Antibiotic resistance: an emerging water quality threat

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Abstract

Antimicrobial resistance is increasing worldwide, jeopardizing our capacity to treat infectious bacterial diseases. In both US and the EU it is estimated that more than 20000 people die annually due to antibiotic resistant bacteria. Antibiotic resistant bacteria and their genes are nowadays important environmental contaminants, which capacity to auto-replicate and disseminate in the environment is well documented. Because water represents a privileged bacterial habitat, the urban water cycle, comprising wastewater, surface water and drinking water, represents a critical route of dissemination of antibiotic resistance in the environment and eventually also to humans. The importance of the urban water cycle on the dissemination of antibiotic resistance and the need to improve surveillance and data sharing will be discussed.

Keywords

Urban water cycle, Wastewater, Drinking water, Acquired antibiotic resistance, Risks

1. INTRODUCTION

Acquired antibiotic resistance is considered nowadays one of the most serious threats to human health, responsible for high rates of mortality and morbidity and with high economic impacts (1). The health and economic burden due to antibiotic resistant bacteria is most evident when associated with health care practices, in particular hospitals and long term health care facilities. However, it has been increasingly recognized that antibiotic resistant bacteria and their genes (ARB&ARG) are no longer a threat confined to health care facilities. Over the last decade, the occurrence in the environment of antibiotic residues and ARB&ARG from human and animal origin has received much attention (2, 3, 4, 5). Because it is recognized that ARB&ARG found in the environment are associated with human activities, they are considered environmental contaminants. In addition, given their widespread distribution, auto-replicative capacity and potential threat for human health, ARB&ARG are considered contaminants of emerging concern. Besides a privileged route of dissemination of environmental contaminants, water is also one of the most important habitats for bacteria. For this reason, the urban water cycle represents a critical link in the transmission of ARB&ARG from humans and animals to the environment and from the environment to humans. The occurrence of ARB&ARG in different parts of the urban water cycle and measures that could be implemented to control this problem are the major topics of discussion in this presentation.

2. METHODS

The data to be presented and discussed will make an overview of studies on antibiotic resistance in the urban water cycle, published in peer-reviewed journals over the last decade and in which the presenting author was involved. Specifically, this review will characterize some compartments of the urban water cycle regarding the occurrence of ARB&ARG, will discuss important surveillance and control measures that could be implemented, and will present some ongoing networking activities on antibiotic resistance monitoring.

3. RESULTS AND DISCUSSIONS

Antibiotic residues, ARB&ARG and wastewater treatment

Domestic wastewater contains high doses of antibiotic residues, ARB&ARG, a combination that is supposed to favor the proliferation of ARB&ARG. The conventional wastewater treatment do not assure the extensive removal of ARB&ARG, which prevalence may even increase after wastewater treatment (3, 5). It is observed that urban wastewater, either raw or treated and ready to discharge in the environment, presents a high prevalence of ARB&ARG to "old" antibiotics, such as sulfonamides, tetracyclines or penicillins, suggesting the cumulative effect of this form of contamination (3, 5). In addition, ARG of emerging concern in health care facilities and common in hospital effluents is observed to rapidly disseminate to the environment through wastewater treatment facilities (6, 7).

ARB&ARG as environmental contaminants

ARB&ARG are auto-replicative environmental contaminants, with genetically related ARB being found in hospitalized patients, hospital effluents, municipal wastewater and surface water or in wild birds living in urban areas. The tracking of some ARG in these ARB also demonstrate that the borders between clinical and environmental settings are loose in what respects ARB&ARG dissemination (8, 9).

Drinking water: are there reasons for concern?

Drinking water produced after water abstraction from surface or ground water, collection, disinfection, and distribution until its final consumption, is in principle free of pathogens. The question that is been posed is if ARB&ARG disseminated in water can also reach drinking water, which therefore would present an increased risk of transmission to humans. Although acquired ARB&ARG is not expected to be highly prevalent in drinking water, it is known that this type of water is inhabited by an impressive diversity of environmental bacteria, some of which exhibit multidrug resistance phenotypes, probably intrinsic in those species.
In addition, old generation ARG, conferring resistance to sulfonamides or beta-lactams, common in wastewater and in environmental samples can also be found in tap water, suggesting that drinking water contamination with ARB&ARG, even when complying with all legal recommendations, may occur (5).

Control and risk assessment are needed

From what is known, it is clear that the improvement of wastewater treatment technologies, aiming at reducing the levels of ARB&ARG discharged in the environment would represent an important strategy to reduce the environmental antibiotic resistance burden. In addition, although it is now consensual that ARB&ARG are widely disseminated in the environment, it is difficult to assess the risks of the transmission, directly or indirectly, of ARB&ARG from the environment to humans. A major limitation is related with the absence of surveillance and data sharing systems comprising both environmental and clinical data, allowing a global overview of the emergence and evolution of antibiotic resistance and how it can affect human health (10).

4. CONCLUSIONS

ARB&ARG are disseminated throughout the urban water cycle, with wastewater treatment facilities representing important nodes of selection and propagation. Dedicated and advanced water treatment processes, to be implemented at critical control points, and integrated surveillance and data sharing systems may be relevant strategies to combat ARB&ARG and to accurately assess the risks of transmission from the environment to humans.

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