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# Pharmaco-EcoMicrobiology: A newer component of medical sciences bridging pharmacovigilance, ecology, and environmental microbiology

M. Shahid<sup>a,\*</sup>, Nancy Khardori<sup>b</sup>, T. Tripathi<sup>a</sup>, Scott Bergman<sup>c</sup>

<sup>a</sup> Section of Antimicrobial Resistance Researches and Molecular Biology, Department of Microbiology, Faculty of Medicine, Jawaharlal Nehru Medical College & Hospital, Aligarh Muslim University, Aligarh 202002, U.P., India

<sup>b</sup> Department of Internal Medicine, Illinois University, 701 North First Street, Room A477, P.O. Box 19636, Springfield, IL 62794-9636, USA

<sup>c</sup> Department of Pharmacy, Illinois University, 701 North First Street, Springfield, IL 62794-9636, USA

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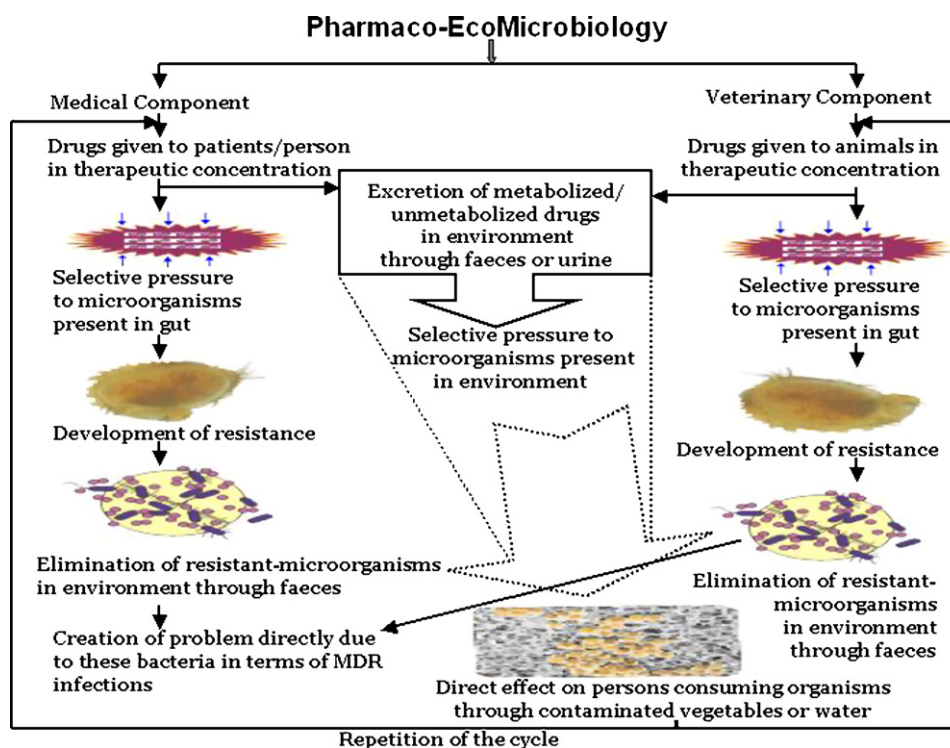
## KEYWORDS

Environmental toxicology;  
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Pharmaco-EcoMicrobiology;  
Ecology;  
Microbiology;  
Adverse drug effects

**Summary** Environmental scientists are now raising great concern on the impact of drugs on the environment and microbiologists are concerned about increasing antibiotic resistance due to irrational usage. However, a focus on the impact by the use of antibiotics (irrational/prescribed) to the environment at therapeutic doses has not been instituted. Even the World Health Organization (WHO) defined “Pharmacovigilance” activities as the monitoring, detection, assessment, understanding and prevention of any adverse reactions to drugs at therapeutic concentration on animals and humans. Nevertheless, there is little attention being given to identifying the adverse effects (ADEs) of antimicrobial agents on the environment (given at therapeutic doses). This issue has been highlighted in the present commentary and a new domain, “Pharmaco-EcoMicrobiology”, has been proposed which should deal with and monitor such adverse effects. The term “Pharmaco-EcoMicrobiology” has been proposed to define the interplay between antimicrobial pharmacological agents and animate microbial ecology. This new domain, “Pharmaco-EcoMicrobiology”, has been derived by the aggregation of three important branches of science (pharmacology + ecology + microbiology) and would be responsible for studying the ADEs due to antimicrobial drugs excreted in environment.

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\* Corresponding author. Tel.: +91 571 2720382; fax: +91 571 2721776.  
E-mail addresses: [shahidsahar@yahoo.co.in](mailto:shahidsahar@yahoo.co.in), [drmohdshahid123@yahoo.com](mailto:drmohdshahid123@yahoo.com) (M. Shahid).



**Figure 1** Algorithms showing the recent term “Pharmaco-EcoMicrobiology”, its components, direct and indirect impacts to microorganisms and human/animals, and their interrelationship. MDR infections in above figure refer to multi-drug-resistant infections.

In this article, We propose the term “Pharmaco-EcoMicrobiology” to define the interplay between pharmacological antimicrobial agent and animate microbial ecology. A detailed algorithm describing the components of this newer domain and the adverse drug effects (ADEs) occurring and to be monitored under this domain is shown in Fig. 1. In brief, this proposed domain includes medical and veterinary components through which the metabolized and non-metabolized antimicrobial drugs in human and animal guts, as well as those excreted in the environment, give rise to the development of antibiotic resistance in bacteria due to the selection pressure. These multi-drug resistant (MDR) organisms are then responsible for giving rise to MDR infections.

To review possible sources of antibiotics in the environment, including those mentioned above; these could be as follows:

(a) *Sewage*: The antibiotics that we take in are not all processed by our bodies. Clearly, the unprocessed drug will pass into the environment along with feces and urine and ultimately reside in our wastewater treatment plants. Not only unprocessed drugs, but also the metabolites with active components excreted through the same routes.

- (b) *Animal production and veterinary practice*: Antibiotics are commonly added to animal feeds as growth promoters and also added to fishery waters. Similarly, antibiotics are given at therapeutic doses by veterinary doctors to treat diseases in animals.
- (c) *Medical waste*: The dispensing of antibiotics in a medical facility inevitably leads to waste.
- (d) *Household products*: Many “antibacterial” household products have been introduced in recent years, including, toothpastes, cements, paints, etc. with antibacterial ingredients like triclosan, quaternary ammonium compounds, alcohol, and bleach. These antimicrobial compounds are eventually disposed of and can cause an impact on the environment.
- (e) *Crop-sprays*: Antibiotics are sprayed on crops to treat bacterial infections that in turn cause adverse effects to the environment.

According to the World Health Organization (WHO), “Pharmacovigilance” activities are done to monitor detection, assessment, understanding and prevention of any obnoxious adverse reactions to drugs at therapeutic concentration on animals and humans. However, in recent years, environmental scientists have raised a great concern on the impacts of drugs on the environment and surround-

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