Original Article

# Assessment of Physical Characteristics and Fecal Contamination of Drinking Water in Tertiary Care Hospitals of Lahore

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**Objective:** To assess physical characteristics and fecal contamination of potable water in public and private tertiary care hospitals of Lahore.

**Methods:** This cross sectional study was carried out in 25 tertiary care hospitals of Lahore (11 public and 14 private). 145 samples of water were collected from tube-wells, storage tanks, filtration plants and end-user points in emergency and outpatient departments from all hospitals. Physical characteristics were examined at the time of collection of samples. Chlorine estimation was done by Lovibond Comparator. Temperature and pH was examined. Presence of E. coli was detected by Multiple Tube Method. Results of fecal contamination were confirmed in Bacteriology Laboratory of Institute of Public Health, Lahore. Data was entered in SPSS version 24.0 and analyzed.

**Results:** Fecal contamination was present in 55.86% of all samples of water collected. Out of 70 samples of water taken from private hospitals, fecal contamination was present in 61.4% samples as compared to 50.7% samples taken from public sector hospitals (p = 0.19). Overall, E. coli were detectable in 37.9% samples whereas coliform organisms were seen in 17.9% samples.

**Conclusions:** The tertiary care hospitals, both public & private fail to provide safe drinking water to the patients and their attendants. Fecal contamination of more than 50% of all samples points towards the gravity of the situation and demands serious measures by the concerned authorities to address the issue.

**Keywords:** potable water, fecal contamination, cholera, diarrheal diseases.

## Introduction

Potable water is drinkable water that should be free from pathogenic microorganisms, harmful chemical substances, should be palatable and free of any colour and odor.[1,2] Water forms the basis of all body fluids, acts as a solvent and a lubricant, helps in metabolism and regulates the body temperature. Adequate supply of clean and safe water is imperative to health to accomplish routine activities of life like drinking, cleaning, washing and bathing. Being a good solvent, it can dissolve any type of impurities.[2,3] According to World Health Organization, water should be colorless, odorless and tasteless. It should have less than 5 Nephelometer Turbidity Units.[4] pH should vary between 6.5 to 8.5.[5] E. coli and fecal coliform bacteria must not be detectable in 100 ml sample of water.[6] Daily requirement of drinking water of an adult is about 2-2.5 liters that is equivalent to 10 -12 glasses per day. Requirement can be increased or decreased depending on the type of activity he/she is involved in and the climatic conditions.[7] Fecal contamination of potable water is a significant health hazard responsible for causation of waterborne diseases. Availability of safe and clean water in developing countries is a prime focus of WHO so as to reduce the burden of water borne diseases worldwide which are responsible for 801,000 deaths from diarrheal diseases per year occurring in children under five years of age.[8] Environmental, ecological and socioeconomic factors have a great impact on the occurrence of infectious diseases. Rapid population growth, extreme weather conditions and changes in climate influence the water resources regarding quality and quantity leading to emergence of water associated diseases. Most of the outbreaks are related to waterborne diseases. Pathogens involved are linked to fecal oral route, water, sanitation and hygiene.[9,10] Pakistan is blessed with sufficient surface water and ground water by nature. Due to rapidly increasing population with 2.6% per annum growth rate and industrialization with urbanization and anthropogenic activities, the availability of quality water is decreasing. It has decreased from 5600 $m^3$ per annum per capita in 1951 to 1000 $m^3$ in 2010. Only 20% of the population has access to safe drinking water due to scarcity of healthy water resources.[11] According to UNICEF 40% of diseases in Pakistan are waterborne. Contaminated water, lack of sanitation and inadequate hygiene are responsible for 90% of child deaths secondary to diarrheal diseases. Pakistan Standards &

Quality Control Authority (PSQCA) has devised parameters following guidelines of World Health Organization and water sanitation and hygiene. Policies have been devised and certain programs have been initiated to provide safe water to the population of Pakistan to ascertain Millennium Development and Sustainable Development Goals.[12]

Tertiary care hospitals are hotspots where masses flock together and are thus exposed to contamination related diseases including waterborne ailments. Lahore city, now a metropolis, plays important role in providing tertiary care health facilities to the people from all over Punjab and Pakistan. Both public and private sector services are heavily visited and therefore could spark outbreaks of potentially fatal diarrheal diseases. This study was conducted in public and private tertiary care hospitals of Lahore. The purpose of the study was to assess the quality of drinking water made available to the patients and their attendants and to find out possible factors contributing to fecal contamination at various levels of distribution.

## Methods

This cross sectional study was carried out between July & October 2017 on all 25 tertiary care hospitals of Lahore comprising of 11 public and 14 private sector hospitals. 145 samples of water were collected from tube-wells, storage tanks, filtration plants and end-user points in emergency and outpatient departments from all hospitals. Physical characteristics were examined at the time of collection of samples i.e. colour, odor, taste and turbidity. Chlorine estimation was done by Lovibond Comparator. Temperature and pH was examined. Presence of E. coli was detected by Multiple Tube Method. The test was done to detect the presence and estimation of most probable number of coliform organisms in 100 ml of water.

The data was collected using a predesigned proforma after seeking consent from the medical superintendents of the concerned hospitals. Samples were collected using full aseptic technique by trained laboratory staff of the Water Testing Lab of IPH Lahore. These samples were subjected to Multiple Tube Method in the Water Testing Lab by the staff of the laboratory under supervision of the supervisor of this research. Data was entered in SPSS version 24.0 and analyzed. Descriptive statistics were presented using frequencies & percentages for categorical variables and mean±SD for continuous variables. Chi square was applied to compare categorical variables while student's t test was used to compare means of two groups. The p value of ≤0.05 was taken as significant.

## Results

145 samples of water were collected to assess fecal contamination of water. These samples were taken from tube wells, storage tanks and out-patient and emergency departments. Samples from filtration plants or reverse osmosis (R.O) plants were also taken where such installation was available. Fifty one percent samples were collected from public sector hospitals. Twenty eight percent samples were taken from tube wells, 26.9% from tanks, 15.9% from emergency taps, 20% from OPD taps, 8.3% from filtration plants and 2.8% samples were taken from cafeteria or canteens.

The mean value of pH was 7.91±0.197 with a range of 7.2 to 8.4. The mean temperature was 26.05±2.72 ˚C with a range of 17.2 ˚C to 29.7 ˚C. Mean free residual chlorine concentration was 0.016±0.045 mg/l with a range between 0.2 & 0.7 mg/l. Mean total chlorine concentration was 0.27±0.122 mg/l with a range between 0.2 & 1.0mg/l. Fecal contamination was present in 55.86% of all samples of water collected. Out of 70 samples of water taken from private hospitals, fecal contamination was present in 61.4% samples as compared to 50.7% samples taken from public sector hospitals (p=0.19) **(Table-1).**

**Table-1:** Fecal contamination of potable water in public and private hospitals of Lahore.

| Category | Fecal contamination present | | Fecal contamination present | | Total Samples | P-value | Remaks |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | | | |
| **Private** | 43 | 61.4 | 27 | 38.6 | 70 | 0.192 | Not Significant |
| **Public** | 38 | 50.7 | 37 | 49,3 | 75 | | |

E. Coli were detectable in 37.9% samples whereas coliform organisms were seen in 17.9% samples. Results of fecal contamination were confirmed in Bacteriology Laboratory of Institute of Public Health, Lahore.

E Coli were detected in 93% (40 out of 43) of the contaminated samples from private sector hospitals in comparison to 39.5% (15 out of 38) of contaminated samples from public sector hospitals (p< 0.05). **(Table 2)**

## Discussion

Accessibility and availability of safe and clean drinking water to an individual is of prime importance in both urban and rural areas of a

country. Because of its relation with the increased incidence of waterborne diseases, significant efforts have been made for its provision to the masses by the governments.

**Table-2:** Frequency distribution of presence of E Coli in the contaminated water samples obtained from various water sources from private and public sector hospitals of Lahore.

| Contaminated Water Source | Presence of E Coli in contaminated Water Samples | | | |
|---|---|---|---|---|
| | Private (n-43) | | Public (n=38) | |
| | n | % | n | % |
| Filtration Plant | 01 | 100.0 | 01 | 25.0 |
| Cafeteria/Canteen | 01 | 100.0 | 00 | 0.0 |
| OPD | 10 | 83.3 | 00 | 0.0 |
| Emergency | 09 | 100.0 | 04 | 50.0 |
| Overhead Tank | 13 | 92.9 | 06 | 42.9 |
| Tube wells | 06 | 100.0 | 04 | 44.4 |
| Total | 40 | 93.0 | 15 | 39.5 |

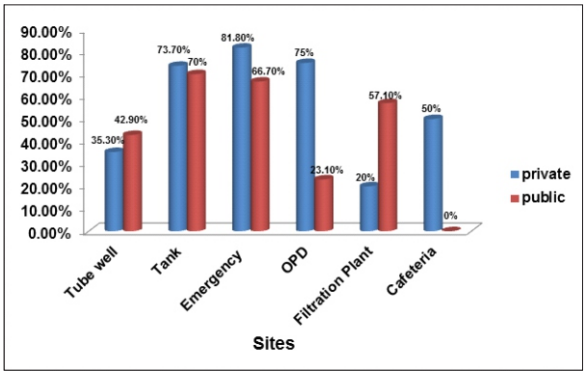


**Fig-1:** Fecal contamination detected from various levels of water distribution system in Hospitals of Lahore.

This can be reflected in decreased global burden of waterborne diseases in developed countries by better planning, monitoring and implementing better technologies and maintaining a good surveillance system.[13] Being an urban metropolis, Lahore has a population of more than eleven million spread over an area of 1772 km.[2] Multiple problems are emerging and one of them is the insufficient provision of safe drinking water to the citizens. Quality of water can be assessed partly by examining the physical characteristics of water. Clean and transparent appearance with colorless, odorless and palatable taste was observed in all samples taken from all tertiary care hospitals of Lahore including both public and private sectors. Turbidity of water is caused by suspended particles of organic material, silt and clay. All samples presented with less than 1 Nephelometer Turbidity Unit and pH ranged from 7.2 to 8.4 which reflected good quality of water by appearance. Studies done previously in Lahore revealed physical characteristics within normal parameters formulated by WHO which states that safe drinkable water should be colorless, odorless, transparent and palatable to taste.[1] Fecal contamination was present in 55.86% of 145 water samples taken from both public and private hospitals. Out of these contaminated samples, 37.9% were positive for E. coli and 17.9% for total coliforms. Comparison of fecal contamination between public (50.7%) and private (61.4%) hospitals was not statistically significant (p=0.192).E Coli were detected in 93% (40 out of 43) of the contaminated samples from private sector hospitals in comparison to 39.5% (15 out of 38) of contaminated samples from public sector hospitals ($p<0.05$). As is visible in table 2, all tube wells (06) in private sector were contaminated with E Coli, as compared to 4 (44.4%) of tube wells in the public sector. This finding was augmented by the fact that the mean depth of the tube wells in public sector was 815.96 ± 484.587 feet as compared to 371.25±221.856 feet in the private sector ($p<0.05$). The mean number of years since construction of public sector tube wells was 11.8226±8.213 years as compared to 8.001±5.914 years for private sector hospital tube wells (p= 0.078). So, deeper the well, the lesser are the chances of fecal contamination. However the same may not be true for the duration since construction.

## Conclusion

The tertiary care hospitals, both public & private fail to provide safe drinking water to the patients and their attendants. Fecal contamination of more than 50% of all samples points towards the gravity of the situation and demands serious measures by the concerned authorities to address the issue. The results also highlight the need to monitor the quality of water provided to the rest of Lahore and ultimately contribute towards prevention and control of potentially life threatening diarrheal diseases.

More than 55% samples of water positive for fecal contamination reflects some of the deficiencies which need to be catered. Multiple factors are involved which may be categorized as:

a) General factors: these are related to population density, environmental pollution, climate change etc that require political commitment to develop long term policies and their implementation.[3,4,5,11,14]

b) Administrative factors: which point towards the need to be addressed by the higher administrative authorities like Water & Sanitation Authority

(WASA), Environment Protection Agency (EPA) as well as Health department, regarding adoption of measures to prevent contamination of surface and ground water sources and implementation of rules and regulations on all concerned. The same authorities need to be vigilant in monitoring and evaluation of the water related issues and suggest measures to be adopted to prevent worsening of the situation.

c) Hospital related factors: which need to be addressed by the hospital administration locally. These factors involve care of local water sources, water distribution system and ensuring provision of safe drinking water to the end users. Monitoring regarding cleanliness, disinfection of water, accessibility and availability to the consumers has to be ensured by the hospital administration). Most of the tertiary care hospitals in Lahore are located within densely populated areas of the metropolis. Water supply distribution lines run parallel to sewerage lines at most places. Old rusted pipes and frequent digging of roads due to development work causes leakage resulting in mixing of sewage with drinking water. The negative pressure created within the water pipelines during no supply period (as happens during electric load shedding) also contributes to suction of sewage from the vicinity.

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