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Original Research Article

PREVALENCE OF ANTIBIOTIC-RESISTANT BACTERIA IN URBAN VERSUS RURAL WATER SOURCES

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Abstract:

The purpose of the experiment was to understand the antibiotic resistance patterns between rural and urban water sources. The present study thus explored and sought to differentiate the bacterial isolates from urban and rural water bodies with antibiotic resistance patterns evaluating the causes of the dissimilarities. The fact is that the study managed to interpret the occurrence of antibiotic resistance as being one of the significant sources for the infection of the waters in the cities, and the country, too. The study confirms that the difference in the number of resistant bacteria between city water sources and country water sources is significant. Research has shown that antibiotic resistance is the most likely urban contributors to industrial pollution and sewage discharge, as well as the copious human density of the city. Urban places have been confirmed to harbor higher amounts of bacteria that are resistant to the antibiotic compounds than other places due to the antibiotic and other pollutant residues that are commonly found in these areas. Consistent with the previous research that urban wastewater, which is mostly loaded with a wide variety of antibiotic residues or other contaminants, showed the highest diversity of resistant bacteria. The fact that there are different species of soft corals growing in different antifungal treatments further supports the hypothesis of a host-microbe interaction. Rehearsing to get to the main point is the emphasis of this study. Water in urban areas, as a matter of fact, exhibits a much higher concentration of antibiotic-resistant bacterial levels thus the differences are becoming clearer every day. Therefore, the studies have further typified the communities of the uncultivated new species and those of the domestic species.

Keywords: Antibiotic-Resistant Bacteria, urban water sources, rural water sources, Water culture, bacterial isolates.

Introduction:

One of the current global developing health risks are resistant bacteria, the trouble of bacterias shielding against medicines is increased quite a lot by overuse and mishandling the issue of antibiotics which mostly happens in urban surroundings. The urban area with its crowded population and heavy industrial activities has an environment that is most conducive to the growth and spread of a multitude of antibiotics-resistant bacteria. The almost total use of antibiotics in the hospitals, as well as in the fields of agriculture, creates rather heavy selective pressure within these urban societies. This (selective) pressure, along with the contamination from wastewater and industrial effluents, has been responsible for the coming into being of the strains of bacteria that no longer respond to the treatment (1, 2). While rural areas may have less traffic because of the absence of industrial pollution, we should not deny the importance of the agricultural practices they carry out. The direct impact of agricultural runoff is the perpetuation of the spread of antibiotic resistance genes. Comparatively speaking, the uncontrolled disease due to antibiotics is more prevalent in the countryside than the city counterparts but it is vital to know that these systems are not completely tucked away from the danger of the drug (3, 4). Overall, antibiotic resistance is a highly complex topic which is directly related to human actions both in urban and rural settings. The identification of the diverse factors that contribute to resistance in each of the various environments is crucial to the establishment of effective strategies against the body\'s growing resistance to the drugs.Urban water sources have been known to be polluted with industrial effluent, municipal sewage and effluents from regions with high usage of antibiotics. The latter enhance the likelihood of development of antibiotic resistant bacteria, since the bacteria are constantly exposed to antibiotics and many other selective factors (5, 6). Previous research has revealed that bacteria living in urban water systems remain often associated with multiple antibiotic resistance levels associated within these environments due to selective pressures (7, 8).

On the other hand, rural water sources, and despite being relatively protected from industrial pollutants are not without their difficulties. So, one of the possibilities of the appearance of antibiotic-resistant water bacteria is agricultural runoff with antibiotics used in treating livestock or regulating plant growth.

The overall levels of resistance may well be lower when compared with those from urban sources but rural environments can, nevertheless, serve as a reservoir for antibiotic resistant bacteria (9, 10). Studies of this type are valuable as they help to reveal the approximate levels of resistance and possible sources, as well as ways of its dissemination in these settings.

This work aims at comparing the occurrence of antibiotic-resistant bacteria in water samples obtained from urban and rural areas, and in doing so, bring the environmental and anthropogenic factors into perspective. The findings are beneficial for understanding the trends of antibiotic usage and designing the directions for public health policies to prevent the growth of antibiotic resistance. Measures which are aimed at proper usage of water and targeted intervention both in the developed and the developing world are vital in combating this vice and preserving the health of the population.

Aim

To investigate the occurrence of antibiotic resistance patterns in bacterial isolates from urban and rural water bodies, and to evaluate the sources of dissimilarity in the patterns.

Objectives

1. To sample and culturable bacterial types from aquatic sources in the urban and rural settings.

2. To find out the proportions of antibiotic resistant bacteria present in these isolates.

3. To use antibiotic resistance pattern to distinguish between bacteria which originated from the urban and rural water sources.

4. In order to assess possible sources and factors of resistance in urban and rural contexts.

Materials and Methods

Study Design and Sampling

Surface water samples were taken from ten urban and ten rural sites obtained over a period of six months. Water samples from the urban areas were collected from rivers, lakes, and treated sewage water, while those from the rural areas were collected from wells, stream and agricultural drainages. Blood samples were taken aseptically in sterile bottles and transported to laboratory and processed within 4-hr of sample collection in tertiary care hospital.

Bacterial Isolation and Identification

Stricking the water samples through a sterile membrane filters after which the filters were cultured on nutrient agar plates. Colonies were typed by Gram staining, API 20E biochemical test and 16 s rRNA gene sequencing (9 & 10).

Antimicrobial Susceptibility Testing

Cumulative antimicrobial sensitivity was determined using standardized disks and the disk diffusion method. The following antibiotics were tested:The following antibiotics were tested:

• β-lactams: Amoxicillin, cephalexin

• Quinolones: Ciprofloxacin

• Sulfonamides: Trimethoprim-sulfamethoxazole

- Aminoglycosides: Gentamicin
- Other: Nitrofurantoin

Data Analysis

The proportion of antibiotic-resistant bacteria was determined and expressed as percentage of the number of resistant isolates to the total isolates obtained from the different sources. Inferential comparisons in the resistance rates between urban and rural sources were conducted through the chi-square tests.

Results

Table 1: Bacterial Isolation from Urban and Rural Water Sources

Source	Total Samples (n)	Number of Bacterial Isolates	Common Bacterial Species Identified
Urban	10	120	E. coli, Enterococcus spp., Pseudomonas aeruginosa
Rural	10	110	E. coli, Staphylococcus spp., Bacillus spp.

The analysis of bacterial isolates from different sources revealed distinct microbial profiles. In urban samples, a total of 120 bacterial isolates were identified, with common species including E. coli, Enterococcus spp., and Pseudomonas aeruginosa. Conversely, rural samples yielded 110 bacterial isolates, predominantly featuring E. coli, Staphylococcus spp., and Bacillus spp.

Table 2: Prevalence of Antibiotic Resistance in Urban vs. Rural Water Sources

Antibiotic	Urban Isolates Resistant (%)	Rural Isolates Resistant (%)
Amoxicillin	45%	25%
Ciprofloxacin	40%	30%
Trimethoprim-sulfamethoxazole	50%	35%
Gentamicin	25%	15%
Nitrofurantoin	10%	20%

The antibiotic resistance data reveals notable differences between urban and rural bacterial isolates. In urban settings, resistance rates are higher across most antibiotics: 45% for Amoxicillin, 40% for Ciprofloxacin, and 50% for Trimethoprim-sulfamethoxazole. In contrast, rural isolates show lower resistance rates, with 25% for Amoxicillin, 30% for Ciprofloxacin, and 35% for Trimethoprim-sulfamethoxazole. Gentamicin resistance is also more prevalent in urban isolates at 25% compared to 15% in rural isolates. Interestingly, Nitrofurantoin resistance is higher in rural areas at 20%, while urban resistance is only 10%.

Table 3: Comparison of Resistance Patterns

Resistance Pattern	Urban Isolates (%)	Rural Isolates (%)
Resistant to Amoxicillin, Ciprofloxacin, and Trimethoprim-sulfamethoxazole	30%	15%
Resistant to Amoxicillin and Ciprofloxacin	20%	10%
Resistant to Ciprofloxacin and Trimethoprim-sulfamethoxazole	15%	10%
Resistant to All Tested Antibiotics	10%	5%

The resistance patterns of bacterial isolates show significant disparities between urban and rural settings. In urban areas, 30% of isolates are resistant to Amoxicillin, Ciprofloxacin, and Trimethoprim-sulfamethoxazole, compared to only 15% in rural areas. Additionally, 20% of urban isolates exhibit resistance to both Amoxicillin and Ciprofloxacin, while this is true for just 10% of rural isolates. Resistance to Ciprofloxacin and Trimethoprim-sulfamethoxazole is also higher in urban isolates at 15%, compared to 10% in rural areas. Lastly, 10% of urban isolates are resistant to all tested antibiotics, compared to 5% in rural isolates.

Discussion

This work shows that antibiotic-resistant bacteria are more likely to be found in the urban water source rather than rural sources. It is believed that certain specific regions, such as urban areas have a high level of contamination from industrial and domestic use hence exerting more selective pressure to the bacteria hence the high resistance (1, 5). On the other hand, the water sources from the rural areas had a lower resistance levels and may be attributed to the fact that the water regularly in contact with antibiotic residues and different sources.

The study also establishes a significant difference in the occurrence of antibiotic resistant in water sources, more especially in urban and rural sources. Studies also showed a clear indication that antibiotic-resistant strains were more predominant in urban areas because of exposure to industrial pollutants, sewage and high population density which puts pressure in the resistance to antibiotics. These results are consistent with prior studies showing that urban water resources, often exposed to a wide range of antibiotic residuals and other pollutants, host a higher range of resistant bacteria (1, 5).

On the other hand as compared to rural water sources which in general responded comparatively lower levels of resistance, they are also affected by agricultural pollution and the conventional use of antibiotics in animals. This means that even in areas with low pollution levels there is reason for concern because contamination can be local and considerable in terms of antibiotic resistance (3, 4). The gender, age and geographical distribution show that the rural settings need lower amounts of resistance as compared to the urban environments, thus highlighting the differences in the stratification of resistance by factors such as environmental and anthropogenic influences.

Approach to combating Antibiotic resistance should therefore consider with distinction between the urban and rural population. For urban areas there is a need to enhance the waste management system as well as increase the legal measures on the use of antibiotics. Measures that can help reduce resistance in rural areas include, observing the kind of farming practices being enacted and reducing the effects of runoff. Special measures should be taken to monitor antibiotic resistance in bacteria and take appropriate measures in order to inhibit its further development.

Conclusion:

Present study highlights This study highlights the differences between urban and rural water sources. The higher prevalence of antibiotic-resistant bacteria in urban water sources underscores the need of improved waste management and strictness in regulation in managing contamination of water sources. Rural water sources needs to be monitored potential increases in resistance of water. Continuous research are needed to monitior the water resources and prevent from antibiotic resistance from these water sources.

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