SCCWRP #0939

Antibiotics as CECs: An Overview of the Hazards Posed by Antibiotics and Antibiotic Resistance

Geoffrey I. Scott[1], Dwayne E. Porter[1], R. Sean Norman[1], C. Hart Scott[1], Miguel I. Uyaguari-Diaz[2], Keith A. Maruya[3], Steve B. Weisberg[3], Michael H. Fulton[4], Ed F. Wirth[4], Janet Moore[4], Paul L. Pennington[4], Daniel Schlenk[5], George P. Cobb[6], and Nancy D. Denslow[7]

[1]Department of Environmental Health Sciences, Arnold School of Public Health, University of South Carolina, Columbia, SC

[2]Department of Pathology and Laboratory Medicine, University of British Columbia, Vancouver, BC, Canada

[3]Southern California Coastal Water Research Project, Costa Mesa, CA

[4]NOAA/NOS/NCCOS Center for Coastal Environmental Health and Biomolecular Research, Charleston, SC

[5]Department of Environmental Studies, University of California, Riverside, Riverside, CA

[6]Department of Environmental Sciences, Baylor University, Waco, TX

[7]College of Veterinary Medicine, Center for Environmental and Human Toxicology, University of Florida, Gainesville, FL

ABSTRACT

Monitoring programs have traditionally monitored legacy contaminants but are shifting focus to Contaminants of Emerging Concern (CECs). CECs present many challenges for monitoring and assessment, because measurement methods don't always exist nor have toxicological studies been fully conducted to place results in proper context. Also some CECs affect metabolic pathways to produce adverse outcomes that are not assessed through traditional toxicological evaluations. Antibiotics are CECs that pose significant environmental risks including development of both toxic effects at high doses and antibiotic resistance at doses well below the Minimum Inhibitory Concentration (MIC) which kill bacteria and have been found in nearly half of all sites monitored in the US. Antimicrobial resistance has generally been attributed to the use of antibiotics in medicine for humans and livestock as well as aquaculture operations. The objective of this study was to assess the extent and magnitude of antibodies in the environment and estimate their potential hazards in the environment. Antibiotics concentrations were measured in a number of monitoring studies which included Waste Water Treatment Plants (WWTP) effluent, surface waters, sediments, and biota. A number of studies reported levels of Antibiotic Resistant Microbes (ARM) in surface waters and some studies found specific ARM genes (e.g., the $bla_{M\text{-}1}$ gene) in *E. coli* which may pose additional environmental risk. High levels of this gene were found to survive WWTP disinfection and accumulated in sediment at levels 100-1000 times higher than in the sewerage effluent, posing potential risks for gene transfer to other bacteria in aquatic and marine ecosystems. Antibiotic risk assessment approaches were developed based on the use of MICs and MIC Ratios [High (Antibiotic Resistant)/Low (Antibiotic Sensitive) MIC] for each antibiotic indicating the range of bacterial adaptability to each antibiotic to help define the No Observable Effect Concentration (NOEC) for each antibiotic which were compared to maximum Measured Exposure Concentrations (MEC) in the environment to predict individual environmental risks. Four antibiotics had high MEC/NOEC and high MIC ratios and were identified as higher risks for concern based upon this approach, but on Triclosan had MEC/NOEC ratios > 1 and was recommended for monitoring in future studies.

Full Text

http://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/939_OverviewOfHazardsPosedByAntibiotics.pdf