

Chapter 13

Pharmaceuticals in Environment: Global Concerns and Regulations

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ABSTRACT

Pharmaceuticals and personal care products (PPCPs) constitute an integral part of modern healthcare systems which enter the environment through various routes. Because of their inherent biological activity, their presence in soil and the aquatic environment poses several eco-toxicological problems. Antibiotic contamination of soil and water bodies is leading to the development of microbial resistance to antibiotics and this has been recognized by several global bodies like WHO and EPA. Effective steps need to be taken in this regard including increased awareness, reduced pharmaceutical discharges in environment, green and sustainable pharmaceutical practice by pharmaceutical industry and healthcare professionals and improved remediation/bioremediation methods. This chapter outlines the various anticipated routes of exposure of pharmaceuticals to the environment along with their detrimental effects, fate and degradation in aquatic and terrestrial environments. The chapter also dwells upon the role of various regulatory bodies and plausible measures that may be adopted to alleviate the problem.

INTRODUCTION

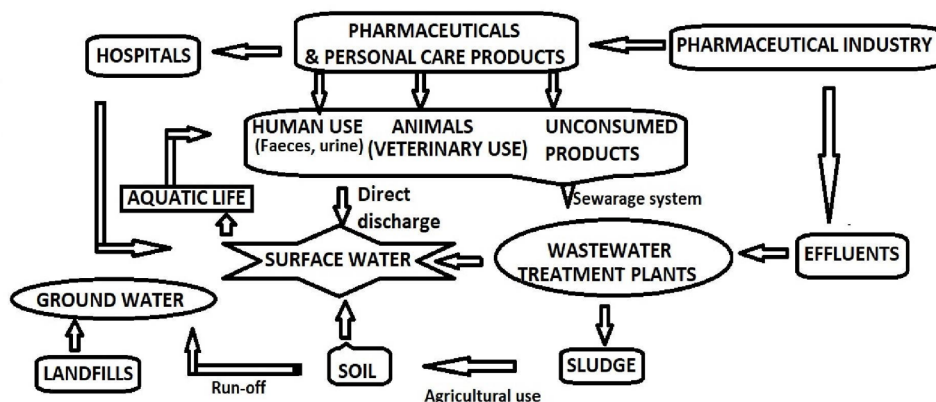
Pharmaceuticals and personal care products (PPCPs) are the broad group of compounds designed for cure and treatment of various diseases in human and veterinary healthcare setup. These have been an integral part of modern healthcare system and are primarily intended to improve health and the quality of life in the general population. The US FDA has approved over one lakh compounds making up thousands of prescriptions, as well as over the counter (OTC) marketed drug products. Further, there are a large number of drug molecules not approved by the FDA which are in therapeutic use in other countries. Majority of pharmaceuticals are drugs or pharmaceutical excipients and are synthetic/ semi-synthetic molecules belonging to various therapeutic categories such as antibiotics, anti-inflammatory drugs, an-

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tidepressants, antihypertensives, hormonal drugs, etc. Several compounds have their origins in natural sources including plants, animals, marine products, bacteria or fungi. Pharmaceuticals are utilized for their various therapeutic applications and subsequently, these are excreted from the body along with their metabolites (i.e., breakdown products) as part of normal biochemical elimination processes and enter the environment through various routes. Pharmaceuticals also enter the environment as discharges from the pharmaceutical industry effluents or unused medical products. Veterinary pharmacy is another source of pharmaceuticals entering the environment. Fig. 1 gives a concise representation of the various routes through which pharmaceuticals gain entry into the soil and aquatic environment. In recent years, there has been an increased awareness about this issue (Steger-Hartmann, & Schweinfurth, 2006)

Several of these PPCPs are known to be incompletely removed by wastewater treatment process systems and finally enter rivers, streams, lakes or landfills. Possible harmful contribution of pharmaceuticals towards environmental populations remained a non-existent topic for a long time till early 90s when studies conducted in this area provided an insight that production of pharmaceuticals resulted in the generation of 50-100 times of pharmaceutical and solvent waste (Sheldon, 2007). Various studies suggested that measures are needed to be taken by the pharmaceutical industry to reduce environmental pollution and to introduce greener approaches towards generation. Pharmaceutical pollution is a dynamic entity because life expectancy has been progressively increasing over the years, so the consumption of pharmaceuticals, especially by the elderly population, will also proportionately increase resulting in an increase in pharmaceutical pollution of the environment. Hence, dynamics of the problem needs to be considered for true assessment of the problem. Research in this area has considerably evolved over this decade, beginning with detection and analysis of these micro-pollutants to evaluation of toxicity aspects of pharmaceuticals and presently, risk assessment and risk management issues are being targeted. This book chapter highlights the environmental risks associated with the regular use of pharmaceuticals, their ubiquitous contamination of environment and the role of regulatory agencies in preventing health hazards associated with their environmental exposure. A brief overview of the current status and risks involved are discussed along with the methods and approaches to ameliorate the situation. For greater details, the reader is advised to consult the more specific texts and reviews (e.g., Kummerer, 2009a, 2009b).

Figure 1. Sources of pharmaceuticals in the environment



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