The Antibiotic Resistance Profiles of Pseudomonads from Hospital Waste Water

Abstract

 With pathogens becoming increasingly resistant to multiple drugs, it is important to catalog and describe the genetic and metabolic changes that are occurring among the pathogens. *Pseudomonas aeruginosa* has become a problem in the medical community due to its diversity, increasingly multi-drug resistant qualities and its ability to colonize multiple environments. The goal of the study was to catalog the genetic variety and specific drug resistance compared against the stages in the effluent processing cycle. The importance of the research is to accurately evaluate the current resistance of pathogens and to create new ways to combat them and correct old practices that may not be effective the waste water treatment. This is crucial to preventing the spread of not only pathogens but increasingly multi-drug resistant pathogens and this is important in developing nations such as Brazil where a large majority of the population has no access to untreated water putting many people at risk of developing serious illnesses. The studies research reconciled with similar studies done previously and showed that while many pathogens were removed the treatment acted as more of a filter against the least resistant, allowing the most resistant strains of *P. aeruginosa* to pass into the aquatic environment. This study has identified the current most effective antimicrobials, but has not given a strong or lasting answer against the constantly changing resistance of microorganisms. Current problems are that few effective treatment methods are available to combat evolving pathogens and the ones that are effective are not available to developing nations.

Introduction

 *Pseudomonas aeruginosa,* is an aerobic bacteria that is opportunistic in its infection of humans. It mainly effects patients in hospitals or patients with weakened or compromised immune systems due to such things as stem cell therapy or HIV. The pathogen is the main cause of cystic fibrosis (Santoro 1527). Strains of *P. aeruginosa* in hospitals have become resistant to multiple types of antibiotics and when released into the environment through the hospitals effluent they bring the antibiotic resistant qualities with them to possible non-resistant aquatic populations. Through horizontal gene transfer resistant qualities in a population can become resistant to multiple drug strains rather quickly. In developing countries such as Brazil, waste treatment is often inadequate and water drains into local water sources (Santoro 1528). In Brazil *P. aeruginosa* colonies have been isolated in hospital settings and have been found to be many times more resistant. These organisms are able to switch between free body and pathogenic life styles which allows resistant strains to enter the natural aquatic environment more readily and spread with it multiple drug resistant traits. The current processing methods were studied with strains of *P. aeruginosa* being taken from each with each being genetically sequenced and then tested for antimicrobial susceptibility against twelve antimicrobials, specifically piperacillin/tazobactam (100/10 µg), ticarcilin/clavulanic acid (75/10 µg), ceftazidime (30 µg), cefepime (30 µg), imipenem (10 µg), meropenem (10 µg), polymyxin B (300 units), aztreonam (30 µg), gentamicin (10 µg), tobramycin (10 µg), ciprofloxacin (5 µg), norfloxacin (10 µg) (Santoro 1530).

Recent Progress

In the study conducted twenty-seven strains of *P. aeruginosa* were isolated from the five stages of a Rio de Janeiro hospital in Brazil. The hospital waste treatment plant (HWTP) is a five stage treatment. Each stage of the treatment is divided into its own tank, HWTP 1: waste water arrival, HWTP 2: aeration tank, HWTP 3: settling tank, HWTP 4: chlorination tank, HWTP 5: chlorinated effluent output (Santoro 1529). In total 29 strains of microorganisms were observed with 27 being genetically identified as *P. aeruginosa.* HWTP 1 contained 5 strains, HWTP 2 contained 6, HWTP 3 contained 8, HWTP 4 contained 0 and HWTP 5 contained 8. Bacteria from HTWP 4 failed to grow on agar plates incubated at 37°C for 24 hours, but after 72 hours two colonies were identified but were revealed through gram staining to be spore forming bacilli. Strains from HWTP 1, 2, 3, and 5 were exposed to the 12 previously stated antimicrobials in the given amounts. 6 of the 27 strains exhibited multi-drug resistance. Only two of the antimicrobials tested were affective against all strains, those two being polymyxin B and piperacillin/tazobactam (Santoro 1532). The strains with the most resistance were identified in HWTPs 1, 2, and 3. This specific resistance ability in these tanks attributed to the other waste that had not been filtered out yet, such as non-metabolized antibiotics, heavy metals, and acids that put selective pressures allowing for higher resistance (Santoro 1536). The specific resistance of the *P. aeruginosa* soecimines collected from various stages in treatment was rather high, with 62.9% demonstrating a resistance to aztreonam, 33.3% showed resistance to ticarcillin/clavulanic acid and 22.2% showing resistance to cefepime. These results give a good insight to see the diversity in resistance among the *P. aeruginosa* family and shows the danger that these bacteria can poses in a free aquatic ecosystem.

Discussion

 The results show that hospital waste is not being processed well enough to keep all strains of *P. aeruginosa* from being filtered out and that the treatment method allows for creating multi-drug resistant strains in the waste product. While these results suggest that the urban water ways should be filled with similarly resistant strains of *P. aeruginosa,* a previous study of the urban aquatic environment had shown that *P. aeruginosa* had been found in the Jacarepaguá lagoon system and those strains of *P. aeruginosa* were found to be susceptible to all the antimicrobials tested (Coutinho 449). The antimicrobials tested all overlapped with the HWTP study. The antimicrobials dosages in the Jacarepaguá lagoon study were the same as the HWTP study. While the strains of *P .aeruginosa* were not resistant other types of pathogens were highly resistant and able to take extremely high doses of the antimicrobials tested (Coutinho 450).  This discrepancy in resistance ability in *P. aeruginosa* could be attributed to the Jacarepaguá lagoon system not being exposed to resistant strains such as the ones that came out of the hospital waste treatment plant. The results from the HWTP study while valid in the results do not provide an answer to the resistance of the colonies where the waste water is dumped. If the water where the HTWP is dumped after treatment does not have higher resistance then the importance of the study fall drastically. The study does show that highly resistant strains are coming out of hospitals, this means that the current waste disposal methods inadverntelty cultivate multi-drug resistant pathogens and this, especially in the developing world limits the amount of treatment that current medical treatments can provide. In developing countries where medical treatment is already limited, further limits put stress on the healthcare system and put more lives at risk. Current unanswered questions are the possible treatment methods and the cumulative medical side effects of a large urban aquatic population becoming resistant to antimicrobials.

References

Coutinho, Felipe H., Cynthia B. Silveira, Leonardo H. Pinto, Gigliola R. B. Salloto, Alexander M. Cardoso, Orlando B. Martins, Ricardo P. Vieira, and Maysa M. Clementino. "Antibiotic Resistance Is Widespread in Urban Aquatic Environments of Rio De Janeiro, Brazil." *Microb Ecol Microbial Ecology* 68.3 (2014): 441-52. *Springer*. Web. 4 Feb. 2016

Santoro, D. O.1, et al. "Diversity And Antibiotic Resistance Profiles Of Pseudomonads From A Hospital Wastewater Treatment Plant." *Journal Of Applied Microbiology* 119.6 (2015): 1527-1540. *Biological & Agricultural Index Plus (H.W. Wilson)*. Web. 4 Feb. 2016.