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Investigating the microbial quality of cooler drinking water of hospitals, clinics and health centres of Behbahan in 2014

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Received: 18/Oct/2015 Accepted: 5/Jan/2016

ABSTRACT

Background and aims: The main cause of many problems in developing countries is related to the provision of safe drinking water. Since the health of drinking water is important in the busy centers such as hospitals, clinics and health centers, this study was done to investigate the role of water coolers connected to the municipal system in microbial quality of drinking water in Behbahan city.

Methods: In this study, the samples were provided from all influent and effluent 30 water coolers located in hospitals, clinics and health centers in the Behbahan. They were carried out and transferred to the laboratory. Then, the amounts of total coliforms and fecal coliforms, residual chlorine, pH and temperature were measured. Collected data were analyzed using SPSS and Excel software.

Results: The results showed that the average residual chlorine in input and output of the mentioned water coolers is significantly more than the standard values. Total and fecal coliforms in the input and output of water coolers are also more than the standard values. At the same time, both indicators in the output of water cooler were increased rather than the input one. By using paired t-test, a significant relationship was found between the amount of total coliform, fecal coliform and residual chlorine before and after of water cooler.

Conclusions: The results showed negative effects of water coolers on microbial quality of water. If constant control, monitoring and inspections proceedings were done, these contaminations would be reduced significantly.

Keywords: Drinking water, Water cooler, Microbial quality, Fecal coliform, Behbahan.

Original article

INTRODUCTION

The development of a community depends on the people health and it is, subsequently, related to sufficient drinking water supplement.[1-3] The root causes many problems in developing countries and is associated with the provision of safe drinking water.[4] The main goal of qualitative investigating of drinking water is

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to provide public health and the health of consumers.[5] Wide distribution of water, its ability to sustain the survival of microbial agents and the possibility of navigation and transmission of micro-organisms in the aqueous solution to their hosts, makes water an important factor in the transmission and distribution of the disease.

Although we can use various methods for achieving the water with high quality of appearance, biological and chemical characteristics, the maintenance of this quality during transferring and distribution operations is another challenge of treatment technology.[6] Various microorganisms growing in water can cause illness and mass casualties, in the absence of proper and timely treatment. Of course, in addition to planning and controlling the water quality, we need to do continuous water tests.[7,8]

Since different types of bacterial, protozoa, viral, and even fungal diseases can catch people healthy through contaminating water, they are usually taken under control and health and qualitative monitoring. This, in fact, is done in order to prevent them from transmission. The most important way of controlling water contamination includes monitoring its microbial quality. On the other hand, this parameter is influenced by some factor such as water turbidity, residual chlorine and also its pH. Therefore, if these factors are monitored, it can be said that the quality of water health condition is assessed.[9]

Since people like drinking cold water more, their need to water cooling devices has been increased these days. This need is found more in Iran as a warm and dry country. Among those tools which are widely used in summer, water cooler is a popular device.[10,11] In our country, both traditional water coolers and those ones connected to the municipal system are used. Since latter one is less possible to be contaminated it is much more used. Considering the structure of the coolers having reservoir in which the water keeps stagnant, it can provide a suitable environment for the growth and development of micro-organisms. So, checking the water quality in the output of these devices seems to be necessary.[9,12]

One of the most important parameters of coolers water quality assessment is to find level of coliform and fecal coliform in the water. The main goal of this study was to evaluate the effect of coolers on the microbial quality of drinking water. At the same time, a number of physical and chemical properties such as temperature, pH and residual chlorine which affect the growth of bacteria are studied.[13]

Since no study has been done in Behbahan for identifying the effect of coolers connected to the municipal system on drinking water microbial quality, and drinking water safety in crowded centres such as hospitals, clinics and health centres, this investigation was designed and proposed.

METHODS

This cross-sectional study was conducted in 2014. Sampling was done by census method. The samples were provided from all 30 inputs and outputs of water cooler units in hospitals, clinics and health centres in 2 months of summer. 60 samples were taken per season including 30 samples of input and 30 samples of output).

All testing and sampling were performed according to standard methods.[14] For providing the samples of the coolers input and output, the valve was kept open for one minute and then the cotton was burned and the tap and its peripherals were heated for one minute. The tap was open again and microbial testing samples were harvested in sterile glass flasks containing sodium thiosulfate to neutralize free residual chlorine.[15]

The samples were sent to the laboratory as soon as possible and were tested immediately.

For studying the presence of coliform and fecal coliform in the water of coolers and urban distribution system water, nine tube tests (MPN the most probable number) was used.[16,17] Measurement of residual chlorine and pH was conducted in sampling site with kits and by using reagents Diethyl Para Diphenyle Diamin (DPD) and phenol red. The temperature of water was measured by a thermometer in situ.

Since the aim of this study was to investigate the water microbial quality, the usual method called multiple tube fermentation (MPN) was used for measuring the coliforms in accordance with standard methods of testing water and sewage.

Data were analysed by SPSS software 22. The significant difference between input and output parameters of coolers was tested by paired t-test. The comparison of the parameters with standard was done by using one-sample test. The effect of physicochemical parameters on the microbiological quality of water samples were also investigated by Pearson correlation coefficient. All mentioned tests showed significant results.

RESULTS

The results of measured indicators at the input and output water cooler are shown in Table 1. Based on the obtained results, the residual chlorine of coolers at the input and output are 0.2-1ppm and 0-1ppm, respectively. At the site of coolers input, there was no significant difference ($P<0.86$) between the average of residual chlorine and standard value (0.5-0.8 ppm). But at the coolers output, the average of this parameter was significantly different with the standard level ($P<0.01$). It represents the effective role of coolers in changing this parameter in input and output. Also, there was a significant association (reliability 95%) between the amount of residual chlorine at the coolers input and output.

Table 1: The results of the measured parameters before and after cooler

Parameters	Output			Input		
	Maximum	Minimum	Average	Maximum	Minimum	Average
Residual chlorine (mg/l)	1	0.2	0.327	1	0	0.655
pH	7.6	7.4	7.5	7.6	4.2	7.39
Total coliforms (MPN/100CC)	28	0	3.72	75	0	6.08
Fecal Coliform (MPN/100CC)	7	0	2	43	0	4.42

Water temperature range in input and output sites are, in turn, 14-38 °C and 0-10 °C. There is not any significant relation between the input and output water temperature and the rates of total coliforms and fecal coliforms ($P<0.05$).

At the coolers input and output pH values have been in the standard range. There was no significant relationship between the pH of coolers input and output with total coliforms and fecal coliforms.

The results of total amount of coliforms in the coolers input and output represents the significant difference with the standard value (zero in 100 ml) (Table 2).

The average of the mentioned parameter was not also compatible with standards in

input and output site, respectively (P=0.017) (P=0.01). In the input and output of coolers, the relationship between residual chlorine and total coliforms was significant and negative (P<0.001), (P=0.03).

The amount of fecal coliforms shows the significant difference in the coolers input and output with the standard value (zero in 100 ml) (Table 2) so that the parameter average, at the input and output sites does not met the standard (P=0.017), (P=0.01). The relationship between residual chlorine and fecal coliforms in the water coolers input and output is a sort of significant and negative one (P<0.001), (P=0.03).

Table 2: The distribution of fecal coliforms and total coliform in positive samples

Samples	Value	Total	Distribution of microorganisms				
			0	**1-100**	**101-500**	**501-100**	**>1000**
Input	Number	60	49	5	0	0	0
	%	100	81.67	9	0	0	0
Output	Number	60	55	11	0	0	0
	%	100	91	18.33	0	0	0

According to the results, the amount of positive samples at coolers input was 9%, while this amount at the coolers output increased up to 18.33%.The relationship between total coliforms and fecal coliform was significant with 95% confidence, at the input and output sites (P=0.013). According to Tables 2, it can be declared that coolers have an effective role in microbial contamination of samples so that the number of infected samples have increased at coolers output and also the number of microorganisms.

Coliform and fecal coliform increased in outputs infected samples compared with inputs. It represents positive impact of these devices on microorganism growth.

DISCUSSION

For the prevention of disease transmission by water, it is usual to do and monitor health and quality control during the production processes up to water consumption. Naturally, micro-organisms are present in the water and on surfaces which are in contact with it.[18] Frequent testing of fecal indicators, is a method known as the most sensitive and specific assessment for determining water health.[3,19] One of the most important indicators of water pollution control is its microbial quality. This is affected by factors such as residual chlorine, pH and temperature. The presence of coliform bacteria indicates inadequate treatment, secondary contamination and plenty of nutrients in water.

In this study, which investigated the microbial quality of coolers water in the health centres and hospitals of Behbahan, the results showed that a significant relation was seen between studied parameters such as residual chlorine, total coliforms and fecal coliforms in input and output of coolers. It indicates the negative effect of these devices on the microbial quality of water. So that the most possible number of total coliforms and fecal ones increased in the output site rather than input site of the coolers. It, at last, shows the negative effect of these devices on water microbial quality.

In fecal coliform test, 18.33 percent of achieved samples were positive in complementary stage and, subsequently, the growth of microorganism was happened.

According to mentioned results and WHOs and water and wastewater organizations recommendations, the microbial quality of cooler drinking water is found inappropriate in health and treatment centres.

According to the standards of Iran drinking water, the appropriate level of free chlorine left in every part of the network is supposed to be 0.5-0.8 mg/L in usual condition and after half an hour from contact time. This level should be 1 mg/L in emergency situations with regard to possibility of distribution gastrointestinal diseases and natural disasters condition.[14] Based on the results of present study among which 18.3 and 58 percent of input and output samples have one meter of residual chlorine concentration from standard limits, it can be concluded that the amount of residual chlorine decreased in the coolers reservoirs. This has led to increase microbial growth and the number of positive samples in the coolers output.

As well as the results of this study which are consistent with the results of similar ones, it suggests that these devices have a negative impact on water microbial quality. In fact, microbial quality of coolers compared to water distribution system, is in poor condition.[20,21] The frequent cleaning of coolers is suggested in order to remove various contaminants and, therefore, reduce the possibility of waterborne diseases transmission.

Considering the results of this study, it is indicated that microbial contamination of drinking water is provided by the cooling of these places. In addition, because of referring of the people having mostly disease and suffering from the weakness of the immune system, it is possible to aggravate the incidence of diseases and their severity. So, it can be realized the importance of investigating and controlling the microbial quality of these devices. Consequently, the following items are suggested diminishing the problems and contaminations of these devices water.

It is crystal clear that these devices should be managed and observed closely and their defects must be removed.

The measures and performance of monitoring and implementing departments should be cooperated with each other in order to decrease the contaminations and also make better the microbial quality index of coolers.

The standards and instructions must be provided just for controlling the water quality of these devices.

Episodic sampling and continual microbial tests should be done for drinking water of these coolers.

Hospitals and health centres must be encouraged to be cooperated with each other in assessing waters microbial quality and also providing human forces for doing this process.

CONCLUSION

The results of this study indicate a negative impact of coolers on water microbial quality. There is also the possibility of growing the organisms in the water distribution system and cooler. As was found, the bacteria are grown in the tested samples of coolers input and output. At the same time, the reduction of residual chlorine in the coolers output rather than before is the sign of contamination in the coolers. This can be greatly reduced by performing sufficient monitoring. Bacterial increase in water samples is caused by many reasons, including lack of hygiene dispenser, the possibility of contamination in the water distribution system, inadequate coolers connected to the plumbing system, water stagnating in the cooling tanks and the presence of joints in their body. Therefore, it is necessity to develop the standards and guidelines for monitoring drinking water microbial quality in coolers located in different places. They have a significant impact on the prevalence of digestive diseases undoubtedly.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ACKNOWLEDGEMENT

This article is the result of a research project (No. 9308) approved by the Faculty of Medical Sciences of Behbahan. We thank specially Vice Chancellor for their financial support.

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How to cite the article: Baboli Z, Neisi A, Ghaed Rahmat Z, Alidosti M, Badiee Nejad A. Investigating the microbial quality of cooler drinking water of hospitals, clinics and health centres of Behbahanin 2014. Int J Epidemiol Res. 2016; 3(2): 112-118.