Appraisal of potential environmental risks associated with human antibiotic consumption in Turkey

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ABSTRACT
A comprehensive analysis of Turkish antibiotic data was conducted to evaluate potential environmental risks associated with antibiotic consumption in Turkey for year 2007. Antibiotics were defined for systemic use or group J01 of the WHO Anatomical Therapeutic Chemical (ATC) classification system. Total emissions and prescriptions for each ATC group were classified separately into 17 different J01 categories and three forms of medication (capsule/tablets, injectables and suspensions). Capsules and tablets were found as the most emitted form of medication in year 2007, with a total emission rate of about 385.5 tons/year (76%). Total antibiotic emission rates including all forms of medication were determined to be about 664.2 tons/year (86%) and 110.1 tons/year (14%) for adult and pediatric patients, respectively. An environmental risk assessment of 8 human antibiotics was conducted according to the EU draft guidance (CEC/III/5504/94, draft 6, version 4) and the risk was indicated by the ratio of predicted environmental concentration (PEC) to predicted no effect concentration (PNEC) for the aquatic environment. Available acute and chronic toxicity data were collected from the open peer-reviewed literature to derive PNEC. Risk quotients (PEC/PNEC) were then calculated for 8 pharmaceutical substances. PEC/PNEC ratio exceeded 1.0 for β-lactams (cephalosporins and penicillins), fluoroquinolones, macrolides and aminoglycosides. The findings of this study concluded that the release of these compounds from wastewater treatment plants may potentially be of an important environmental concern based on today’s use of antibiotics in Turkey.

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1. Introduction

Antibiotic consumption has received a lot of attention in the media in the last several years due to the increasing numbers of diseases and infections becoming resistant to traditional treatments for both humans and animals. However, after administration to humans and animals in hospitals or by prescription, a high percentage of antibiotics (up to 90%) are excreted unchanged via urine and/or feces into domestic sewage, and are discharged to wastewater treatment plants (WWTPs) without a second thought [1–5]. The resultant higher concentrations of antibiotics and other pharmaceutical products in urban waste streams have substantial impacts on the environment and human health, which are very difficult to control using conventional practices. More importantly, in WWTPs, these pharmaceutical compounds are only partially removed and there is a potential for residues of antibiotics to be released through the WWTP effluents into the aquatic environment [3]. Therefore, urgent risk assessment and proper risk management are needed to ensure a robust and resilient control of antibiotic emissions for both developed and developing countries.

The main sources of antibiotics are homes, hospitals, nursing homes (medical treatment, disposal of unused medication), poultry and livestock feeding operations (growth promotion), and pharmaceutical manufacturers [6]. Kümmerer [7] has reported that if antibiotics used for veterinary purposes or as growth promoters in animal husbandry, they seep through the soil from manure and enter ground water. In addition, antibiotics may reach surface water and ground water, and potentially drinking water if they are not degraded or removed during sewage treatment, in soil or in other environmental compartments [7]. Although some antibiotics such as penicillins and ampicillin can be easily biodegraded in the aquatic environment, however, many antibiotics such as tetracyclines, erythromycin, metronidazole and sulphamethoxazole may not be readily destroyed by conventional wastewater treatment techniques [6,8]. In addition, various antibiotics such as sulphonamides bind strongly to sludge, soil, sediments and manure, and may show a recalcitrant behaviour to a possible further biodegradation. Furthermore, many antibiotics are designed to be persistent and lipophilic, so that they can retain their chemical structure long enough to do their therapeutic work [4]. Because of aquatic contamination by these persistent chemicals, bacteria