

## Research Article

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# Analysis of physicochemical parameters of hospitals wastewater: a case study in Faisalabad, Pakistan

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### Abstract

Water is the supreme essential thing that has direct effects on the life of any living organism. Water contamination is one of the alarming problem in our society and that contaminated water also includes wastewater of hospitals and laboratories. Blood and urine both are major agents that are present in the sewage of hospitals. The main objective of this study was to analyze the physicochemical parameters of sewage water of hospitals in Faisalabad city. Sewage water samples were collected from 13 different hospitals of the Faisalabad. Different physicochemical parameters like Total dissolved solids, Total hardness, Calcium, Magnesium, Bicarbonate and Chloride were analyzed in sewage water and their values were compared with the standard values given by the World Health Organization. Total dissolved solids of Faisal hospital were maximum 2710 mg/l whereas, the topmost total hardness 580 mg/l was found in Allied hospital. Calcium & magnesium of T.B hospital (544 mg/l) and Iqbal hospital (249 mg/l) were highest respectively. The number of bicarbonates and chlorides in T.B hospital & Faisal hospital was 1000 mg/l and 1568 mg/l, beyond the recommended WHO values. Descriptive statistics was applied to data to evaluate the significant differences between the means of samples. Results demonstrate that sewage water of Allied hospital, Faisalabad hospital, Iqbal hospital and T.B hospital is not ecofriendly and highly unfit for aquatic and human life.

**Keywords:** Aquatic life; Blood; Contamination; Eco-friendly; Physicochemical parameters; Sewage water; WHO

### Introduction

Water is the most principal component of life. About 75% of our earth is enclosed by water, out of this only 1% is freshwater. Due to its polar nature, it dissolves many things in it. It is the most vital thing that has uninterrupted effects on the life of any living organism. Water defilement is one of the alarming problems in our society and in which nonstop dispose of sewage water

without treatment. This sewage water also includes sewage water of hospitals and laboratories without any management. Blood and urine both are major agents that are present in the sewage of hospitals and should be cured prior to discharging in sewage outlets. For instance, the compounds which are used for its treatment are itself the cause of contamination [1] and this pollution may cause secondary pollution.

Waste of hospitals contains many micro-organisms comprising pathogenic species [2]. Other than many pathogens, hospitals sewage water also includes a great number of antibiotics [3]. The physicochemical parameters like total hardness (TH), total dissolved solids (TDS), calcium, chlorides, carbonates and bicarbonates are also analyzed in it. The antibiotics which are not completely metabolized in animal and the human body are excreted through excreta and it is a major source of antibiotics in the ecosystem. Commercial areas like hospitals are major dissolved of antibiotics to municipal waste [4, 7]. The wastewater coming from hospitals and laboratories contains too much pathogens, fecal matters, blood, disinfectants, antibiotics and so much of the heavy metals dissolved in it.

The demand for water in hospitals is 500 L per bed per day which is far more than the consumption of residences which is 100 L per head per day [8]. The alarming issue is that this hospital wastewater is disposing of in the ecosystem same as the household sewage [9]. This sewage water is directly disposed of in freshwater bodies without any treatment [2]. The Taiwan Environmental Protection Agency (TEPA) has passed a law that hospitals should have sewage water treatment plants that treat the wastewater before it is discharged. If this water is disposed of without treatment, then this water not only affects badly to human beings but also to aquatic life. Wastewater treatment does not completely remove the antibacterial medicines from hospital effluents and that remainings ultimately disposed of in groundwater [10]. The wastewater coming from hospital outlets is greater than the sewage water of housing colonies.

Normally the methods used to treat the sewage water are activated sludge process (AS), contact aeration process (CA), rotating biological contractors (RBC), trickling filters (TF) and chemical coagulation (CH). The number of micro-organisms removed depends on which type of treatment you are using. The number of microorganisms can be decreased by following microbiological guidelines. In a simple settling tank process about 50% to 60% viruses can be eliminated [11]. The research of United States Environmental Protection Agency (USEPA) has recently detected that relative contributions of pharmaceutically active compounds (PhACs) from residential effluents, hospital wastewater and concentrated animal feeding operation (CAFO) effluent required topmost research [12]. The topmost antibiotics like sulfonamide, fluoroquinolone and macrolide are identified in waste and surface water [13]. The present study was conducted to distinguish the chemical and physical nature of sewage water of hospitals and those parameters were compared with standard values given by water and sanitation agency of Pakistan and WHO guidelines.

## **Materials and methods**

### **Sample collection**

The present study was intended from different hospitals of Faisalabad, Pakistan to estimate the physicochemical parameters of hospitals sewage water. Thirteen hospitals i.e. Allied hospital, Kardar hospital, United hospital, Chiniot hospital, Al-Noor hospital, Faisal hospital, Mian Trust hospital, T.B. hospital, Hilal-e-Ahmar hospital, DHQ hospital, Yaseen Memorial hospital, Social Security hospital and Iqbal hospital were selected for collection of samples. Samples were taken from boreholes of hospitals.



**Figure 1.** Location of the sampling area

### **Preparation of samples**

The samples were placed in small sampling bottles which were washed with distilled water before placing the samples to ensure the maximum accuracy. After taking the samples, the bottles were labeled to avoid any mixing of bottles. The samples of each hospital covered the whole area of the hospital. Samples were kept at 4°C in the freezer.

### **Analysis of water sample**

After sampling, the experimentation is performed in the Water and Sanitation Agency, Faisalabad. Five parameters i.e. Total hardness, Total dissolved solids, Calcium, Chloride, Magnesium and Bicarbonate experimented through the titration process.

### **Determination of sewage water quality parameters**

The wastewater quality parameters were analyzed as follows: total dissolved solids (TDS) were estimated by a standard method, calcium contents and total hardness (TH) by EDTA titrimetric method, chloride contents by argentometric method and bicarbonates by using methyl orange.

### **Statistical analysis**

Statistical analysis was applied to complete the data set of hospital wastewater. Suitable tables were arranged, and means were assessed. Descriptive statistics was applied to check the difference at a certain level.

### **Results and discussion**

This study was conducted to analyze the physicochemical parameters (TDS, Total hardness, calcium, magnesium, chlorides, bicarbonates) of sewage water from thirteen

different hospitals of District Faisalabad, Pakistan. The focus of this analysis was to determine whether these sewage water parameters from hospitals were ecofriendly or not. Table 1 exhibited that the mean values of physicochemical parameters vary significantly. Mean TDS value was 1659.23 mg/l followed by 466.46 mg/l (total hardness), 180.61 mg/l (calcium), 75.53 mg/l (magnesium), 538.30 mg/l (chlorides) and 669.07 mg/l (bicarbonates) respectively. Mean TDS, bicarbonates and chlorides values were not according to the WHO recommended guidelines, proving not ecofriendly. As [9] studies explained the contamination level and side effects of hospital sewage water in his study. His study relates to the above-mentioned study that is on the physicochemical analysis of sewage water and analysis of variance. Results showed that this sewage water is highly contaminated and should not be disposed of without treatment.

In the water sample of Allied hospital TDS, total hardness and chlorides were beyond the given values while calcium and magnesium were within range. The TDS value of all the hospitals was exceeding the normal value except Al-Noor and Hilal e Ahmar hospital. Total hardness assessed values of Allied, Kardar and United hospital were beyond the limit while the other hospitals' values were in range. The tested water samples of T.B, Iqbal, Faisal and United hospital revealed the high values of calcium whereas, other hospitals showed within range values. The water sample of Iqbal hospital and T.B hospital exhibited surpass values of magnesium while the United, Faisal, Hilal e Ahmar and DHQ revealed below the range values. Tested water sample of Al-Noor hospital showed below the range bicarbonate value whereas other hospitals revealed within range values. The water sample of all hospitals exhibited high chloride value except Al-Noor hospital (Table 2).

**Table 1. Descriptive statistical analysis of all physicochemical parameters**

Statistical factors	TDS	Total Hardness	Calcium	Magnesium	Bicarbonates	Chlorides
Mean	1659.23	466.46	180.61	75.53	669.07	538.30
Median	1500.00	480.00	112.00	55.00	616.00	374.00
Mode	N/A	480.00	N/A	51.00	N/A	N/A
Standard Error	167.51	21.24	46.30	20.75	44.35	108.21
Standard Deviation	603.99	76.60	166.93	74.82	159.93	390.18
Sample Variance	364807.7	5868.1	27868.8	5599.4	25579.1	152247.2
Kurtosis	-0.85	-0.44	2.10	2.24	0.04	3.20
Skewness	0.16	-0.57	1.77	-0.57	1.03	1.76
Range	2010.00	244.00	491.00	248.00	528.00	1364.00
Minimum	700.00	336.00	53.00	1.00	472.00	204.00
Maximum	2710.00	580.00	544.00	249.00	1000.00	1568.00
Sum	21570.00	6064.00	2348.00	982.00	8698.00	6998.00
Confidence Interval (95.0%)	1294.24	420.17	79.73	30.32	572.42	302.51

**Table 2. Physicochemical parameters of different hospitals wastewater**

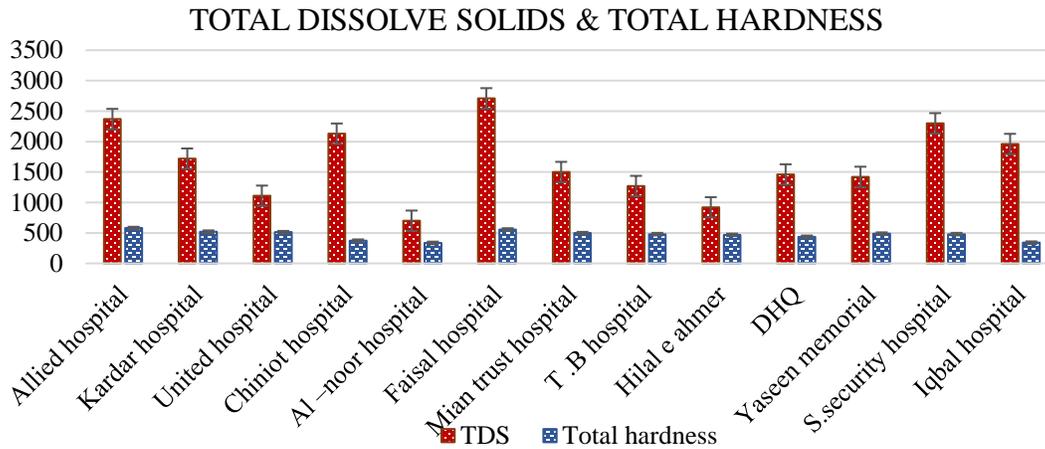
Sr. No.	Hospitals	TDS	Total Hardness	Calcium	Magnesium	Bicarbonates	Chlorides
Units		Mg/l	Mg/l	Mg/l	Mg/l	Mg/l	Mg/l
WHO guideline		1000 mg/L	10-500mg/L	75-200mg/L	50-150mg/L	<500mg/L	250mg/L
1	Allied hospital	2370	580	134	61	596	264
2	Kardar hospital	1720	520	101	67	640	374
3	United hospital	1110	512	206	1	756	248
4	Chiniot hospital	2130	372	58	51	840	848
5	Al-noor hospital	700	336	53	51	472	204
6	Faisal hospital	2710	556	208	9	540	1568
7	Mian trust hospital	1500	496	110	55	572	450
8	T.B hospital	1270	480	544	220	1000	296
9	Hilal-e-ahmer	920	468	154	21	542	260
10	DHQ	1460	436	112	39	628	484
11	Yaseen memorial	1420	488	72	77	616	356
12	S.security hospital	2300	480	62	81	580	946
13	Iqbal	1960	340	534	249	916	700

Graph 1 showed the total dissolved solids and total hardness values of physicochemical parameters of different hospitals located in Faisalabad. 2710 mg/l was the maximum recorded TDS value of Faisal hospital which was very high from WHO recommended value (1000 mg/l) followed by 700 mg/l noted from Al-Noor hospital as compared to the other hospitals. Greater TDS from the recommended range exhibited that the water of Faisal hospital is seriously hazardous for both human and aquatic life. The total hardness value of Allied hospital was highest (580 mg/l) whereas, the lowest value (336 mg/l) was recorded from Al-Noor hospital. Both these values were in the normal range.

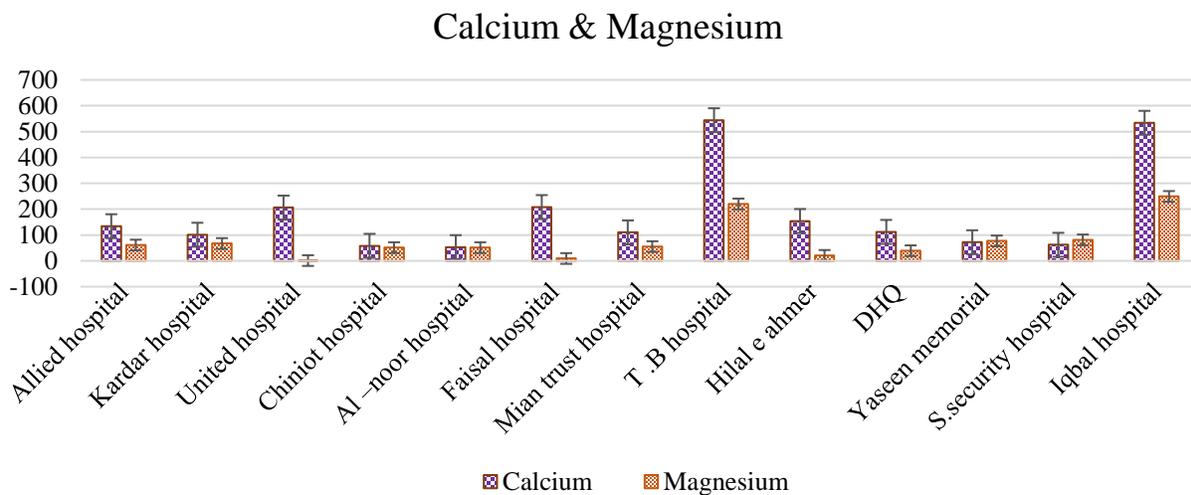
[14] explained the physicochemical and genotoxicity analysis. The physicochemical test showed that the direct dispose of sewage water increased the amount of total dissolved solids in it. The mixtures of chlorides, sulphates and bicarbonates increased the probability of toxicity in aquatic organisms. In the graphical representation (Graph 2) calcium value of T.B hospital was maximum (544 mg/l) in this assessment of wastewater whereas, Al-Noor hospital had low calcium (53 mg/l) in its water. Iqbal hospital magnesium value (249 mg/l) was beyond the WHO given value (50-150 mg/l) as compared to the other hospitals. The lowest magnesium (1 mg/l) value was recorded in

the United hospital. Surpassing level of both calcium and magnesium revealed that water of these hospitals was seriously perilous. The study by [15] demonstrated the effects of sewage water on the saturation of calcium. Results elaborated that 120mg/l value of Ca

was recorded while the recommended value for calcium was 85-150mg/l. The high content of calcium makes the water alkaline and color changes to milky which making it unfit for human use but also infectious for aquatic life.



**Graph 1. Comparison of total dissolved solids and total hardness in the wastewater of different hospitals in Faisalabad**



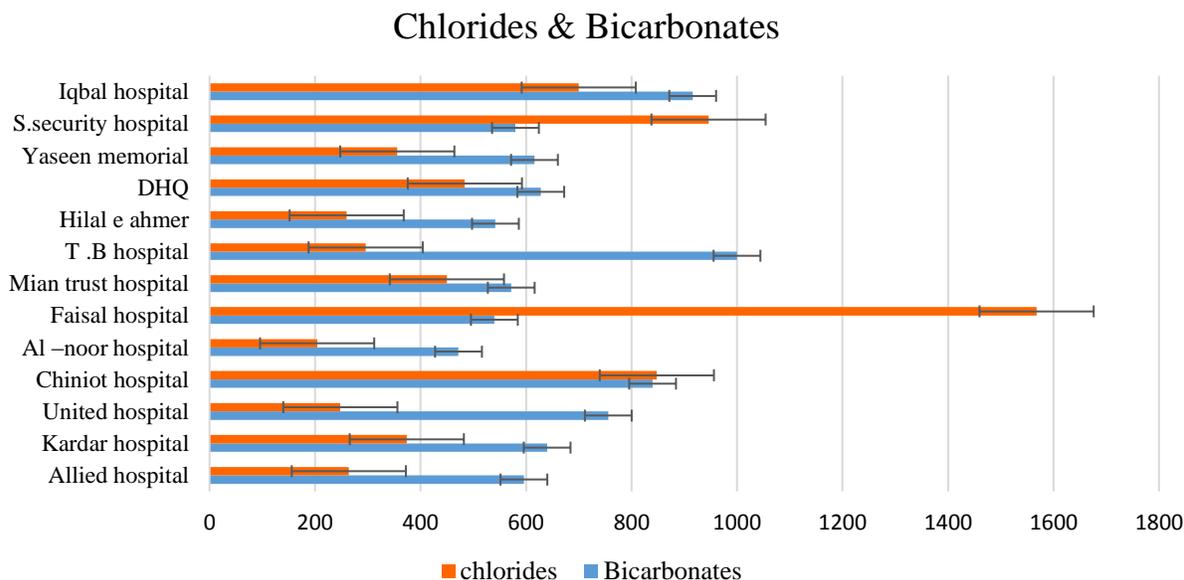
**Graph 2. Comparison of calcium and magnesium in waste water of different hospitals in Faisalabad**

Graph 3 exhibited the bicarbonates and chlorides existing in the water of different hospitals. 1000 mg/l was the maximum noted bicarbonate value of T.B hospital. The lowest

bicarbonates value 472 mg/l was documented in Al-Noor hospital. The chloride value (1568 mg/l) of Faisal hospital water was high while the Al-Noor hospital possesses the

lowest chloride value (204 mg/l). Exceeding levels of both bicarbonates and chlorides showed that the water of these hospitals is lethal for aquatic and human life. The study of [16] illustrated that the concentration of

organochlorides was 0.09mgAOX/L in hospital water which was not a suitable amount for the survival of aquatic life and human.



**Graph 3. Comparison of chlorides and bicarbonates in the wastewater of different hospitals in Faisalabad**

### Conclusion

The evaluation of wastewater parameters from thirteen hospitals of Faisalabad city proved that all the tested physicochemical parameters (TDS, total hardness, calcium, magnesium, bicarbonates, chlorides) are surpassing the WHO recommended values. All the hospitals do not treat their sewage water well except Al-Noor hospital and when this wastewater mix with freshwater it becomes unfit for both aquatic and human lives. From the results, it is concluded that the wastewater of Faisalabad hospitals is seriously hazardous as it contains all physicochemical parameters that surpass the WHO guidelines. It is suggested that there should be proper channels to dispose of the wastewater to keep aquatic environments clean and less hazardous.

### Authors' contributions

Conceived and designed the experiments: H Rehman & NA Khan, Performed the experiments: H Hira, Analyzed the data: H Rehman, Contributed materials/ analysis/ tools: A Bibi & H Hira, Wrote the paper: H Rehman & NA Khan

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All the authors have a contribution to work.

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