Karina Gin

National University of Singapore, Singapore

Tracking antibiotic resistance from hospitals to the environment

Statement of Problem: An emerging health problem is the increase of antibiotic resistant pathogens arising from indiscriminant usage of antibiotics, and the transfer of antibiotic resistant genes (ARGs) between pathogens via mobile genetic elements. Last-resort antibiotics, such as extended-spectrum β-lactam (ESBLs) and carbapenems used in the treatment of patients have resulted in the spread of carbapenem-resistant *Enterobacteriaceae* (CRE) extending beyond the hospital setting. Hospital wastewaters in particular are important sources of antibiotic resistant bacteria (ARB) and ARGs. Hence determining the removal efficiencies in wastewater treatment processes, and the occurrences of ARB and ARGs in the urban environment (surface waters) and sites of aquaculture activity (fish farms) provides bearing on the spread of antimicrobial resistance.

Methodology: Metagenomics, qPCR and culturing methods were used as an assessment of ARB and ARGs in hospital and domestic wastewaters. Gram-negative pathogens (i.e. *Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa*) at high concentrations exhibited pheno- and genotypic resistance (e.g. bla_{KPC}, bla_{NDM} genes) to ESBL and carbapenem antibiotics. To characterize the occurrence and risk of these antibiotic resistant pathogens in the urban water cycle and environmental waters, samples were tested on a routine basis using selective media supplemented with 5 different classes of antibiotics.

Findings: The membrane bioreactor treatment (MBR) process of a wastewater treatment plant showed complete removal of all four pathogens (influent MBR), however there were periods where *E. coli,* K. *pneumonia* and P. *aeruginosa* were detected in MBR effluent (6-7 log removal). Of the P. aeruginosa isolates detected, a few exhibited phenotypic resistance to carbapenem and ESBL antibiotics. In environmental waters, higher abundance of pathogens was detected in urban surface waters followed by aquaculture sites than marine sites within the vicinity of and outfall discharging treated effluent.

Conclusion & Significance: A comprehensive surveillance framework was developed to track hotspots of antimicrobial resistance in the urban water cycle and the spread of ARB and ARGs in the environment.

Biography

Karina Gin is an Associate Professor at the Civil & Environmental Engineering Department at the National University of Singapore (NUS). She received her BEng in Civil Engineering from the University of Melbourne (1988), MEng Degree from NUS (1991) and Doctor of Science (ScD) Degree jointly from the Massachusetts Institute of Technology and the Woods Hole Oceanographic Institution (1996). Her research specialisation is in water quality, especially in the development of rapid and sensitive methods of detection for emerging contaminants of concern and understanding their fate and transport in the environment. Her current research focuses on the occurrence and fate of pathogens and emerging organic contaminants in tropical surface waters and harmful algal blooms in fresh waters. She received UN Atlas Award for excellence (co-author of "The Environment in Asia Pacific Harbours"). She is a member of the WHO Expert Group on Antimicrobial Resistance in Water Safety and Hygiene and is currently holding the Dean's Chair at the Faculty of Engineering (NUS).

ceeginyh@nus.edu.sg

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