Thirdly, to mislead chemical moiety by creating a new protein that is the same as the target protein. Fourthly, create target protection protein to prevent chemical moiety combined with Antibiotic targe. Finally, it will efflux lots of active chemical moiety [10].

5.2. The Treatment of Antibiotic Resistance in the Human Body

A broad-spectrum synthetic antibiotic that does not evoke bacterial resistance. Its main component is Conjugated oligo electrolytes (COEs). That is a class of small amphiphilic molecules that share a modular structure that can spontaneously interact with lipid bilayers. The ease of molecular design and synthesis allows the construction of a spectrum of bacterial interfacing synthetic compounds that can be readily modified to alter membrane affinity and other properties like solubility, charge and stability. Although COEs were initially designed to insert into bacterial membranes and function as electron transporters, some were found to inhibit bacterial growth in culture for a limited number of pathogens. Such findings launched an effort to synthesize and screen a diverse array of COEs chemical variants for antibacterial activity against 17 clinically relevant Gram-negative and Gram-positive pathogens. Here we report on a specific COE, COE2-2hexyl, that exhibited broad-spectrum activity, effectively treated [11].

6. Conclusion

This article reviews the impact of antibiotics and antibiotic resistance on the environment and the human body. Clearly pointed out the pollution and solutions of antibiotics to water, soil, and other environments, as well as the impact and causes of excessive antibiotic use on the human body in clinical practice, as well as the emergence and treatment of antibiotic resistance. This article mainly reviews the impact of antibiotics on the environment and human body, but the solutions, especially how to prevent and control antibiotic abuse, are not fully pointed out. In the future, the focus can be on preventing antibiotic abuse, pollution caused by antibiotics, and the treatment of antibiotic resistance in clinical practice.

References

[1] Wang J, Liu K, Liang L L, Tian yan, Huang N Research progress of analysis and detection technology of antibiotics in water environment [J] Environmental Science and Management 2023.04.03 p150

[2] Liu Y X, Li P, Wang Z Distribution and treatment of Typical Antibiotics in sewage treatment plants in China [J] CHINA WATER & WASTEWATER 2021-02-22 p25-27

DOI: 10.54254/2753-8818/15/20240432

[3] Yuan Q B, Wang N, Guo X Y, Chen Z Y, Wang X L, Li W, Li X, Lei L S, Luo Occurrence and risk of antibiotics and drug resistance genes in the water environment of river basins in China [J] China Science magazine 2023-08-15 p2

[4] Li Y, Yin LP, Liu D Liang YH Fan Y Antibiotic pollution and its impact on plankton in China [J] Journal of Applied Ecology 2023.3 p847-859

[5] Ke S W, Wang Y Y, Li H, Duan Y Q, Liu YH the emergence, transmission, and impact of antibiotic resistance in the ecological environment[J] China Medical Herald 2023.7 p49-50

[6] Ren J F, Wang Z F, Hou F J, et al. Effects of antibiotic residues on nitrogen transformations in soil [J]. Asian Journal of Ecotoxicology, 2023, 18 p2-3,5

[7] LI Zhenhuan, ZHU Ying, HU Xiaojian, et al. Research progress on human health risk, internal exposure characteristics and analysis technologies of antibiotics [J]. Environmental Chemistry, 2023, 42 (12). p5,8,10

[8] Zhang J, Xu HH Analysis of Clinical Application and Mechanism of Antibiotics[J] Chinese Journal of Drug Abuse Prevention and Control 2023(29) p999-1000

[9] Chen X The Current Situation and Harm of Antibiotic Abuse[J] Brand and Standardization 2023(3) p115-117

[10] Elizabeth M. Darby, Eleftheria Trampari, Pauline Siasat, Maria Solsona Gaya, Ilyas Alav, Mark A. Webber , & Jessica M. A. Blair Molecular mechanisms of antibiotic resistance revisited [J] nature reviews microbiology 5.2023 p282

[11] Douglas M. Heithoff, Scott P. Mahan, Lucien Barnes V, Semen A. Leyn, Cyril X. George, Jaime E. Zlamal, Jakkarin Limwongyut, Guillermo C. Bazan, Jeffrey C. Fried, Lynn N. Fitzgibbons, John K. House, Charles E. Samuel, Andrei L. Osterman, David A. Low, and Michael J. Mahan A broad-spectrum synthetic antibiotic that does not evoke bacterial resistanc[J] eBioMedicine 2.2023 p2