Study on Antibiotic Resistance Transmission and Proliferation in Delhi and Development of Possible Mitigation Strategy

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Abstract

Rapid emergence of antibiotic resistance (AR) in developing countries is posing a greater health risk and increasing the global disease burden. Lack of access to safe drinking water, poor sanitation and inadequate sewage treatment facilities in these countries are fueling the problem associated with emergence of AR. Rapid proliferation of AR mediated by treated and untreated discharges from hospitals and sewage treatment plants (STPs) is a prime public health concern. The present study aims to estimate the abundances of antibiotic resistance bacteria (ARB), antibiotic resistant genes (ARGs) and genes assisting AR proliferation (integrons) in various environmental settings (hospitals, drains, STPs and Yamuna River) in New Delhi. Samples collected from the outfalls of 12 major hospitals, 20 drains, 12 STPs and 5 sites of the river Yamuna were analyzed to estimate the abundances of coliforms, ARB [ESBL (Extended spectrum β-lactam) and carbapenem resistant bacteria], ARGs (blaCTX, blaOXA, blaTEM, blaNDM-1) and integron genes (int1, int2 and int3) in summer and winter seasons. Higher abundances of ARB and ARGs were observed in the hospital effluents compared to the samples collected from STPs, drains and river. Inefficiency of the present STPs to remove AR, poor connectivity between drains and STPs has worsened the situation of the river Yamuna. Higher abundance and significant correlation between faecal coliform (FC) and ARB at all the sites indicates possible association of ARB with faecal matter. Strong correlation between ARGs and integrons (int1 and int3) indicates a faster proliferation of AR in the environment. The abundance of ARB and ARGs were higher in winter than summer. ARB isolates obtained from the samples were dominated by gram-negative pathogenic ARB. Complete treatment of the entire sewage generated using tertiary treatment techniques could prevent the introduction of these emerging pollutants in the environment. Treatment studies in various bioreactors showed that the use of hybrid sponge reactor along with the tertiary treatment using UV/Ozone was superior to ASP and septic tank in reducing both the conventional and emerging pollutants. Though complete removal of coliforms and ARB was observed by treating the wastewater using the hybrid sponge reactor followed by UV or ozone but substantial levels of ARGs were observed. Therefore, different advanced and effective treatment technologies need to be developed and evaluated for complete removal of ARGs along with the ARB. Combinations of different tertiary treatment techniques should also be tested to reduce the burden of AR in the environment.