



CHARACTERIZING AND PREDICTING ANTIBIOTIC RESISTANCE GENE FATE DURING DISINFECTION PROCESSES: INSIGHTS AND IMPLICATIONS FOR (WASTE)WATER TREATMENT, HEALTHCARE, AND BEYOND

Speaker

Prof. Michael Dodd

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Abstract

Disinfection processes are key barriers to the spread of viable antibiotic resistant bacteria (ARB) and their antibiotic resistance genes (ARGs) within environmental systems and human populations. Although increasing attention has been paid to the fates of ARB and ARGs during exposure to various disinfectants, there remains an incomplete understanding of fundamental kinetic parameters governing ARG elimination during disinfection, consequent impacts on ARGs' biological activities, and key factors which may influence the relative efficiencies of such processes in practice. Our work has helped to address these knowledge gaps through systematic evaluations of the degradation and "deactivation" (i.e., biological activity loss) of a broad cross-section of ARGs during exposure to many of the disinfectants most commonly-used in (waste)water treatment, as well as in healthcare and personal care. Our investigations show that (a) kinetics of ARG (and more generally, DNA) degradation and deactivation by many chemical and physical disinfectants exhibit strong dependencies on the abundance of certain nucleotide targets (e.g., interstrand AT or GC bps, and intrastrand 5'-bipyrimidine-3' or 5'-GG-3' doublets) within the ARGs' DNA sequences, and (b) that these dependencies can in turn provide the basis for quantitative models enabling accurate prediction of rate constants governing ARG degradation and deactivation kinetics under realistic treatment conditions (including during full-scale disinfection of municipal wastewater). Observations from this work also provide important insights into heretofore underappreciated and/or unrecognized factors governing the relative efficiencies of ARG degradation and deactivation during various (waste)water disinfection processes (particularly during chlorination of non-nitrified/ammonia-rich wastewater), and have significant implications for control of ARB and their ARGs during such processes. This talk will provide an overview of key findings and conclusions from our studies, and how this information can be used to improve decision-making regarding antibiotic resistance control when selecting, designing, and operating disinfection processes for (waste)water treatment and reuse, as well as for personal care and healthcare.

Biography

Michael (Mike) Dodd is a Professor in the Department of Civil and Environmental Engineering and an Adjunct Professor in the Department of Environmental and Occupational Health Sciences at the University of Washington. He received a B.S. in Civil Engineering and M.S. in Environmental Engineering from the Georgia Institute of Technology, Ph.D. in Environmental Sciences from the Swiss Federal Institute of Technology in Zurich, and was a postdoctoral fellow in the Environmental Engineering Program of Yale University, prior to beginning his appointment at the UW. Mike's research emphasizes the characterization of (in)organic and microbiological contaminant fate during (photo)chemical oxidation and disinfection processes in water and wastewater treatment and within natural systems, development of assays to quantify the impacts of such processes on contaminants' chemical and biological properties and effects, and engineering novel approaches to centralized and decentralized treatment – especially with regard to optimization for organic pollutant and pathogen elimination. Particular focus areas of his group's research activities include characterization and control of antibiotic resistance dissemination in the environment, development of novel advanced oxidation and disinfection processes, and characterization of (photo)chemical transformations of environmental organic contaminants at gas-solid and gas-liquid interfaces. Mike has received a number of honors for his work, including the Allan and Inger Osberg Endowed Professorship at the UW from 2018-2023, a Visiting Professorship in 2017 at the École Polytechnique Fédérale de Lausanne (EPFL), a US National Science Foundation CAREER Award, the CH2M Hill/AEESP Outstanding Doctoral Dissertation Award from the Association of Environmental Engineering and Science Professors, the ETH Medal from the Swiss Federal Institute of Technology-Zurich, and Excellence in Review and Outstanding Reviewer awards from Environmental Science and Technology and the ASCE Journal of Environmental Engineering.



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