Research Article

Bacteriological analysis of the drinking water from different schools in Northern India: A concern in developing countries

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Abstract

Introduction: Potable water is an essential ingredient for good health and the socio-economic development of man. In developing countries, biological contamination of drinking water is a major concern for public health authorities. According to the World Health Organization, approximately 5% of all deaths in these countries are directly related to water diseases resulting from poor quality of drinking water and lack of hygiene and sanitation. Material and methods: The aim of this study was to determine the water quality of reservoirs at schools in district Amritsar. A total of 903 drinking water samples were collected from various water sources in different schools and the samples were analyzed to assess bacteriological quality of water for presumptive coliform count by multiple tube test. Results: A total of 39.8% (360/903) samples from various sources were found to be unfit for human consumption. Of the total 360 unsatisfactory samples, 189 were from submersible pumps, 97 were from taps of piped supply (domestic / public), 48 from hand pumps and 26 were from various other sources. Conclusion: It is therefore important to determine the quality, microbial diversity from water sources consumed by the people, especially used by children, because they are vulnerable to different kinds of diseases since their immune systems are still developing. Bacteriological assessment of all water sources for drinking should be planned and conducted on regular basis to prevent water borne dissemination of diseases.

Keywords: Water quality; Coliforms; Escherichia coli; Multiple tube method.

Introduction

Biological contamination of drinking water is a major concern for public health authorities in developing countries and approximately 5% of all deaths are directly related to diseases resulting from poor quality of drinking water and lack of hygiene and sanitation [1]. The World Health Organization has currently estimated that 1.1 billion people worldwide lack access to improved water supplies and the hourly toll from biological contamination of drinking water is 400 deaths of children below the age five [2]. Gastrointestinal infections resulting in diarrhea show high frequency among children, accounting for 25% of patients treated at hospitals and clinics [3]. The human pathogens that present serious risk of disease whenever present in drinking water include *Salmonella species*, *Shigella species*, pathogenic *Escherichia coli*, *Vibrio cholerae*, *Yersinia entercolitica*, *Campylobacter species*, various viruses such as *Hepatitis A*, *Hepatitis E*, *Rota virus* and parasites such as *Entamoeba histolytica* and *Giardia* species [4]. Many diseases are perpetuated by the faecal-oral route of transmission in which the pathogens are shed only in human faeces. Monitoring the microbiological quality of drinking water relies largely on examination of indicator organisms such as coliforms. *E. coli* is a member of the faecal coliform group and is a more specific indicator of faecal pollution than other faecal coliforms. At present, *E.coli* appears to provide the best bacterial indication of faecal contamination in drinking water which is based on the prevalence of *E. coli* in human and animal faeces as compared to other coliforms and the availability of affordable, fast, sensitive, specific and easier to perform detection [5]. The main objective of the reported study

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was to determine the contamination level of coliforms bacteria in water reservoirs of different schools in district Amritsar (India).

Material and Methods

A total of 903 drinking water samples from various water sources of government schools in district Amritsar received during the period from January 2014 to December 2015 were analyzed in the department of Microbiology of a tertiary care hospital. The samples were collected aseptically in sterilized containers and tested by a trained health educators and senior laboratory technician of the department by a predefined laid down guidelines by WHO and ICMR in 'WHO guidelines for Drinking Water Quality ' and 'Manual of Standards of Quality for Drinking Water Supplies' [6]. Two hundred milliliters of water samples from each source were collected in sterile glass stoppered bottles for microbiological examination. The samples were transported and stored strictly in accordance with guidelines described in standards methods. Presumptive coliform count test based on multiple tube fermentation method to estimate the most probable number (MPN) of coliform organism in 100 ml of water for diagnosis of bacteriological contamination. The test was carried out by inoculation (for 48 hours at 35°C) of measured quantities of sample water (0.1, 1.0, 10, 50 ml) into tubes of double and single strength McConkey's Lactose Bile Salt Broth with Bromocresol purple as an indicator. The tubes showing gas formation were regarded as 'Presumptive Coliform Positive'. The results of MPN are interpreted by McCrady's probability tables from the no. of tubes showing acid and gas (fermentation by coliform organisms) to define the sample as satisfactory or unsatisfactory [7]. Differential coliform count (Eijkman'sTest) was performed on suspicious water samples in which subcultures from positive presumptive test were made into MacConkey broth and peptone water and incubated at 44°C in thermostatically controlled water bath for overnight. Presence of *E.coli* was confirmed by the production of gas from lactose at 44°C and indole production from tryptophan followed by subculture on MacConkey agar [8].

Results

Among the total water samples (903) taken from various water reservoirs of the schools (Govt. & Private), 360 (39.8%) samples were unsatisfactory for human consumption, 235(26.1%) were satisfactory and 308(34.1%) were found to be excellent (Table-1). Among the total, 495 samples were taken from submersible pumps, out of which 189 were found to be unsatisfactory, 254 samples were collected from piped supply/ taps (97 were unsatisfactory) followed by 83 samples taken from handpumps, of which 48 were reported to be unsatisfactory and of the 67 samples taken from tubewells, 24 were unfit for human consumption (Table 2).

Table 1: Grades of water Sample.

Grade of water sample	Presumptive coliform count/ 100ml	Number(percentage)of water sample (n= 903)
Excellent	0	308 (34.1%)
Satisfactory	1-3	235 (26.1%)
Unsatisfactory	>10	360 (39.8%)

Table 2: Source of water collection.

Source of collection	No.of samples analysed (n= 903)	Excellent	Satisfactory	Unsatisfactory
Submersible pumps	495 (54.8%)	179 (19.8%)	127 (14.1%)	189 (20.9%)
Taps	254 (28.1%)	102 (11.3%)	55 (6.1%)	97 (10.8%)
Hand pumps	83 (9.1%)	11 (1.2%)	24 (2.7%)	48 (5.4%)
Tube wells	67 (7.4%)	16 (1.7%)	27 (2.9%)	24 (2.7%)
Water Tanks	04 (0.6%)	0 (0%)	02 (0.2%)	02 (0.2%)

Discussion

The consumption of drinking water contaminated with pathogenic microbes of faecal origin is a significant risk to human health. As a standard procedure, water intended for human consumption is distributed to consumers after treatment. Nevertheless, the quality of treated water can deteriorate during distribution due to contamination and inadequate storage conditions. In developing world, especially in remote rural areas and industrial areas, over 3 million deaths per year are attributed to water-bone diarrhoeal diseases, especially among infants and young children in poor communities [9].

It is therefore important to determine the quality, microbial diversity from water sources consumed by the people in the city, especially used by children, because they are vulnerable to different kinds of diseases since their immune systems are still developing. In Malawi, 3000 children were infected with diarrhoea and 1000 of them died and reported that 43% of the population obtains water from wells, streams and other unreliable water sources leaving them prone to water related diseases including cholera [10]. Another study in Brazil, Heller and colleagues carried out an investigation based on a case-control study which aimed at identifying factors that lead to acute diarrheal disease (ADD) in children [11].

The study concluded that one of the main factors that contributed to this outbreak was the way water was usually stored. Cairncross and others pointed out that the discussion is restricted to the water source and the distribution system, without taking into consideration the piping system inside the dwellings [12]. Regarding to storage water tanks emphasized that the major issue involving deterioration of drinking water quality is the inadequate maintenance of the internal distribution system, which is nowadays recognized as the major factor that compromises. Thus, water contamination problems have led investigators to assess the quality of the water which runs inside the buildings, dwellings and schools. The poor health status of population is reflected in high infant mortality rate of 12.6% and as low as 7% fertility rates reported in other study (Pakistan). The scanty hospital's data shows that many of the diseases treated are caused by water borne microbes indicating that a substantial proportion of morbidity in Pakistan is due to use of polluted water[13]. The present study assessed the bacteriological quality of water in different drinking water sources in schools of district Amritsar (India) and 39.8% of the samples were found to be unsatisfactory and unfit for human consumption (Table 1). The results are found to be consistent with the various other studies conducted in the same setting (revealed 47.5% samples to be non satisfactory) as well as different settings [14, 15]. Another similar study also reported 250/550(45.5%) of the water samples supplied through municipal taps (presumed to be pre-treated) were unsatisfactory, whereas other workers have reported 20% of the treated water supply to be contaminate[16]. d Our study also supports the WHO recommendation that *E. coli* is the most discriminating marker for faecal contamination and therefore a microbiological indicator of choice for drinking water potability and safety especially in developing countries with limited resources [6]. The indicator organisms namely heterotrophic bacteria, total and feacal coliform for ensuring water quality, were also taken as one of the indicator of water quality in other studies . Sinha (1991) et al has also reported number of coliform bacteria which varied from 600-1600/100 ml from Susta pond and 1200-2000/100ml from Madhaul pond of Muzzarpur, Bihar [17]. Similarly 197 coliform species have been isolated from drinking water in five rural areas of Lucknow in India [18].

Several researchers have attempted to estimate the total burden of waterborne diseases which might account for one-third of the intestinal infections world-wide [19]. It has been estimated that water, sanitation and hygiene are responsible for 40% of all deaths and 5.7% of the total disease burden occurring worldwide [20]. In developing world, especially in remote rural areas and industrial areas, over 3 million deaths per year are attributed to water-bone diarrhoeal diseases, especially among infants and young children in poor communities [9]. A survey in Pakistan on water revealed, bacterial causes of water contamination to be 68% giving rise to 100 million diarrheal cases seeking hospital admissions and 40% mortality associated with it [21].

Monitoring the quality of water is very essential for environmental safety. WHO, (1985) specified that potable drinking water should be devoid of total coliform in any given sample [2]. Also, according to USEPA standards,water samples in which coliforms are detected should be considered unacceptable for drinking water as they are regarded as the principal indicators of water pollution [22].

Conclusion

Water quality is a growing concern and availability of safe drinking water still remains a much sought after commodity for majority of public in developing countries would like to recommend the proper sanitary survey, design and implementation of water and sanitation projects; regular disinfections, maintenances and supervisions of water sources and regular bacteriological assessment of all water sources for drinking should be planned and conducted.

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