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ORIGINAL ARTICLE

Occurrence of Fecal Contamination in Drinking Water available in municipal hospitals in Karachi, Pakistan

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ABSTRACT
This investigation looks into various problems faced by patients in Central Public Hospitals of Karachi. Under the elaborated dimensional analysis, the study aims to spot the scarcity of pure or decontaminated drinking water in public hospitals that adversely affects health of patients. A detailed survey was made of the hospitals situated in different areas of Karachi. The main focus is on analyses bacterial load of drinking water of hospitals. A total of 13 hospitals were selected. It has been found that water is contaminated and also it does not pass through chlorination.. It has been recommended that proper attention, and implementation of sound infrastructure, proper treatment of drinking water its check and balance will reduce the existing problem at public hospitals.
***Key Words**: Karachi, Hospitals, drinking water, bacteriological quality*

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INTRODUCTION

Potable water is the basic need of man to sustain life. Water serves as lubricant, regulates the body temperature and gives the basis for the body fluids and metabolism [1]. Water is a vital requirement of all life forms. Adequate supply of clean, safe and healthy water is imperative for health. Drinking water performs an important role intaking essential minerals and elevated level of nonessential elements can cause morphological abnormalities, reduce growth, increase death rate and mutagenic effects [2,3,4].
Frequent improvement in the quality of water for purposes of drinking, domestic use, hygiene and certain medical situations is among the top challenges of the world. Water is a good solvent that's why picks up impurities easily and thus changes its taste, color and odor. It is well-known that when water is polluted or contaminated, its normal functioning and properties are affected [5].Physico-chemical parameters of water are important to determine the quality of drinking water as according to WHO (1996)[6] the physical parameters that are likely to give rise to objection from consumers are colour, turbidity, taste and odor while low pH causes corrosion and high pH results in taste complaints [7]. The natural water analyses for physical and chemical properties including trace element contents are essential for public health. Such studies are integral part of investigations of environmental pollution of an area[8,9].Drinking polluted and unhealthy water results in high prevalence of waterborne diseases [10,11].
The presence of contaminants in drinking water is a great menace to the public health resulting in a number of diseases. The severe toxicity of these contaminants may also cause death [12].
On a worldwide basis waterborne diseases are the cause of death and misery of billions of people, especially infants and children in developing countries [13]. The provision of high-quality drinking water is one of the most important utility for improving human health of a community by preventing the spread of water born disease [14]. Drinking water should be fit not only for human consumption but also for washing/ showering and domestic food preparation because chemical and other composition of the water would give rise to economical damage as well[15].
Both ineffective treatment and contamination in the system expose the individuals from infectious diseases. Disease is a problematic situation and natural phenomenon in which the victims visit the doctor at public hospital or private clinic. Some diseases are such that they can be cured only in the hospitals. A hospital is an institution providing medical treatment and nursing care for ill and injured people, while a

public or government hospital is a hospital which is owned by government and receives government funding and providing medical facilities with regards to health [16]. Hospitalization of the patient depends upon the disease with the patient suffers. In many cases a patient has to stay in the hospital for months. There are two types of hospitals common in the world for health care: Public Hospitals and Private Hospitals. In Pakistan, public hospitals are not in a condition to provide proper medical care to the people. Whenever a poor person falls ill he/she as dependent on public hospital as he/she cannot afford the high expenses of private hospital. In public hospital, the patients have to face a number of inimical problems [17].

In Pakistan, water supply through closed network and hand pumps is around 66%[18].Approach to safe drinking water falls below satisfactory levels with only 25% of the population has sustainable access to quality drinking water [19]. Like many other countries in the world, Pakistan is also under great risk regarding availability of safe and clean drinking water. Since independence, health and fertility indicators in Pakistan have improved substantially with the infant mortality rate and the total fertility rate [20]. Despite these, the majority of the Pakistani population frequently suffer from poor health.The polluted water is becoming the major cause in deteriorating the health associated issues to the public in the country. Further the quality of ground water in the country is also no longer safe due to the manipulation of many extrinsic factors. Most of the water available to public sector for drinking is of poor quality. The old and rusty pipelines shipping drinking water are becoming more dangerous to the natural composition of the water. Insufficient water treatment measures and infrequent monitoring plan make this problem more severe [21]. As a defensive measure, consumption of bottled water has increased in recent years in developing countries, in particularly in Pakistan and elsewhere. Sale of bottled water has gone to more than 35 billion US dollars [22].

Karachi, the metropolitan city, is towards south of Pakistan, near the coast of Arabian Sea. Karachi city is an urbanized area of Pakistan, where clean water demand is very high. To the best of our knowledge, very few studies have been conducted to evaluate the quality of drinking water in Karachi. Therefore, this research was undertaken to analyze the bacteriological quality of water from Karachi hospitals and to check their compliance with the standards. Presence of coliform bacteria, fecal coliforms, *E. coli*, fecal streptococci is noticed. Contaminated and estimated hospital water supply with potentially pathogenic organisms is fairly common. A wide range of microorganisms(bacteria, fungi, and protozoa) in the water supply may be pathogenic. Karachi is not only the largest city of Pakistan but also one of the most settled city of the world having an estimated population of more than 20 million spread over an area of 2787 Sq. Km. Karachi is the industrial hub of the country and generates more than 70% of the total income of the country. The water supply network of Karachi is exclusive in the sense that unlike other major cities of the country which usually supply groundwater, the foremost water source of Karachi is surface water located more than 100 miles away from the city. The source of water for Karachi is Kenjhar Lake which is fed by river Indus. Karachi has an availability of 1200 cusec water from river Indus which is being almost completely utilized. The other major source of water for Karachi which supplies only 100 MGD water is the Hub dam. This is not a very trustworthy source as it has a storage capacity for only three years and in case of no rains in its catchments area it goes dry. Nowadays water supply from the Hub resource has totally stopped as it has completely dried up.

The purpose of this study was to determine the water supply in different hospitals of Karachi area for pathogenic microorganisms present in water used by patients and hospital staff. Such information may allow us to evaluate as to what extent the supplied water is being disinfected and also to analyze any contamination in the water supply system. This study explicitly demonstrates the existing water facilities in public hospitals. The statistical analyses further elucidate that there is lack of clean drinking water in public hospitals which are counted (10-15%) to lower extent and greater extent accordingly. Most of the people particularly poor ones are dependent on public hospitals but in many cases, these hospitals lack basic facilities that adversely affect the health of patients. Further the unhygienic conditions contribute to the patients' problems in public hospitals in a systematic manner.

MATERIAL AND METHOD

Sample Collection and Preservation

Sixty two (62) drinking water samples were collected from various municipal hospitals in Karachi city as shown in Table-1. After collection the sample bottle was labeled properly assigning a sample code. Samples were collected in duplicate, one bottle used for bacteriological analysis contained 1 ml of sterile sodium thiosulphate to neutralize the effect of residual chlorine if any, and another sample bottle was retained for determining residual chlorine. After collection of samples the bottles were placed in an ice-box maintained at temperature of 4-8^{o}C and transported to the Institute of Environmental Studies, University of Karachi for analysis.

Microbiological Quality Assessment

The samples were processed in a laminar flow hood using sterilized culture media (the sterility of media was checked prior to use) by Most Probable Number Technique (MPN) as per standard methods described in [23].Total Coliform and Faecal Coliform test were also performed, as per standard methods to check the quality of the water[23]. Moreover, Flouorocult LMX broth was also used for simultaneous enrichment and detection of total coliforms and *E.coli* in water samples.

Chlorine Estimation

Residual chlorine was determined by using Merck kits.

RESULT AND DISCUSSIONS

In the present study the bacteriological examination of 62 different water samples was carried out. Alarmingly, 85% of these samples did not comply with the standard guidelines of Pakistan and WHO for drinking water. In these specimens average TCC of all hospitals is 1171 (Figure 2). Average TFC was found to be 814 in 62 water samples (Table 2). Bacteriological quality of different water samples are shown in Table 1.Mean TFC of all hospitals is very high showing high contamination of water and also there is almost zero chlorination in water due to which patients are at high risk of bacterial diseases.

Table 2.shows descriptive analysis of all 13 hospitals. According to figure 2 high value of TFC was found to be in Kulsum Baivalika social security and Civil hospital while lowest TFC were found in Ojhainstitute,Dow and U.P Mour hospitals. Out of 62 samples, 36 samples were not fecally contaminated and 26 samples were positive for E.Coli test. According to Table 1 Jinnah hospital gave TFC 1045.9 because of no chlorination. Dow hospital gave low TFC value 28.4 because of chlorination. Civil hospital gave relatively high value of TFC 1494.625.Ojha institute of chest disease, Sindh Gov. U.P. Mour and Social security hospitals showed low value of TFC because of chlorination.

Table 1. Descriptive statistics of water quality available in different Municipal hospitals in Karachi

Hospitals	Parameters (MPN / 100ml)	No. of Samples	Mean	Median	Min.	Max.	Std. Dev.	Std. Error	Skewness
Jinnah	TCC	10	1074.00	225.00	120.00	2400.00	1141.74	361.05	0.48
	TFC		1045.90	210.00	43.00	2400.00	1166.78	368.97	0.48
	TFS		6.80	7.00	4.00	11.00	2.82	0.89	0.44
	CHL		0.00	0.00	0.00	0.00	0.00	0.00	-
Dow	TCC	5	67.20	2.00	2.00	210.00	94.78	42.39	1.09
	TFC		28.40	2.00	2.00	93.00	40.24	18.00	1.39
	TFS		5.20	2.00	2.00	11.00	4.44	1.98	0.72
	CHL		0.14	0.17	0.05	0.22	0.08	0.03	-0.45
Civil	TCC	8	1631.25	1750.00	150.00	2400.00	878.69	310.66	-0.53
	TFC		1494.63	1750.00	64.00	2400.00	1042.08	368.43	-0.48
	TFS		5.25	4.00	2.00	11.00	2.92	1.03	1.15
	CHL		0.00	0.00	0.00	0.00	0.00	0.00	-
Qatar	TCC	5	1005.20	210.00	2.00	2400.00	1275.95	0.59	-
	TFC		1002.80	210.00	2.00	2400.00	1278.29	0.59	-
	TFS		5.80	7.00	2.00	11.00	3.83	0.25	-
	CHL		0.00	0.00	0.00	0.00	0.00		-
Landhi Medical Complex	TCC	5	1664.20	2400.00	21.00	2400.00	1077.34	481.80	-1.14
	TFC		1094.60	460.00	3.00	2400.00	1202.60	537.82	0.53
	TFS		5.40	7.00	2.00	9.00	3.21	1.44	-0.30
	CHL		0.00	0.00	0.00	0.00	0.00	0.00	-
Abbasi Shaheed	TCC	5	1102.00	460.00	40.00	2400.00	1194.29	534.10	0.54
	TFC		661.60	210.00	28.00	2400.00	983.87	440.0	2.10

								0	
	TFS		3.40	2.00	2.00	9.00	3.13	1.40	2.24
	CHL		0.00	0.00	0.00	0.00	0.00	0.00	-
Ojha institute of Chest diseases	TCC	4	2.25	2.00	2.00	3.00	0.50	0.25	2.00
	TFC		2.25	2.00	2.00	3.00	0.50	0.25	2.00
	TFS		2.00	2.00	2.00	2.00	0.00	0.00	-
	CHL		0.19	0.20	0.15	0.22	0.03	0.02	-0.63
Sindh Govt Hospital Liaquatabad	TCC	4	1800.50	2400.00	2.00	2400.00	1199.00	599.50	-2.00
	TFC		990.50	780.00	2.00	2400.00	1041.99	521.00	0.99
	TFS		7.25	8.00	2.00	11.00	3.86	1.93	-1.00
	CHL		0.00	0.00	0.00	0.00	0.00	0.00	-
Pakistan Steel	TCC	3	1966.67	2400.00	1100.00	2400.00	750.56	433.33	-1.73
	TFC		376.67	460.00	210.00	460.00	144.34	83.33	-1.73
	TFS		2.00	2.00	2.00	2.00	0.00	0.00	-
	CHL		0.00	0.00	0.00	0.00	0.00	0.00	-
KulsumBaiValika Social Security Hospital	TCC	4	2075.00	2400.00	1100.00	2400.00	650.00	325.00	-2.00
	TFC		1527.50	1750.00	210.00	2400.00	1070.99	535.50	-0.56
	TFS		6.75	7.00	4.00	9.00	2.06	1.03	-0.71
	CHL		0.00	0.00	0.00	0.00	0.00	0.00	-
Lyari General Hospital	TCC	3	1533.33	1100.00	1100.00	2400.00	750.56	433.33	1.73
	TFC		886.67	1100.00	460.00	1100.00	369.50	213.33	-1.73
	TFS		2.67	2.00	2.00	4.00	1.15	0.67	1.73
	CHL		0.00	0.00	0.00	0.00	0.00	0.00	-
Sindh Govt Hospital U.P. Mour	TCC	3	38.67	39.00	2.00	75.00	36.50	21.07	-0.04
	TFC		8.67	9.00	2.00	15.00	6.51	3.76	-0.23
	TFS		2.00	2.00	2.00	2.00	0.00	0.00	-
	CHL		0.19	0.20	0.15	0.22	0.04	0.02	-1.15
Social Security Hospital	TCC	3`	1167.33	1100.00	2.00	2400.00	1200.42	693.06	0.25
	TFC		75.67	75.00	2.00	150.00	74.00	42.73	0.04
	TFS		2.00	2.00	2.00	2.00	0.00	0.00	-
	CHL		0.12	0.15	0.00	0.21	0.11	0.06	-1.15

Total coliform count (TCC), Total fecal coliform count (TFC), Total fecal streptococci (TFS), CHL= Residual Chlorine

Table 2. Descriptive statistics of water quality available in all Municipal hospitals in Karachi

Parameters	Mean	Median	Min.	Max.	Std. Dev.	Std. Error	Skewness
TCC	1171.6	1100	2	2400	1074.798	136.49	0.144
TFC	814.14	210	2	2400	992.28	126	0.861
TFS	4.82	4	2	11	3.19	0.41	0.69
CHL	0.039	0	0	0.22	0.077	0.0097	1.61

Total coliform count (TCC), Total fecal coliform count (TFC), Total fecal streptococci (TFS), CHL= Residual Chlorine

Table 3. Summary of the analysis

No of samples collected	E. Coli		UFHC	FHC
	Present	Absent		
62	26 (42%)	36(58%)	51(82%)	11(18%)

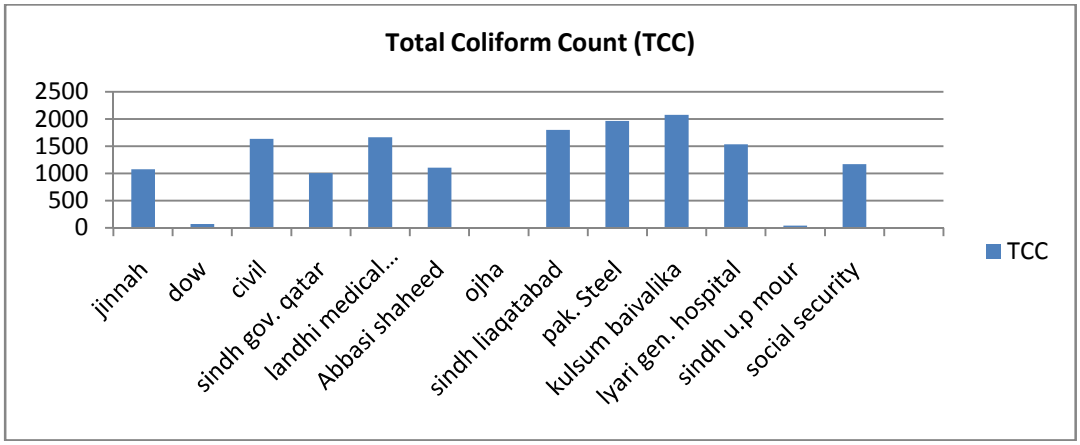

Fig.1. Graphical representation of Total coliform count of water samples in different municipal Hospitals in Karachi

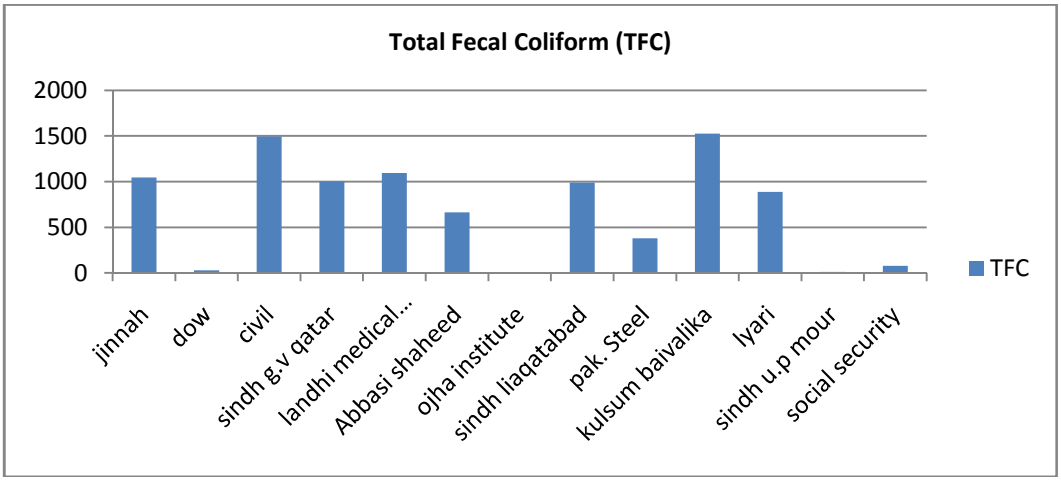

Fig.2. Graphical representation of Total fecal coliform count of water samples in different municipal Hospitals in Karachi

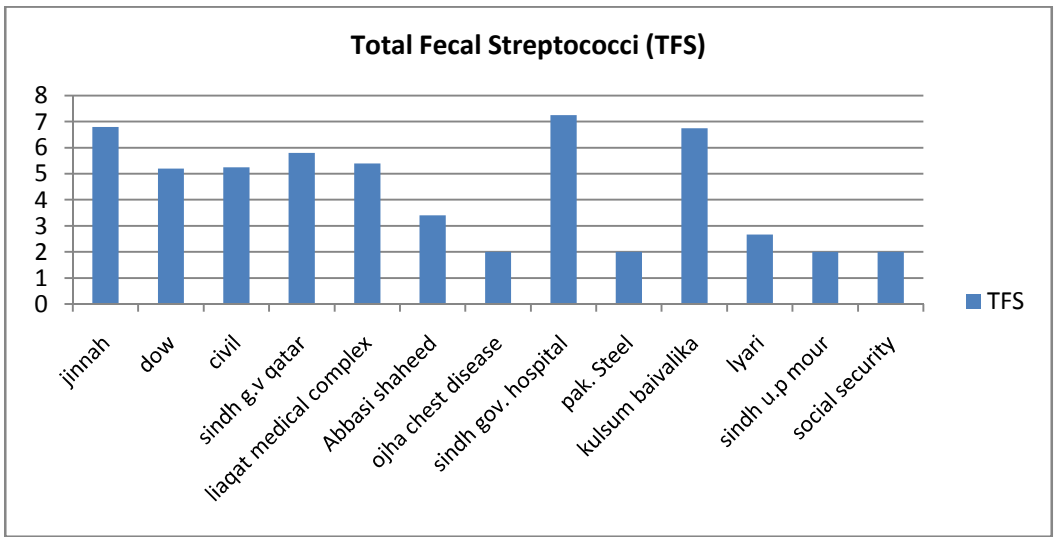

Fig.3. Graphical representation of Total Fecal Streptococci of water samples in different municipal Hospitals in Karachi

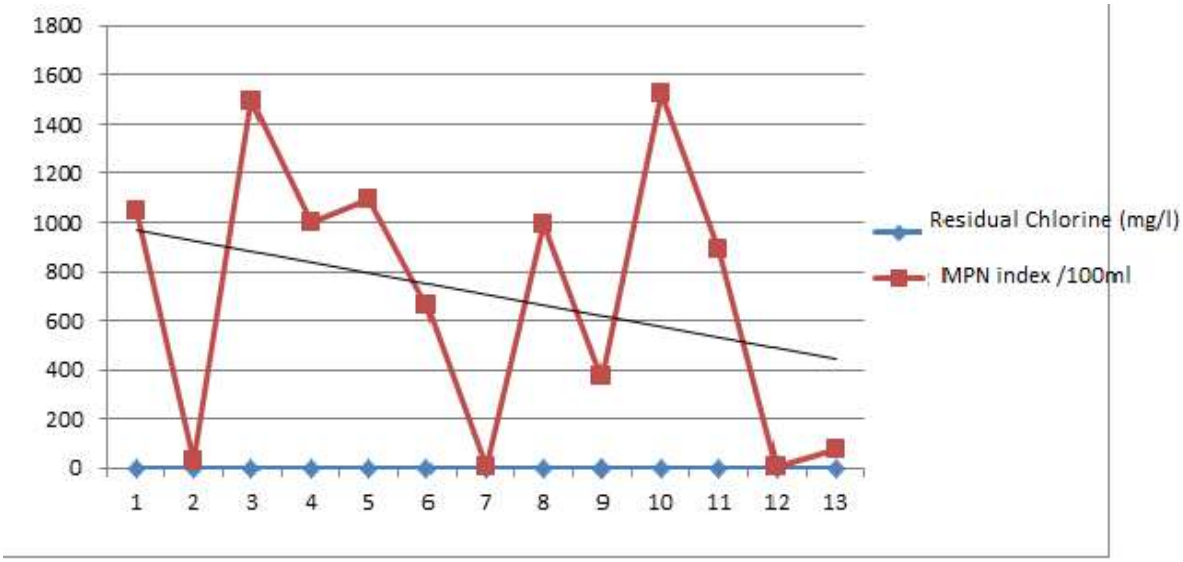

Fig.4. Chlorine level corresponding to MPN Index/100 ml

The presence of indicator bacteria in the water samples indicates the bacterial pollution of drinking water. Although 36 samples were negative for fecal coliform and 26 of these were found to be positive for *E.Coli*, sign of fecal contamination. The presence of coliforms and *E coli* in water samples not only indicates the presence of pathogenic enteric microorganisms but also questions the efficiency and integrity of water system. It is therefore recommended to monitor the complete water processing system to avoid major public health problems. Accordingly, the quality of drinking water in hospitals of Karachi is poor and shows a potential source of human exposure to pathogenic bacterial species that canlead to the development of severe diseases caused by these organisms. In addition to thecontamination by broken sewage pipelines that affects water quality, the environmental,climatic and locality factors play a vital role in the rate of bacterial contamination.

Frequent epidemics of waterborne diseases in Pakistan are mainly due to contamination of drinking water mostly with municipal sewage and industrial waste. According to the Pakistan National Conservation Strategy report of 1992, about 40% of communicable and infectious diseases are waterborne [24]. Major diseases mostly connected with drinking water in Pakistan are diarrhea, GIT, typhoid, cryptosporidium infections, giardiasis intestinal worms, and some strains of hepatitis. According to International Union on Conservation of Nature (IUCN), 60% of infant deaths are caused by waterborne diarrhea in Pakistan,which is the highest in Asia. A silent humanitarian crisis kills about 3900 children every day and move for progress towards all the Millennium Development Goals (MDGs), especially, in Africa and Asia [25]. It is estimated that, in Pakistan, 30% of all diseases and 40% of all deaths are just because of poor water quality [26]. Diarrhea, a water borne disease is found to be as the leading cause of death in infants and children in the country while every fifth citizen suffers from illness and disease caused by the polluted water [27].It is projected that water related diseases cause annual national income losses of US$ 380–883 million or approximately 0.6-1.44% of the GDP [24,28]. Ground water, the source of drinking water for human beings around the World, is contributing about one-third in total water resources of Pakistan and is a major resource of water supplies in major municipalities [29]. Widespread bacterial pathogens include *Legionella* spp., *Pseudomonas aeruginosa*, and some *mycobacteria*. Aspergillus is a chiefly disconcerting mold found in hospital water. Pathogenicity of many waterborne parasites (e.g. *Cryptosporidium*) has been well recognized, some protozoa such as Acanthamoeba are not only pathogenic ,but they can also protect bacterial pathogens such as *Legionella pneumophila* from destructive chemical disinfectants and environmental forces as they support bacterial growth and replication.

CONCLUSIONS

The present study indicates the polluted condition of the water source of Karachi hospitals which will have serious implications. Enteric pathogens cannot normally multiply in water hence water is not its mode of transmission to humans [6]. However, the presence of enterobacteria would be enough infective doses in people whose local or general natural defense mechanisms are largely impaired. The people likely to be at risk would be the old or the very young as well as immunosuppressed patients. Other immuno-compromised patients suffering from AIDS or hepatitis would also be susceptible to the bacterial diseases. Also, polluted water with high microbial load, when permitted to contaminate food would lead to the

multiplication of the pathogens to a great extent.Hospital Water as a Source of Infectious Microorganisms Hospitals generally draw their water from the municipal water supply. As a consequence of the fact that municipal water, once disinfected at the treatment plant, travels through a system of biofilm-laden pipes before reaching the hospital.Water- borne microorganisms have been found in hospital water tanks, as well as the tap water that flows from faucets and showers. It is the water's contact with biofilm that is the primary cause of poor tap water quality at the point-of-entry to the hospital.

RECOMMENDATIONS

It is clear that both urban and rural drinking- water supplies in Pakistan are largely contaminated and pose serious health risks to the consumers. To ensure safe water supplies for drinking, there is need to formulate an effective management strategy. The key actions for such a strategy should comprise of the following strategies.

- Ensure drinking-water quality standards.
- Stoping land disposal of wastewaters.
- Strictly implement national environmental quality standards(NEQS)
- Elaborate the type of monitoring for hospital drinking-water quality.
- Set up district-level drinking-water quality monitoring projects.
- Give surveillance responsibilities to EPAs.
- Ensure sanitary inspection of water sources.
- Strengthen district and county administration for drinking-water quality monitoring.
- Upgrade analytical laboratories in terms of staff and equipment.
- Establish a national database on water quality at PEPA.
- Assist research institutions to develop appropriate water treatment technologies.
- Raise public awareness for the issues of drinking-water quality in hospitals.

REFERENCES

1. Staci, N. (2005). Willaim's Basic Nutrition and Diet Therapy. *ELSEVIER MOSBY*. 1: 156-165.
2. Nkono, N.A. and O.I. Asubiojo. 1998. Elemental composition of drinking water supplies in three states in Southeastern Nigeria. *Journal of Radioanalytical and Nuclear Chemistry*. 227: 117-119.
3. Adeyeye, E.I. (2000). Bio-concentration of macro and trace minerals in prawns living in Lagos lagoon. *Pakistan Journal of Scientific and Industrial Research*, 43: 367-373
4. Asaolu, S.S.(2002). Determination of some heavy metals is Orechromisnicoticus, Clariasgariepinus and Synontisspp from the coastal water of Ondo State, Nigeria. *Pakistan Journal of Scientific and Industrial Research,* 45: 17-19.
5. Trivedi, P., A. Bajpai and S. Thareja. (2010). Comparative Study of Seasonal Variation in Physico-Chemical Characteristics in Drinking Water Quality of Kanpur, India With Reference To 200 MLD Filtration Plant and Ground Water. *Nature and Science*. 8(4): 11-17.
6. World Health Organization – WHO. (1996). Guidelines for drinking water quality: health criteria and other supporting information. Vol. 2.
7. Chan, C.L., M.K. Zalifah and A.S. Norrakiah. (2007). Microbiological and physicochemical quality of drinking water. *Malaysian Journal of Analytical Sciences*, 11(2): 414-420.
8. Kot, B., Baranowski, R., Rybak, A., (2000). Analysis of mine waters using X-ray fluorescence spectrometry, Polish J.Environ. Stud., 9, 429.
9. Soylak. M., ArmaganAydin, F., Saracoglu, S., Elci, L., Dogan, M., (2002a), Chemical analysis of drinking water samples from Yozgat, Turkey. Polish Journal of Environmental Studies., 11 (2), pp 151-156.
10. Oyedeji, O., Olutiola, P.O. &Moninuola, M.A., (2010). Microbiological quality of packaged drinking water brands marketed in Ibadan metropolis and Ile-Ife city in South Western Nigeria. African Journal of Microbiology Research, 4: 96-102.
11. Fawell, J. &Nieuwenhuijsen, M.J., (2003). Contaminants in drinking water. Br Med Bull 68: 199-208.
12. Esrey S, Potash J, Roberts L, Shiff C (1991) Effects of improved water supply and sanitation on ascariasis, diarrhoea, dracunculiasis, hookworm infection, schistosomiasis, and trachoma. Bulletin of World Health Organization 69: 609- 621.
13. Schafera, A.I., H.M.A. Rossitera, P.A. Owusub, B.S. Richardsc and E. Awuah. (2009). Physico-chemical water quality in Ghana: Prospects for water supply technology implementation. *Desalination*, 248: 193–203.
14. Benjamin, A.P. and R. Brown. (2003). Encyclopedia of Food science and Nutrition, 2nd Edition. Vol.10: UK *Academic Press*.
15. Tihansky, D.P. (1974). Economic damage from residential use of mineralized water supply. *Water Resources Research.* 10(2): 145-154.
16. Hjortdahl, P. & Laerum, F. (1992). *Continuity of Care in General Practice:* effect on patient satisfaction, Bio-Medical Journal, 304(6837)1210-1215.
17. Mamdani, B.(2007). *Governance and Corruption in Public Health Care System, Indian Journal of Medial Ethics.* 4(4).
18. Pakistan Millennium Development Goals Report, 2006., Government of Pakistan. Planning Commission. (2006)75.
19. Nils R (2005) in Nestle's 'Pure Life', Nestle, Pakistan.

20. Lewis, M. (2006). *Governance and Corruption in Public Health care System*. Working Paper No. 78. Center for Global Development. London: Rutledge.
21. Pakistan Council of Research and Water Resources,(2005), Islamabad.
22. Raj, S. D., 2005. Bottled water: how safe is it? Water Environ. Res., 77: 3013-3018.
23. American Public Health Association (APHA). Standard Methods for the Examination of Water and Wastewater. 2005, 21th edition. American Public Health Association. Washington DC., USA.
24. Hashmi I, Farooq S, Qaiser S (2009) Chlorination and water quality monitoring within a public drinking water supply in Rawalpindi Cantt (Westridge and Tench) area, Pakistan. Environmental Monitoring and Assessment 158: 393-403
25. Bartram, J., K. Lewis., R. Lenton and A. Wright. (2005). Focusing on improved water and sanitation for health. *Lancet [Lancet],* 365(9461): 810-812.
26. Global Water Partnership, Draft South Asia - Water Vision 2025, Country Report – Pakistan, (2000).
27. M. A. Kahlown, M. A. Tahir, H. Rasheed and K. P. Bhatti; Water Quality Status, National Water Quality Monitoring Programme, Fourth Technical Report. Pakistan Council of Research in water Resources, (2006)5.
28. UNDP(2003), "Water Crisis", Karachi, p. 7 and 103.
29. Kausar R, Ahmad Z (2009) Determination of toxic inorganic elements pollution in ground waters of Kahuta Industrial Triangle Islamabad, Pakistan using inductively coupled plasma mass spectrometry. Environmental Monitoring and Assessment 157: 347-354.

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