

# Antibiotic Resistant Bacteria in the Waters of Hyderabad

## Causes and Remedial Measures

### The Problem

Most of the water supplies of the big cities of Pakistan have been found to carry high loads of chemical and microbial contaminants. It is estimated that 30% of all diseases and 40% of all deaths in the country are due to poor water quality. The problem has been exacerbated in recent decades because of the continuous evolving nature of bacteria. The widespread use of antibiotics to treat bacterial infections—both for farming and clinical purposes—has resulted in bacteria developing immunity to drugs. These Antibiotic Resistant Bacteria (ARBs), are capable of transferring their genes to human pathogens<sup>1</sup>—a process known as horizontal gene transfer—and, with time, human pathogens become antibiotic resistant too. Often these Multi-Drug Resistant bacteria pose a great threat to human health since treatment of even common diseases through antibiotics becomes almost impossible.

Hyderabad, the second largest city of Sindh and the sixth most densely populated city of the country, is one of the cities plagued by clean water issues. The city has three main sources of freshwater: groundwater, river water, and water supplied by the municipality. Additionally, people use bottled water, and in some areas, water from the Reverse Osmosis plants which have been installed by the city for the purification of groundwater. By and large, however, the majority of the population in the city is dependent on piped municipal water for its daily needs. In areas adjoining Hyderabad, river and canal water are used for domestic purposes.

### The study

This project was designed to evaluate the quality of drinking or tap water—with the objective of identifying ARB present in the waters of Hyderabad and its suburbs—through the use of molecular techniques, and to recommend disinfection mechanisms to purify it. For the study a total of 461 samples of tap, bore and surface water were collected from different localities of the city including its suburbs of Qasimabad and Latifabad, and the outlying areas of Jamshoro and Kotri.

### Findings

The World Health Organization (WHO) specifies that water used for drinking, cooking, and washing, must be free from coliform and fecal coliform bacteria. Unfortunately, microbiological analysis shows that much of the water, in Hyderabad and its suburbs, is not fit for human consumption. This study shows that 39% of municipal water samples collected from Hyderabad

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<sup>1</sup>**Pathogens** are organisms capable of causing disease in its host. A **human pathogen** is capable of causing illness in humans.

and its surroundings, carried coliform bacteria, and 31% of these samples had fecal coliforms. Results of studies of river and surface water, the two other major sources of water for Hyderabad and its surrounding population, show that 70% of river and surface water samples were contaminated with coliform and 49% carried fecal coliforms.

In addition, 40 water samples collected from Reverse Osmosis treatment plants showed that 52% of the samples contained coliforms and 45% tested positive for fecal coliforms. Also, 67% of the Reverse Osmosis water samples were found to carry a high load of heterotrophic<sup>2</sup> bacteria—far above the standard value set by WHO. In the case of mineral water samples, 39% of the samples were declared not fit for human consumption for the same reason. This is alarming, because Reverse Osmosis plant water and bottled water is generally accepted as safe, and most hospitals and patients prefer using this rather than tap water.

The pathogens identified in the water are major sources of waterborne infections, including, among others, diarrhoea and dysentery. Seriously concerning is the fact that a majority of these pathogens were found to be resistant to commonly used antibiotics, leaving consumers exposed to the risk of acquiring infections that are resistant to treatment by many of the commonly used drugs.

### **Causes of contamination**

#### ***In municipal water***

One of the major causes of contamination of water is the sewerage system which runs parallel to drinking water supply lines. Poor monitoring and maintenance, along with old and sometimes corroded pipelines, lead to frequent leakages and intermixing between the two pipelines. Leakages and overflow from the sewerage system are also responsible for microbial and chemical contamination in groundwater bodies.

#### ***In river water***

A second source of bacterial contamination of water supplies is the result of human activity. Hyderabad is located on the left bank of the Indus River, which is the major source of water for the city. People use the river, and the canals that feed into it, to bathe their animals as well as to wash their vehicles and clothes. Besides, domestic waste from households and sewage is also dumped into the rivers/canals without prior-treatment. All this increases pollution and bacterial load.

#### ***In Reverse Osmosis plants and bottled water***

Reverse Osmosis is generally regarded as an effective and reliable method to purify water; but for the technique to be effective, and for the water to be safe from bacterial contamination, it is essential that required safety protocols are maintained and the working guidelines of WHO or PSQCA are followed diligently. In the case of Hyderabad, it was found that most Reverse Osmosis and other commercial water treatment plants were violating set guidelines regarding equipment maintenance and calibration.

The plants are operated by non-professionals and measures to determine water quality are not followed stringently. Most essentially, none of the plants had written documents for membrane

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<sup>2</sup>Bacteria that take the sugars they need to survive and reproduce from their environment.

check-ups—an essential step in Reverse Osmosis. The use of untreated municipal/groundwater by system operators leads to the formation of impurities and bio-fouling agents on the membrane which damages it and results in a high load of bacteria in the product water.

As regards bottled water, a majority of the treatment plants are installed in small shops with doors opening out into streets; all activities—washing and filling of bottles, storage of processed and unprocessed water—are carried out on site in non-sterile conditions and in total disregard of guidelines. That bottled water is exposed to elevated temperatures for long periods of time and this could be a contributing factor for bacterial growth.

### **Treatment**

*Wastewater treatment:* By treating highly-contaminated water into a much-diluted form, wastewater treatment plants play a vital role in slowing down the spread of ARBs. Unfortunately, the presence of large quantities of ARBs in wastewater decreases the efficacy of the treatment and makes it difficult to realize its purpose.

*Chlorination:* Sodium hypochlorite, more commonly known as bleach, is considered to be one of the best antibacterial agents for waterborne bacteria. It is widely used for water purification all over the world. The present study also found chlorination to be an effective method to remove most waterborne pathogens. When a chlorine dose of 1.5 mg/l was applied for one to five minutes to the water samples collected from Hyderabad and its suburbs, a majority of the waterborne pathogens were completely destroyed.

*Ultraviolet disinfection:* This disinfection method which uses short-wavelength ultraviolet light to kill or inactivate micro-organisms by disrupting their DNA, has also been found to be effective for water purification and is used in various parts of the world because of its strong ability to render bacteria and viruses incapable of reproducing and infecting. Moreover, it is a non-corrosive technique and therefore conducive for water treatment plants and distribution network systems as well.

Unfortunately, neither UV treatment, nor chlorination are practised on a regular basis despite the fact that bacterial contamination of water resources and waterborne infections remains a threat and one of the major causes of morbidity and mortality in Hyderabad and its surroundings.

### **Recommendations**

Having looked at the problems affecting the water supply/distribution network, the study suggests the following recommendations to ensure safe water to the people of Hyderabad:

#### **Pre-cautionary measures to avoid bacterial contamination**

- Water supply sources must be protected. All wastewater discharged into rivers, canals, and open depressions must be treated first.
- The entire water supply chain needs to be revamped; old, corroded, and leaking water pipes need to be replaced.
- Proper water pressure in the supply network should be maintained at all times so that untreated water from the ground is not sucked into the network.
- A proper system of disinfection needs to be set-up and monitored along scientific lines to ensure that the water supply meets the standards required for human consumption. This study highlights two disinfection techniques—*chlorination and ultraviolet disinfection*—that can achieve this.

- Overuse of antibiotics both in clinical and agricultural set-ups should be discouraged to lower the amount of residue seeping into the water supplies.
- Raise awareness of the dangers of self-medication through antibiotics to stop the misuse of antibiotics and its contamination of the water supply.

Other issues to be considered

- Illegal siphoning of water with pumps from the public main pipes must be stopped.
- In case of accidental microbial contamination, consumers should be alerted and briefed about the use of water in such a situation.

**Antibiotic Resistant Bacteria (ARB)**

When bacteria survive antibiotics they develop resistance to the drugs through genetic mutation. This mutated bacteria is then referred to as Antibiotic Resistant Bacteria or ARB in short. ARBs are capable of transferring their genes to human pathogens, causing illness in human beings that are difficult to cure through antibiotics.

**Multi-Drug Resistant (MDR) Bacteria**

These are bacteria that are resistant to more than one antibiotic. Multi-Drug Resistant ARBs are increasing at a rapid rate and pose a major challenge to health worldwide since infections caused by MDR bacteria cannot be treated through antibiotics. They are found mainly in hospitals and long-term care facilities and often affect the elder and those who are chronically ill.