From Hospital to Water Table; Study of Antibiotic Resistance

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Biology 222: Majors Cell/Molecular

Abstract

The increase of antibiotic resistance is a significant concern to public health, according to both the CDC and WHO. We wondered, does hospital runoff influence the development of antibiotic resistance in our environment? Despite sophisticated waste water management techniques, we thought that there would be an increase in antibiotic resistance near the hospital and downstream when compared to a separate location within city limits.

Introduction

Hospital waste water has been found to contain higher levels of antibiotic resistant genes (ARGs) than most waste water systems (Zhang et al, 2020). These antibiotic resistant genes can lead to diseases which are more difficult or impossible to treat in humans with unpredictable effects on our environment. While the hospital has a description of their waste water treatment on their website which incorporates offsite treatment, we wondered if this completely managed the disposal of antibiotics and ARG's? We tested the presence of antibiotic resistance to meropenem, a potent antibiotic typically used as a last resort by pharmacists, in our local environment; Bellingham. Our collection sites were next to the hospital parking lot, downstream of the hospital next to Squalicum Park, and at Bennet Outfall by Taylor Dock. These sites were chosen to evaluate the immediate runoff from the hospital, whether ARG's travel downstream, and if ARG's to meropenem are present in an unassociated location of stormwater runoff.

Methods

Materials & Location

We collected soil from three different locations. Squalicum Creek near the Hospital grounds, Bennet Outfall, and Squalicum Creek by Squalicum Creek Park.

Materials used were from our classroom KUL 108. For this experiment we used: MAC plates and MAC+Maro plates, PCR tubes, Glass Beads, Agarose Gel, Pipette tips, Electrophoresis machine, 6x gel loading dye, nuclease free water, 2x gotaq master, 320F primer, 817R primer, 1x TAE buffer solution, graduated cylinder, weight scale, micropipettes, and pipette tips.

Procedure

We began by diluting our soil in sterile water and plated it onto our growth plates. We let them grow for 48 hours in 30˚C. We then counted the bacterial colonies formed and sampled them for PCR. After PCR, we ran AGE and sent the results to Genewhiz for sequencing.

Locations of Data Collection

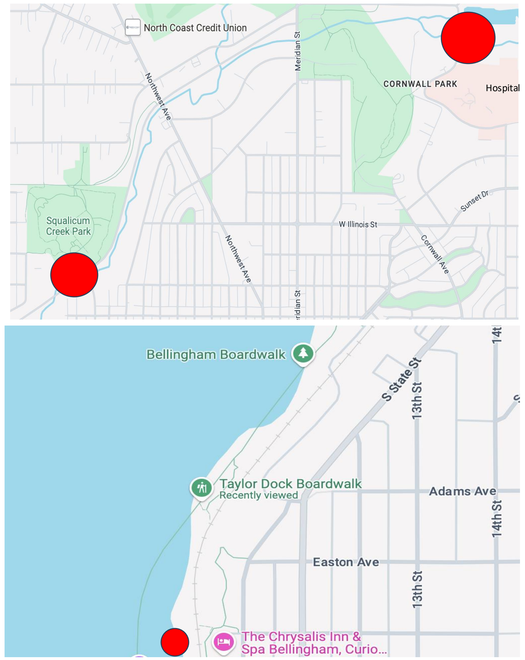

Figure 1. Map of data collection and how much antibacterial resistant genes were found at those locations.

Maro Plates

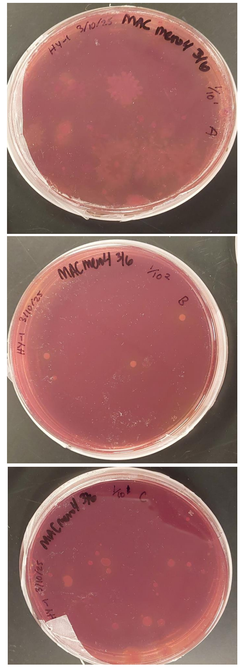

Figure 2. Maropenem Plates for all locations

Percent of Antibacterial Resistant Genes

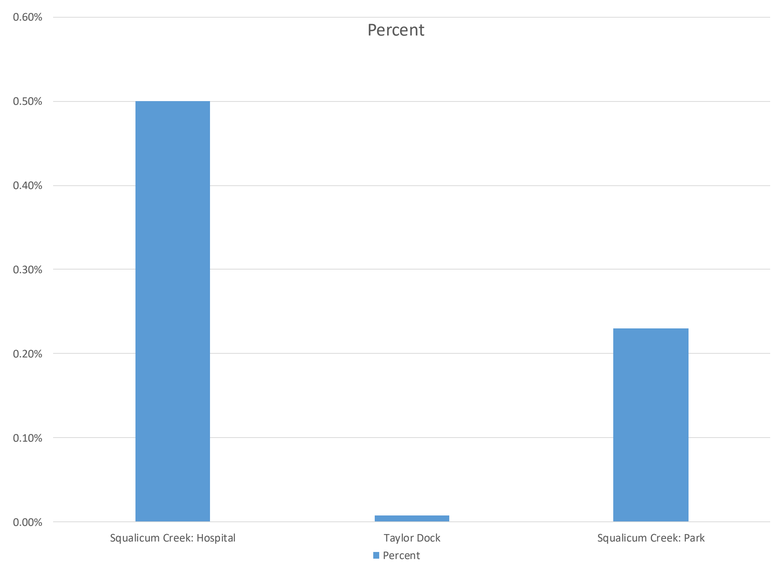

Figure 3. Percent of antibacterial resistant genes at each location our data was collected.

Discussion

We observed a significantly higher percentage of antibacterial resistance genes in areas near hospital grounds compared to other locations. This finding aligns with our hypothesis that hospital runoff influences the development of antibiotic resistance in our environment. The presence of these resistance genes suggests that medical waste, wastewater discharge, or other hospital-related factors may be playing a role in accelerating the growth of antibiotic-resistant bacteria in nearby ecosystems.

Our testing of water runoff near the hospital and downstream of it clearly showed the distribution of ARG's emanating from the hospital. The introduction of antibiotic resistance will have unknown repercussions, it may disrupt plant physiology, seed germination, or cause human health disturbances (Polianciuc et al, 2020). We were able to sequence two samples from our growth plates, one of which came back inconclusive, but the conclusive strain was likely a strain of Massilia sp. according to our BLAST search.

Our findings were inhibited in part by our gel electrophoresis not showing a strong enough signal to sequence most of our findings, but from our sequencing results along with the results of our studies, our data aligns with our hypothesis that hospital runoff influences the development of antibiotic resistance in our environment. Further research on this topic would best include testing sites at other hospital locations and locations downstream from them.

Acknowledgements

We would like to express our gratitude to Professor Tealia Slagle for guidance throughout the course of this research opportunity and for teaching us the skills we that were fundamental for the project. We would also like to thank Bethany Lolkema and Mark Price for preparing the material and the WCC science department for supplying the materials.

References/ Work Cited

Zhang, S., Huang, J., Zhao, Z., Cao, Y., Li, B (2020). Hospital Wastewater as a Reservoir for Antibiotic Resistance Genes: A Meta-Analysis. Publisher: National Library of Medicine.

Polianciuc, S. I., Gurzau, A. E., et al. (2020). Antibiotics in the Environment: causes and consequences. Publisher: National Library of Medicine.