

Pharmaceutically Active Compounds in the Environment: Are we Protected?

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EDITORIAL

Occurrence of pharmaceutically active compounds in the environment is of great concern and has been the focus of an increasing number of recent studies. Although the use of pharmaceuticals has positive effects on treating many diseases in animals and humans, their improper use has become a new environmental problem. More than 600 pharmaceutical substances have been detected in different environmental matrices worldwide such as wastewater, surface water, ground water, soil and even drinking water [1]. The most commonly detected classes include human/veterinary antibiotics, hormones, non-steroidal anti-inflammatory drugs, central nervous system stimulants and antidepressants [1]. These compounds could be detected in the environment at low concentrations ranging from micrograms to nanograms per liter [2]. Continual discharge of pharmaceuticals into the environmental compartments at these levels poses a chronic threat to human and wildlife [1]. It is well documented in the literature bacterial resistance may develop due to continual discharge of antibiotics into the environment [3]. Additionally, accumulation of non-steroidal anti-inflammatory drugs such as diclofenac has shown to cause harmful renal effects [4]. Furthermore, the trace levels of ethinyl estradiol, the active constituent of an oral contraceptive pose harmful effects on aquatic life including impairment of sexual development and the feminization of fish [1]. Pharmaceuticals enter the environment as metabolites from human excretion and also as intact form from improper disposal of unwanted/expired medications via domestic water streams [5]. This pharmaceutical waste goes directly to sewage and unfortunately most of worldwide sewage treatment plants are not designed to remove pharmaceutically active compounds. Because these compounds have high polarity and stability, most of them are not completely eliminated in treatment facilities causing them to discharge into water bodies [5]. Also, disposal of expired/unwanted medicines into household waste may eventually end up in landfills leading to discharge of pharmaceuticals into the environment as leachate. Many studies have investigated the occurrence of pharmaceuticals in different environmental compartments, most of them are conducted in developed countries such as USA, Canada and Australia. This information might be different in developing countries. For example, Saudi Arabia is the fifth

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largest country in the middle east and houses a resident population of 31 million people of multi-ethnicity. The pharmaceutical trade in Saudi Arabia alone has been estimated at 3.5 billion US\$ [6], while the cost of medication wastage was 150 million USD annually [7]. Almost all middle east countries have no standard protocols or regulatory policies for disposing pharmaceutical waste and governmental healthcare facilities offer free medication for citizens which increased the risk of accumulation of unused medications. In addition, many drugs are sold in the middle east without a need for a prescription. Furthermore, most of the waste water treatment plants in the middle east are conventional and not specifically designed to remove pharmaceuticals. Comparatively, advanced wastewater treatment processes, such as activated carbon, ozonation and advanced oxidation technologies, can achieve higher removal rates for pharmaceuticals. Recent studies demonstrated that there is a higher risk for impact on the environment and this makes it necessary to employ a treatment process that is capable of removing and/or destroying residual pharmaceutical compounds. For a more comprehensive picture of the global situation, further studies should be undertaken in middle east countries, especially for those which has large human population. It is also highly required to provide baseline information of the level of pharmaceutical waste on such countries. This information will provide insights for regulators and decision makers when designing future interventions regarding disposal of pharmaceutical waste into the environment.

Monitoring of the pharmaceutical residues in environmental samples is of a paramount importance. Accurate and sensitive analytical methodologies have been developed to determine pharmaceuticals in waterways [8-12] including GC-MS, LC-MS and LC-MS-MS. Analytical methods based on mass spectrometric detection are favored because of its high sensitivity and selectivity. Recently, the development of faster and more sensitive methods became more feasible using UHPLC [2]. This technique can potentially provide greater resolution, increased sensitivity, and speed of analysis. Analysis of pharmaceutical metabolites in the

environment at trace levels and developing advanced sample preparation techniques for extracting pharmaceuticals at trace levels should receive more interest.

Preventive measures, such as implementing official policies and establishing disposal programs aiming at regulating disposal practices can reduce the amount of pharmaceutical waste entering water bodies. Also, raising public awareness about the proper ways of disposing unwanted medications and educating them regarding the environmental risks associated with improper disposal of pharmaceutical waste can effectively help minimizing discharge of pharmaceuticals via sewer systems. In addition, wastewater treatment plants should be improved by adding up new techniques for treatment such as reverse osmosis, micro filtration or membrane reactor, UV- water treatment, ozonation, treatment with powdered active carbon phase and solar treatment of effluents. Also, further research is needed to investigate the chronic toxicity of pharmaceuticals in the aquatic environment.

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