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# Surveillance of Quality of Drinking Water

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**Objective: To study the status of bacteriological contamination of drinking water being supplied by the municipal corporation.**

**Design: Community based longitudinal study.**

**Setting: Department of Community Medicine and Microbiology of Government Medical College.**

**Method: 133 Hand pumps and 107 taps from which people were using water for drinking purposes were included in the study. Bacteriological quality of drinking water was checked by Mackie and Mc Cartney's method; calculating most probable number (MPN) by presumptive coliform count. Water samples with MPN > 3 were considered unfit for drinking purposes.**

**Result: The bacteriological analysis of water samples was carried out for two years from July 2002 to June 2004. It showed that 47.4% hand pumps and 15.9% taps were supplying contaminated water; the range was from 40-70% and 27.8-57.9% during pre-monsoon to post-monsoon, seasons of respective years.**

**Conclusion: The contamination of drinking water unfortunately appears to be a universal phenomenon in most of the developing countries. The authors conclude that there are two spheres, which needs to be strengthened. Firstly, the bacteriological quality of drinking water needs to be improved in general and special care is to be taken during pre-monsoon and monsoon periods. Secondly, regular campaigns may be carried out to inform the public about the importance of safe and potable water including methods for household disinfection of drinking water, during the pre-monsoon and monsoon periods when the incidence of contaminated water samples is highest in the region.**

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Urban living is the keystone of modern human ecology. Large cities in the less developed countries typically combine the traditional environmental health problems of poverty and infections, particularly respiratory and enteric, with those of poor quality of living conditions. Such populations have long been incubators and gateways for infectious diseases associated with poor sanitation and unsafe drinking water[1]. With rapid population growth and rising expectation for a better life, maintaining the quantity and quality of natural resources, drinking water in particular, is critical to ensure public health. Diseases resulting from ingestion of pathogens in contaminated water have the greatest public health impact worldwide. Diarrhoeal diseases are among the leading causes of morbidity and mortality among children under five years of age[2].

More than a century after John Snow identified a hand pump in Broad Street, London, as the primary source of cholera epidemic, supplying safe water and providing sanitation facilities to all still remains an illusive target in most communities in India. Presently, although more than 90 percent of the population have community water supply facilities, health benefits have not been commensurate with the investment made. Lack of water quality surveillance is one of the major reasons among others, for such a scenario[3].

Similar to most cities in India, the public water supply in Chandigarh, Union Territory (UT) India is managed by a municipal body. Even within the city, the population living in slums and peri-urban fringe areas is susceptible to inadequate and intermittent water supply. Overcrowding and inadequate facilities for human excreta and waste water disposal makes the water distribution system prone to microbial contamination.

In order to meet these challenges a system of monitoring and surveillance for drinking water quality was initiated in some areas of Chandigarh to delineate the bacteriological quality of drinking water from hand pumps and taps and to determine the pattern of seasonal variation therein.

The aim of this study was to analyze the status of bacteriological contamination of drinking water being supplied by the municipal corporation.

**METHOD**

This study was undertaken following a community based longitudinal design.

Drinking water samples were collected. Collection of water samples was done bimonthly during the summer and monsoon season from May till October and once every month during the months of November to April. Sampling was carried out by Medical Officers/Demonstrators along with trained health workers in accordance with the methods described in "International Standards for Drinking Water[4]. The samples were tested for bacteriological contamination by coliform organisms using presumptive coliform count employing the method described in Mackie and McCartney[5]. The most probable number (MPN) of these bacteria was determined from McCrady's probability

tables. Samples with MPN more than three were considered unfit for drinking purposes[5]. The samples of tap water which were found contaminated, were repeated in the next visit. Detection of growth of *Vibrio Cholera* was also done using the concentration technique described in Mackie and McCartney[6].

Descriptive analysis of the data was done for a period of two years extending from July, 2002 to June, 2004. In order to explore seasonal variations in the quality of drinking water the months from March till June were considered pre-monsoon, July to October as monsoon and November to February as post-monsoon season.

**RESULT**

A total of 240 drinking water samples, 133 from hand pumps and 107 from taps, were collected from the selected areas of Chandigarh. Eighty (33.3%) were found to have MPN more than three. However some of the tap water samples were found contaminated when the sampling was repeated again from the same source. This figure was 47.4% and 15.9% for hand pumps and taps, respectively. The distribution of contaminated samples was almost similar during the years 2002-03 and 2003-04. Incidence of bacteriological contamination of water from all sources was to the extent of 39.3% in Palsora and 38.7% in colony No. 5. The extent of contamination in the water samples from the hand pumps was 56.9% at Colony No. and 56.7% at Palsora. Bacteriological contamination of tap water ranged from 0 in Colony no. 5 to 30.4% at Dhanas (**Table**). The percentage of contaminated water samples from hand pumps ranged from 9.5% in Dhanas to 46.0% in Colony No. 5 (**Fig. 1**). Seven (41.2%) out of the 17 contaminated tap water samples were from Palsora and Dhanas (**Fig. 2**). Total overall incidence of contaminated water samples in the study area ranged from 16% in Dhanas to 36% in Colony no.5. (**Fig 3**.)

**Table: Seasonal bacteriological quality of drinking water in the study area**

| Area | Total | | Source of Water | Monsoon (July-Oct'02) | | Post-Monsoon (Nov'02-Feb'03) | | Pre-Monsoon (Mar-Jun'03) | | Monsoon (Jul-Oct'03) | | Post-Monsoon (Nov'03-Feb'04) | | Pre-Monsoon (Mar-Jun'04) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. (T) | @Conta. No. (%) | | No. (T) | Conta. No. (%) | No. (T) | Conta. No. (%) | No. (T) | Conta. No. (%) | No. (T) | Conta. No. (%) | No. (T) | Conta. No. (%) | No. (T) | Conta. No. (%) |
| Palsora | 30 | 17 (56.7) | Hand pump | 7 | 2 (28.6) | 2 | 2(100) | 4 | 3 (75) | 6 | 4(66.7) | 5 | 2(40.0) | 6 | 4(66.7) |
| | 31 | 7 (22.6) | Tap | 7 | 1 (14.3) | 0 | 0 | 8 | 1(12.5) | 7 | 2(28.6) | 4 | 0 | 5 | 2(40.0) |
| Dhanas | 22 | 6 (27.3) | Hand pump | 4 | 1(25.0) | 3 | 1(33.3) | 3 | 1(33.3) | 6 | 2(33.3) | 2 | 0 | 4 | 1(25.0) |
| | 23 | 7 (22.6) | Tap | 4 | 1(25.0) | 2 | 1(50) | 2 | 1(50) | 4 | 1(25.0) | 6 | 3(50.0) | 5 | 0 |
| Kajheri & Sector 52 | 30 | 11 (36.7) | Hand pump | 9 | 4(44.4) | 4 | 1(25.0) | 3 | 2(66.7) | 5 | 1(16.7) | 6 | 1(16.7) | 3 | 2(66.7) |
| | 29 | 3 (10.3) | Tap | 11 | 1 (9.1) | 3 | 0 | 2 | 0 | 5 | 2(40.0) | 3 | 0 | 5 | 0 |
| Colony No. 5 | 51 | 29 (56.9) | Hand pump | 14 | 8(57.1) | 6 | 2(33.3) | 10 | 8(80) | 10 | 5(50.0) | 5 | 2(40.0) | 6 | 4(66.7) |
| | 24 | 0 | Tap | 6 | 0 | 3 | 0 | 3 | 0 | 5 | 0 | 3 | 0 | 3 | 0 |
| **Overall** | **133** | **63 (47.4)** | **Hand pump** | **34** | **15(44.1)** | **15** | **6(42.9)** | **20** | **14(70)** | **27** | **12(44.4)** | **18** | **5(27.8)** | **19** | **11(57.9)** |
| | **107** | **17 (15.9)** | **Tap**** | **28** | **3(10.7)** | **8** | **1(12.5)** | **16** | **2(12.5)** | **21** | **5(23.8)** | **17** | **3(17.6)** | **18** | **02(11.1)** |
| **GRAND TOTAL** | **240** | **80 (33.3)** | | **62** | **18 (29.0)** | **23** | **07 (30.4)** | **36** | **16 (44.4)** | **48** | **17 (35.4)** | **35** | **8 (22.9)** | **37** | **12 (32.4)** |

- ** No tap water sample from the same source was found contaminated on repeat testing.

@ Conta. - Contaminated samples i.e. MPN >3 - Water unfit for consumption.

(T) - Tested Water Samples

**Fig. 1 DISTRIBUTION OF HANDPUMPS WITH CONTAMINATED WATER IN CHANDIGARH (INDIA)**

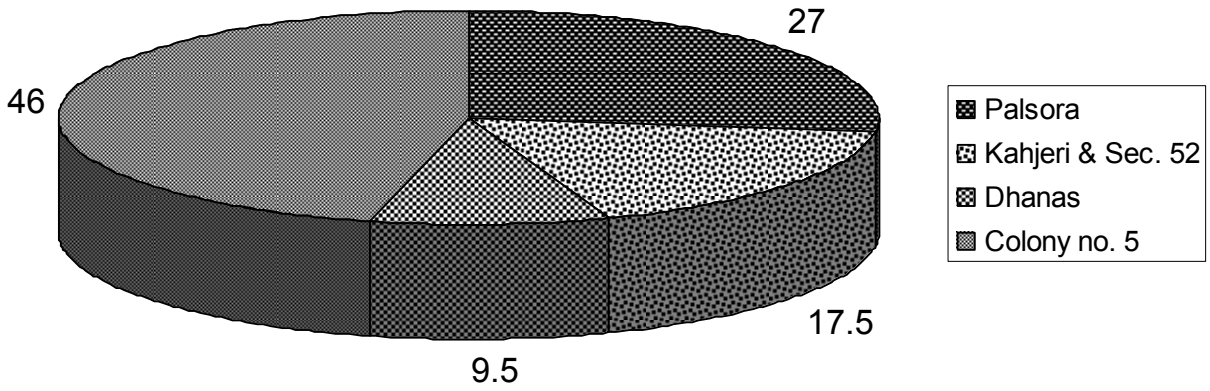



**Fig. 2 DISTRIBUTION OF TAPS WITH CONTAMINATED WATER IN CHANDIGARH (INDIA)**

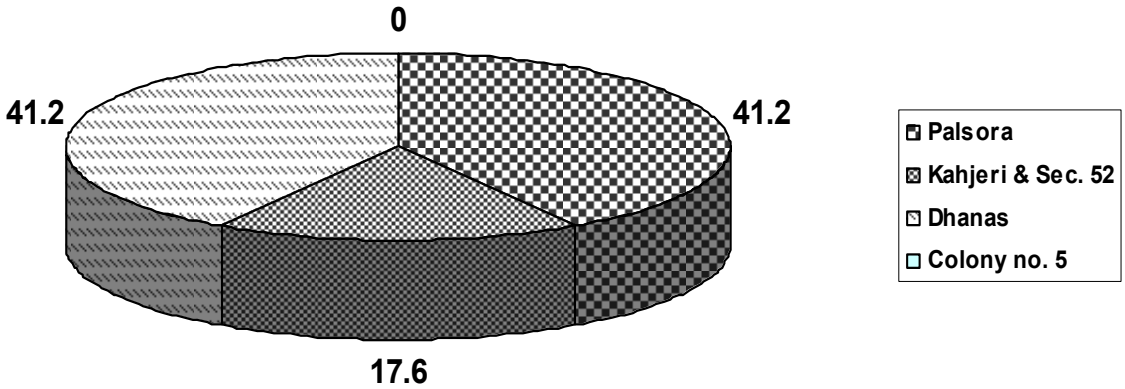
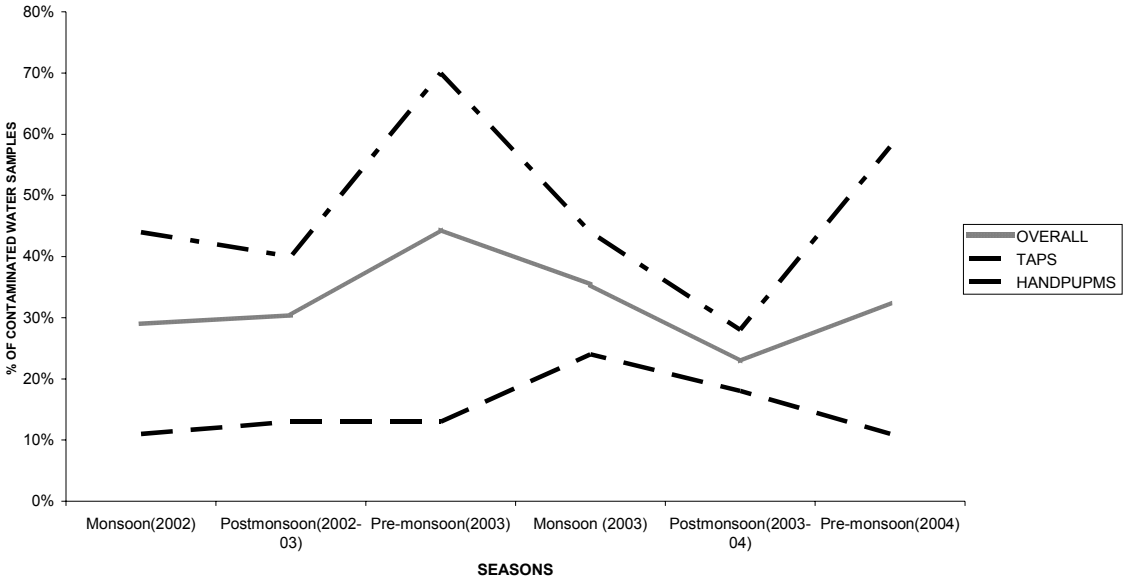



**Fig. 3 OVERALL DISTRIBUTION OF CONTAMINATED WATER SAMPLES OF HANDPUMPS & TAPS IN CHANDIGARH (INDIA)**

It was also observed (**fig 4**.) that over a period of two years the pattern of contaminated (MPN>3) water samples from all sources in the study area was as follows: 44.4% samples in pre-monsoon, 2003 season, followed by 35.4% in monsoon 2003 and 32.4% in pre-monsoon 2004 season respectively. During the pre-monsoon 2003 season 70% of **hand pump** water was contaminated followed by 57.9% in pre-monsoon, 2004 and 44% in monsoon, 2003 and 2004 season. In case of tap water 24% in monsoon 2003, 18% in post-monsoon,2003-04 followed by 13% each in post-monsoon 2002-03 and pre-monsoon 2003 respectively. Seven water samples (6 from hand pumps and 1 from tap) were also detected to be positive for *Vibrio Cholera* during the monsoon 2002 season. No case of Cholera was reported in 2003 and till June, 2004. The peak incidence of bacteriological contamination of water from hand pumps was exhibited in the pre-monsoon season across the study area. It ranged from 25.0% in Dhanas to 80% in Colony no. 5.

FIG.4. SEASONAL BACTERIOLOGICAL QUALITY OF DRINKING WATER IN STUDY AREA OF CHANDIGARH, INDIA (JULY 2002-JUNE 2004)




## DISCUSSION

Safeguarding drinking water supplies is a major health responsibility. The WHO guidelines place the greatest emphasis on the microbiological quality of drinking water[2]. For many years the emphasis in the country remained on achieving the target of "Coverage of population" with thrust on quantity of water. Quality aspects of water supply and education of people has been largely neglected. The concept of safe water eludes the common man. Consequently an outbreak of water borne diseases remains a great burden on society[7].

The bacteriological examination of drinking water is a sensitive method to assess its quality, though it does not detect contamination with protozoa, virus and fungi. Enumeration of coliforms has been recommended by the Indian Council of Medical Research and has been the main method adopted by many workers[8,9-13]. Faecally contaminated water is usually the vehicle for transmission of cholera, either directly or through the contamination of food[14].

A third of all water samples have been found unfit for drinking purpose in the peri-urban and slums areas of Chandigarh, the major proportion from the water from hand pumps. This is better than the figures reported from Madurai (47%), Delhi (43%), Vellore (93%),

Liberia and Sudan[15-19]. However, studies from Mirzapur, Shimla, others parts of Asia and Africa have documented much fewer samples with MPN more than 3[20-23]. More than half of the hand pump water samples have demonstrated contamination with coliforms in Colony No. 5 and Palsora. These are slum areas where the upper level of ground water seems to have been infiltrated with coliforms due to indiscriminate open-field defecation and inadequate facility for human excreta disposal. Tap water samples testing positive for coliforms, mainly in Dhanas, calls for further investigation of the water distribution system in the area.

A steep rise in contamination level of water has been demonstrated during the pre-monsoon months in the study area, with additional peaks in the monsoon season. The pre-monsoon summer months of March to June witness maximum water consumption, more so from hand pumps which provide a perennial source of water as compared to taps which run dry frequently. The rain during the months of July to September on the other hand, acts to amplify contamination of ground and surface water in the insanitary conditions prevailing in the study area. Similar observations have been made by several authors [17,24-26]. Association of seasonal occurrence of contamination with recurrence of water borne diseases such as cholera in this area needs to be explored more extensively.

During two consecutive years the incidence of contamination did not demonstrate much variation. This shows that immediate action could be taken by the people at household level but environmental and engineering measures at community level would take a long time to be applied. The WHO guidelines stress on vigorous disinfection of drinking water which almost universally involves the use of chlorine[2,17]. A sustained programme of health education besides regular surveillance of water is the need of the hour. Such a programme calls for the involvement of women with the support of men and the community to generate a positive attitude among the whole community towards improving water, sanitation and hygiene practices[27].

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