

# Enhancing Waterborne Diseases in Pakistan & Their Possible Control

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## Abstract

In Waterborne disease, water is a carrier of either infectious entities or of chemicals. Recently reported Pakistani data highlights that conditions of both drinking water supply and sanitation are still not satisfactory in urban and rural areas. Aquatic reservoirs of Pakistan are also contaminated so indirectly cause broad spectrum waterborne ailments e.g. gastroenteritis, diarrhea, vomiting, renal and dermal ailments. Leading causes of water linked disorders are unsafe domestic water usage, unprotected water sources, unawareness of sanitation practice, poor management of water treatment, monsoon season and flooding and global warming. It is need of the time that the government of Pakistan should organize new waste water treatment plants and repair of existing ones to provide safer water for consumption. Although currently, reverse osmosis membranes are in use but they are costly and also not fully effective and it is better to plan their replacement by carbon nanotubes. Moreover, waterborne diseases can be minimized in three ways in Pakistan and in other developing countries by improving quality and quantity of drinking water and by safer sewage disposal along with provision of low cost and proper sanitation facilities.

**Keywords:** Carbon nanotubes; reverse osmosis; sanitation; sewage disposal; water borne disease.

## 1. Introduction

Ailments which are transmitted through intake of contaminated water are said to be water linked diseases and also known as waterborne diseases.

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In water linked diseases, water is a carrier of infectious entities i.e. bacterial, parasitic or viral entities (transmitted through fecal–oral route). Moreover, sometimes chemicals are also considered as triggering source for such disorders. The entities are either excreted into water through bleeding wounds or lesions and often with feces, or they are the natural inhabitants of water bodies [1, 2]. Around 15% of World’s population are living in water stressed areas. On the other hand, 2.5 billion people have no access to better sanitation system, and 2 to 2.5 million people die each year from diarrhea. In rural Africa, pure and clean water is very rare due to underdeveloped sanitation systems, the water which is used there on regular basis might be the cause of many infections leading to chronic disability and death [3]. Moreover, in developing countries, the economically sufferers have to face frequent waterborne ailments due to inadequate clean water supply, sanitation and hygiene (World Bank, 2002). That is why; worldwide illness rate is 4 billion per year, of which 30% (1.2 billion/year) are due to unsafe water consumption [4].

## **2. Current situation of waterborne diseases in Pakistan**

Pakistani data from recent past clearly indicate that still conditions of both clean water supply and sanitation are not satisfactory either in metropolitan cities or in countryside population even remote areas are facing worse condition in this regard. It also highlights that the consuming water is usually contaminated with *E. coli*, *Enterobacter*, *Salmonella* and *Clostridium* but general mass awareness is also the major root cause of suffering health of people [5]. Another survey indicates that 43.2 million people of Pakistan lack satisfactory sanitation facilities and 52.8 million people are still without standard drinking water [6]. Today approximately 85% of population is in cities whereas 55% belong to villages and towns but overall only 65% population has access to safe drinking water. Similarly, 42% of population is availing sanitation facilities, of which 30% countryside and 65% cities (World Bank, 2002). The major root causes are alarming rate of population growth and vast industrialization for gradually declining quality of drinking water in this country [7]. In Pakistan, 40% deaths were observed due to disorders transmitted through contaminated water in approximately last 5 years [8]. Even recent most data highlight that still due to lack of proper sanitation and with enhanced anthropogenic activities, waterborne diseases that present about 80% of all diseases and are responsible for 33% of deaths [7].

## **3. Water quality in water bodies of Pakistan**

The water quality of water bodies i.e. canals, shallow pumps, dug wells, and water supply schemes from different districts of Pakistan was measured through physical, chemical, and biological parameters e.g. turbidity, coliform, and electrical conductivity, for which the results were (24%, 28%, 96%, 69%), (96%, 77%, 92%, 81%), (100%, 99%, 44%, 63%), respectively. Moreover, contents of sodium and iron were also measured which are indirect sources of inferior quality water in these aquatic reservoirs of Pakistan and also serve as root causes for the diseases associated with these affected and contaminated water bodies e.g. gastroenteritis, diarrhea, vomiting, renal and dermal ailments [9-14].

## **4. Classification of common waterborne diseases**

Water is usually contaminated by either chemicals or pathogens. In Pakistan, commonly occurring waterborne

diseases are as follows:

#### **4.1. Waterborne diseases due to chemical contamination**

Water has exposure of contaminants having chemical origin, mainly from industrial, municipal and agricultural wastes which are solely responsible for many waterborne diseases. Many heavy metals like chromium (in hexavalent state), cadmium, nickel, lead, mercury and arsenic; cations i.e. sodium, potassium and calcium; anions i.e. carbonates, bicarbonates and nitrates; and pesticides i.e. dichlorodiphenyltrichloroethane (DDT) and benzene hexachloride (BHC) enter in water bodies either from point or non-point sources, cause various health complications among people of Pakistan [15]. Reported data highlights that consumption of drinking water contaminated with heavy metals, pesticides, cations and anions cause serious health problems related to gastrointestinal, renal, cardiovascular, respiratory and reproductive systems. Moreover; urinary tract burning and calculi, leukomelanosis, hyperkeratosis, black foot disease, neuropathy and cancer are also induced by chemicals transmitted through intake of contaminated water [15-19].

#### **4.2. Waterborne diseases of pathogenic origin**

##### **4.2.1. Cholera**

Cholera, spread by the bacterium *Vibrio cholerae*, causes severe diarrhea and vomiting which leads to dehydration. If not undergone by a proper treatment, it can be severe up to 50%, but a treatment lessens its severity to as low as 1%. Globally, mortality rate due to cholera is over 100,000 [2, 20].

##### **4.2.2. Typhoid and paratyphoid fever**

Typhoid and paratyphoid fever are caused by *Salmonella typhi* and *Salmonella paratyphoid*, respectively. The bacteria after entering the human body through contaminated water increase their number from intestine into the blood stream. Even after the treatment of typhoid and paratyphoid fever, some individuals are carriers i.e. the bacteria are not fully eliminated from their body [21].

##### **4.2.3. Shigellosis**

Shigellosis often called bacillary dysentery is a gastrointestinal disease caused by *Shigella* species. These *Shigella* species are classified into four categories i.e. *Shigella dysenteries*, *Shigella Flexner*, *Shigella boydii*, *Shigella sonnet* having the serotypes 15, 14, 20, 1 respectively. The countries having more contaminated water ratio have the *Shigella* species and the mortality rate due to shigellosis is higher in children under five. The symptoms may range from slight watery diarrhea to severe inflammatory dysentery and other clinical manifestations include abdominal cramping, fever, nausea, vomiting, convulsions, septicemia, dehydration, joint pains, hypoglycemia, hemolytic uremia and neurological complications [22, 23].

##### **4.2.4. Giardiasis**

Giardiasis often called gastroenteritis is a disease caused by *Giardia lamblia* in humans. In Asia, over 280

million cases of giardiasis have been observed. *Giardia lamblia* basically hinders the nutrients' absorption from intestine, thus generating malabsorption and its infection to humans might be symptomatic or asymptomatic. Giardiasis is linked with the socioeconomic level of a country, and in developing countries its prevalence is reaching 40% [24].

#### ***4.2.5. Cyclophorias and cryptosporidiosis***

The causative agent of cyclophorias is a protozoan, *Cyclosporin coetaneities*. This disease is associated with diarrhea in humans and it can be treated through co-trimoxazole antibiotic. In order to identify this protozoan, the laboratory staff should measure the size of oocysts in human stool samples [25, 26]. Globally, *Cyclosporin coetaneities* has reported as a potent microbe in 1.8% outbreaks [27]. Whereas *cryptosporidiosis* is a disease caused by *Cryptosporidium parvum* and it is associated with a prolonged diarrhea [23].

#### ***4.2.6. Dracunculiasis and schistosomiasis***

Dracunculiasis and Schistosomiasis are caused by parasitic worms i.e. *Ranunculus eminences* and *Schistosoma* spp., respectively and are associated with painful ulcers on lower limbs and feet, urinary and intestinal damage, and bladder cancer [23].

#### ***4.2.7. Amebiasis and amoebic meningoencephalitis***

Amebiasis associated with diarrhea or may be with severe dysentery which is caused by *Entamoeba histolytica*. Similarly, free living amoebae cause amoebic meningoencephalitis leading to deadly encephalitis [23].

#### ***4.2.8. Estuary associated syndrome***

A syndrome associated with optical and respiratory irritation, deficiencies in learning and memory, and acute phase of mental illness like continuous confusion, is caused by *Pfiesteria piscicida* which proliferates due to the presence of toxins in water [23]. Worldwide, approximately 500,000 deaths occur due to worm parasites each year [3].

#### ***4.2.9. Hepatitis A and E***

Both hepatitis A and hepatitis B are caused by hepatitis A and hepatitis E virus respectively which are basically the traditional disease causing entities [21]. In Islamabad, Pakistan, hepatitis E was found in most of the individuals due to the use of untreated water [14].

### **5. Significant causes of waterborne diseases in Pakistan**

#### ***5.1. Unsafe domestic water consumption***

Like other developing countries, common man of Pakistan is also suffering from shortage of safe water supply and frequently exposed to related contagious diseases [28]. It is observed that about 35% of the gastrointestinal infections amongst tap water consumers are water-associated [29]. Similarly, it has also been found that the

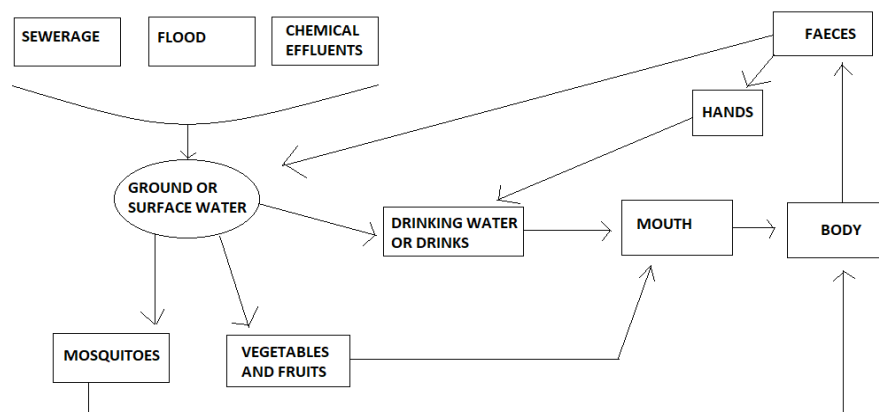
water used by the people of Asian countries for cooking purpose have inorganic arsenic in large amount which is highly toxic to human health. Moreover, cooking meal i.e. rice by using inorganic arsenic contaminated water greatly affect the meal quality and induce broad types of sickness in consumers [30].

### 5.2. Unprotected water sources

According to the reported data the main causes of waterborne diseases is unprotected water sources i.e. a water source is being contaminated with social activities as well as waste matter of living entities. Various surveys describe that waterborne diseases cause approximately 116,000 deaths of children of age under 5 every year. The way, in Bagh District, Kashmir and northern area of Pakistan, water bodies are contaminated by the waste material and algal growth, serve as major cause of contamination in drinking water, leading to diseases [8]. Moreover, the underground water pipe channels can also be polluted with sewerage or flood water, if broken down. Various chemical elements such as arsenic, manganese, chlorine, and iron along with industrial trashes contaminate ground water table and are very harmful as compared to surface water contamination [15, 31]. Pesticides and insecticides had been detected in the runoff water which is entering into the drinking water source form the irrigation land, leading to the bacteriological and chemical contamination in water [8, 15].

### 5.3. Unawareness of sanitation practice

Lack of hygiene awareness is also the root cause of waterborne diseases. People living in houses do not wash out their water bottles on regular basis. It is reported that only 26% homes clean their water bottles habitually in which 32% are of treated homes and 22% are of control homes. Moreover, pathogens may enter into the human body by unprocessed ground water or while taking a bath in an open pond or river water, thus, cause several health disorders. In other words, microorganisms which cause such diseases are usually able to infect a person due to different factors such as lack of cleanliness and hygiene, and unprotected drinking water supply sources (Figure 1) [31].



**Figure 1:** Flow chart elaborating leading sources of water contamination [31].

#### **5.4. Poor management of water treatment**

Lack of proper water treatment, either of industrial effluents or sewage water, before their entry into water bodies or before their reuse is another cause of waterborne disorders [8, 15]. In this regard, the project named Water and Sanitation Extension Program (WASEP) was started in some specific villages of northern Pakistan from 1997 to 2001 in order to improve the drinking water supply in villages and other remote areas, along with other cleanliness services [32]. Whereas, in the rural communities of Abbottabad, the water and sanitation system is quite poor yet, as different pathogens i.e. *E. coli*, *Enterobacter*, *Salmonella* and *Clostridium* have been detected in drinking water which serve as potent source of waterborne diseases [5].

#### **5.5. Monsoon season and flooding**

During monsoon season, masses of Pakistan are greatly affected by various waterborne diseases. Globally, Pakistan comes at 9<sup>th</sup> position, in case of flood affected countries [11]. Haidari and coworkers (2016) reported data of bacterial content in drinking water, during before and after monsoon in Southern Lahore and the readings were 62.5% and 75%, respectively. Similarly, in 2010, around 1600 mortality cases were observed in Khyber Pakhtunkhwa province due to heavy rainfall and flood and approximately 14 million people were affected with pathogenic infections and epidemics of these flooded areas [11].

#### **5.6. Global warming**

Global warming is also responsible for the prevalence of waterborne diseases i.e. cholera which is a cause of severe diarrhea. Due to global warming, floods and droughts occur to large extent which favor waterborne diseases [33].

### **6. Prevention of waterborne diseases & control of water quality assurance**

To control waterborne diseases, the government of Pakistan should improve the water quality by generating more waste water treatment plants and repairing the existing ones so that the people of Pakistan can use safe water for their drinking purpose. Furthermore, the government should improve the sewerage system of Pakistan so that the waste in sewerage pipes cannot seep into water bodies. Moreover, general mass awareness campaign should be organized and maximized to convey hygienic principles and their significance. Either in recent era or in near future following methodologies are in use and they should be improved or replaced by low cost and effective alternatives for provision of safe water consumption.

#### **6.1. Current practice**

Reverse osmosis (RO) technology is currently implied for water treatment to reduce many water related diseases. It is a pressure-driven method by which a partially permeable membrane disallows dissolved aquatic constituents. The working principle is size and charge exclusion, and physical–chemical interactions among solute, solvent and membrane. But the main drawback of this technology is the RO membrane fouling which is caused by the deposition of solutes on membrane surface leading to the membrane pore blockage [34]. In

addition to this, RO membrane demineralizes the water which is unhealthy for humans. Similarly, it also cannot eliminate volatile organic compounds (VOC), chlorine, chloramines and pharmaceuticals. Whereas, large amount of energy is also an important requirement to carry out this RO process [35].

## **6.2. Ecofriendly alternative for future**

Carbon nanotubes (CNTs) can be used for water treatment as an alternative of RO membrane. CNTs have hydrophobic hollow structure with some hydrophilic functional groups at their nanotube ends which allow frictionless movement of polar water molecules, thus, no additional force is required for the flow of water molecules through these hollow tubes. CNTs have the ability to remove micropollutants and ions from water [35]. Moreover, the antimicrobial and cytotoxic effect of CNT membranes lessens membrane biofouling, thus, improves membrane life by killing pathogens (by disrupting their cell membranes) [35, 36]. Thus, CNT membranes may be considered as reliable and low cost alternatives as they are highly recyclable, feasible, stable and ecofriendly [35].

## **7. Conclusion**

It can be concluded that the public health can be improved and waterborne diseases can be controlled in three ways, not only in Pakistan but also in other developing countries by quality and quantity improvement of drinking water and safe disposal of sewage by providing proper sanitation facilities [7].

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