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# Contents

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# A Household Based Safe Water Intervention Programme for a Slum Area in Bangladesh

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**Abstract:** Water intended for human consumption should be both safe and wholesome. It also should be easily accessible, adequate in quantity, free from contamination and readily available throughout the year. In slum areas, so far too many people live without access to safe drinking water and this is a primary determinant of continuing poverty. In the present study, drinking water is an important route for transmission of diarrheal diseases, a leading cause of morbidity and mortality among children. A household based safe water intervention programme was conducted to determine the microbial quality of water in households and its relationship to source and storage devices. The laboratory analysis indicates that significant amount of *E. coli* (5-182/ml sample) is present in both of the sources and storage vessels. The type of household storage device and unhygienic behaviour were associated with coliform contamination. It was estimated that 13.32% households are less affected by diarrheal diseases because they use tube well water for their household work and remaining 86.65% are highly affected due to use of contaminated water. The lack of water supply and sanitation is the primary reason for diseases transmitted via faeces which are so common in slum area. The drinking water quality in Nirala slum area is grossly unfit for human consumption, due to contamination of various water sources, traditional storage practices and unhygienic behaviour. So it is cautioned that without ample and safe drinking water, we cannot provide health care to the slum community.

**Key words:** Safe water, household, diarrhea, *E. coli*, slum.

## Introduction

Water is absolutely essential for man, animals and plants. Without water life on earth would not exist. While man has always recognized the importance of water for internal bodily needs, his recognition of its importance to health is a more recent development, dating back only about a century. Since that time, much has been learned about the role of quantity and quality of water supply in the spread of diseases. Among the first diseases recognized to be water-borne are cholera and typhoid fever. Later, dysentery, gastro-enteritis and other diarrhoeal diseases were added to the list (Ahmed and Rahman, 2000).

In Bangladesh, every year three million children under five years of age die of diarrheal disease and every child suffers an average of three times diarrheal attacks in a year (WHO, 2000).

The Safe Water System (SWS) is inexpensive, simple to use, adaptable to different conditions and can be implemented in a relatively short period of time. In developing country communities, with poor water quality, a successful implementation of the Safe Water System can improve water quality and health. The general objectives of this study are to identify the exact role of safe water and hygienic sanitation on a slum community.

In the developing world, diarrhea is a leading cause of morbidity and mortality in children younger than five years old (Ford, 1999). Drinking water is an important route of disease transmission in many countries where there is no infrastructure for managing human waste or for ensuring safe water through treatment (Mintz and Tauxe, 1995). This problem affects more than a billion people, particularly the economically disadvantaged (Centers for Disease Control, 2000). The Centers for Disease Control (CDC) and the Pan American Health Organization responded to this urgent problem by developing a Safe Water System (SWS) which is a simple, inexpensive, easily disseminated, and effective intervention for safe water treatment and storage at the household level.

In 2002, just 12 years after the end of the United Nations-declared International Drinking Water and Sanitation Decade, the lack of access to safe water remains a problem for over a billion people worldwide (WHO, 2000).

A study among predominantly middle class households throughout Karachi in 1994 found that although 67% of households attempted to purify their water, most commonly by boiling, 240 (85%) of 282 drinking water samples tested were contaminated with coliform bacteria. This suggests that recontamination of water after purification may contribute to disease transmission (Luby et al., 1999).

In a pilot study of this method in Bolivia, the percentage of households with water that met WHO microbiologic criteria for potability (<1 thermotolerant coliform 100/ml water) improved from 21% at baseline to 93% among those receiving the vessel and a hypochlorite solution (Quick et al., 1997). A second study in Bolivia demonstrated a 44% reduction in the prevalence of diarrhea among persons living in households who received the vessels and hypochlorite compared to controls (Quick et al., 1999).

Reiff et al. (1996) stated on his study that a very large segment of the world's population is without a microbiologically safe water supply. Studies have shown that even if water is microbiologically safe upon its placement in such makeshift containers, it is quickly contaminated during storage and use, primarily by contact with human hands or contaminated utensils that are used to withdraw water, as well as the entrance of dust, animals, birds and insects when the vessel is inadequately covered.

The study of Ogutu et al. (2001) suggested that disinfected water stored in traditional clay vessels is at risk for recontamination, which may result from contact with hands during water retrieval. It has also been found that water stored in wide-mouthed vessels typically becomes contaminated, and wide-mouthed storage vessels have been implicated in transmission of cholera. The finding that water stored in modified clay vessels had no detectable *E coli* 24 hours after treatment suggests that water recontamination was reduced by use of the lid and spigot.

Pedro et al. (2000) found on their study that the drinking water in rural communities in Trinidad was grossly unfit for human consumption, due to contamination of various water sources and during household water storage.

## Material and Methods

The study area is located (Figure 1) in the Khulna Metropolitan City under ward no 24 in the southwestern Bangladesh. Khulna City stands on the banks of the river Rupsa and the Bhairab. Khulna lies between 22°49′ north latitude and 89°34′ east longitudes having an elevation of 2.13 metres above Mean Sea Level (Rashid, 1991).

The study area is selected according to the objectives of the study. Khulna is being directly influenced by the tidal water and salinity. Thus the problem of safe and available water is likely to be more acute than any other area. However the slum is representing the exact scene

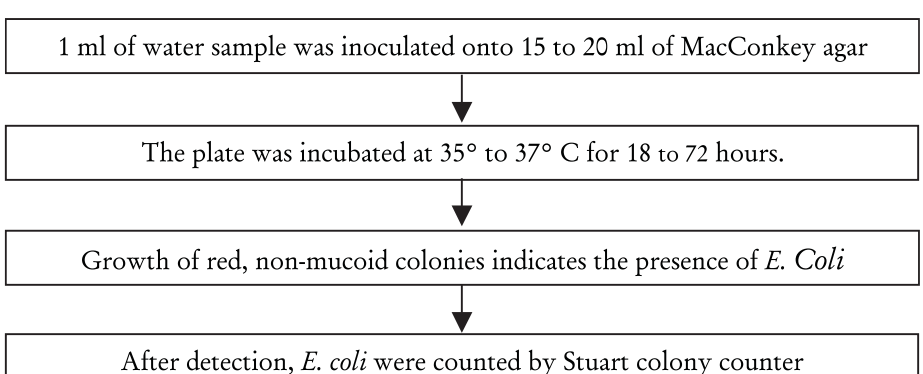


**Figure 1: Flow diagram for detection of *E. coli.***

of typical slum of Bangladesh from water use and sanitary practices.

Water samples were collected from different sources such as groundwater, supply water and storage pot (clay and aluminium) in different households. Clean rinsed and dried plastic bottles of one-litre capacity without any contamination were used for sampling. A total of 20 samples representing five from each category were collected. All samples were processed within six hours of collection.

The physico-chemical properties of water sample like temperature, pH, salinity and electrical conductivity were determined on the spot by the field test kit equipments.

The detection of *E.coli* of the collected samples was done at the Microbiology laboratory of Pharmacy Discipline, Khulna University. In this regard, 1 ml of water sample was inoculated into 15 to 20 ml of MacConkey Agar Medium and incubated at 35° to 37°C for 18 to 72 hours. After incubation, growth of red, non-mucoid colonies of Gram-negative rods indicates the presence of *E. coli* (BP, 2000).

The household information has been collected through personal interview through a set of structured questionnaire.

## Results and Discussion

### Chemical Analysis of Water Samples

The chemical analysis of water samples are having temperature 25º-27ºC, pH 7.5-8.57, EC 836-909 µS/cm and $Cl^-$155-165 ppm. Chemical analysis of water samples indicates that they meet the Department of Environment and WHO's standard for drinking purpose.

### Detection of Microorganisms in Water Samples

The test for bacteria among the water samples was conducted after incubation of seven days. The samples were compared to the control group (positive and negative) and the presence or absence of bacteria were determined readily by visual inspection. For the confirmation test, a loopful of suspension was streaked onto plate of Nutrient agar medium (15 ml each). Then the plates of Nutrient agar medium were incubated at 30° to 35° C for 24 to 28 hours. After incubation the obtained results are shown in Table 1.

**Table 1: Test for Bacteria**

| *Sample No.* | *Incubation* | *Results* |
|---|---|---|
| 1. Tube-well 1 | | ++ |
| 2. Tube-well 2 | | ++ |
| 3. Supply water | | + |
| 4. Storage at aluminium pot | | ++ |
| 5. Storage at aluminium pot | At 30° to 35°C | +++ |
| 6. Storage at aluminium pot | for 7 days | + |
| 7. Storage at clay pot | | ++ |
| 8. Storage at clay pot | | +++ |
| 9. Storage at clay pot | | +++ |
| Control group | | – |
| Control group | | – |
| Control group | | – |

*Note:* (+) sign indicates presence of bacteria; (++) sign indicates moderate presence of bacteria; (+++) sign indicates high presence of bacteria; and (–) sign indicates absence of bacteria.

It is observed from the above result that all water samples were contaminated with bacteria. Microorganisms will normally grow in water, and on surfaces in contact with water as biofilms. The study area contains pit soil. The deposition of excreta in pits may pollute water sources, particularly shallow tube wells, pond etc. located nearby. The danger of pollution increases if the pit is dug down to the water table or to fissured or weathered rock (Ahmed and Rahman, 2000).

### Detection of E. Coli in Water Samples

Detection and count of *E. coli* on different water samples were conducted after incubation. Colony counter was used to count *E. coli.* The results obtained, shown in Table 2, indicate that a significant amount of *E. coli* is present in both the sources (tube well) of water and the storage vessels. During distribution, the bacteriological quality of water may deteriorate. *E. coli* comes from human and animal wastes. During precipitation, *E. coli* may be washed into creeks, rivers, streams, lakes, or groundwater. When these waters are used as sources of drinking water, *E. coli* may end up in drinking water. They

**Table 2: Identification of *E. coli*/ml in Different Sources and Storage Pots**

| *Source* | | *Storage pot* | |
|---|---|---|---|
| Tube well (*n*=5) | Supply water (*n*=5) | Aluminium pot (*n*=5) | Clay pot (*n*=5) |
| Maximum: 35 | Maximum: 30 | Maximum: 51 | Maximum: 182 |
| Minimum: 9 | Minimum: 5 | Minimum: 8 | Minimum: 18 |
| Average: ˜20 | Average: 16 | Average: ≈25 | Average: 61 |

may also gain entrance from soil or natural water through leaky valves and glands, repaired mains or back siphonage.

The chemical analysis of water samples indicates that the water quality shows slight salinity in nature. This is suitable for coliform growth in natural water and may exists upto 72 hours. But in neutral to non-saline water coliform exists only 24 hours.

**Behavioural Pattern and Water Contamination**

In the studied slum, a large number of people are illiterate. Because of illiteracy they have less knowledge about safe water and hygienic sanitation. Interestingly, there is no sanitary latrine in the study area. 99% people of the slum area use open latrine besides lake. They also meet their domestic purpose (eg. bathing, washing) with this lake water. For household work, other than drinking, tube well water is used by only a small percentage (~26.66%) of the slum area. Remaining 59.98% use lake water and 13.33% use supply water (Field survey, 2003). This is in part due to limited awareness or ignorance of the health hazard related to use of unsafe water for household purposes.

Adequate hand washing is very important for good health. In the slum areas, no one uses soap after toilet for hand washing. A few number (26.66%) use soil for hand washing and 13.33% use only water for hand washing. Remaining 60% does not use anything for hand washing. Because of their lack of knowledge, they often introduce their dirty hands on water vessels. As a result, *E. coli* grows spontaneously in the storage vessels.

Field survey and laboratory investigation strongly suggests that household contamination of drinking water significantly contributed to diarrheal diseases. Contaminated water and unsafe storage lead to poor health in the slum community. It was found that all households suffer much in diarrheal diseases, because of their unhygienic behaviour. Among them, a few number of households are conscious about diarrheal diseases. It was estimated that only 13.32% households are less affected by diarrheal diseases because they use tube well water for their household work. Remaining 86.65% households are highly affected by diarrheal diseases. The status of water use pattern, storage and sanitation practices in study slum area is shown in Table 3.

**Storage Vessels and Water Contamination**

For research purpose, all households provide information about their water storage pattern. Only 33.32% use lid on the storage vessels. The storage vessels have wide mouth and they often introduce their dirty hands on these vessels. They clean the storage pot quite often. From field survey, 66.65% households store water, where the storage devices are frequently left uncovered and subject to contamination.

In laboratory investigation, the presence of *E. coli* in clay pot is significantly higher than aluminium pot and source. This strongly suggests the role of containers in the contamination process. Having unsanitary storage containers is known to contribute to substantial reduction in water quality.

Because of their lack of knowledge, they do not know about disinfectant. However, they never use disinfectant in storage vessels. For this reason, *E. coli* occur largely in storage vessels.

**Table 3: Status of Water Use Pattern, Storage and Sanitation Practices in Study Slum Area**

| *Total number of studied household* | *Percentage of household* | *Water use pattern* | | *Water storage* | | *Sanitation practices* | | *Percentage of affected household in diarrheal diseases* |
|---|---|---|---|---|---|---|---|---|
| | | *For drinking* | *Domestic purpose* | *Storage pot* | *Covered with* | *Latrine use* | *After toilet* | |
| 15 | 13.33 | Tube well | Tube well | Aluminum | Lid | Open latrine | Use soil for hand washing | 6.66 |
| 15 | 13.33 | Tube well | Tube well | Clay | Lid | Open latrine | Use water for hand washing | 6.66 |
| 15 | 6.66 | Tube well | Lake water | Clay | Lid | Open latrine | Not at all | 13.33 |
| 15 | 26.66 | Tube well | Lake water | Aluminum | Uncovered | Open latrine | Not at all | 26.66 |
| 15 | 26.66 | Tube well | Lake water | Clay | Uncovered | Open latrine | Not at all | 26.66 |
| 15 | 13.33 | Tube well | Supply water | Clay | Uncovered | Open latrine | Use soil for hand washing | 20 |

*Source:* Field survey, 2003.

## Conclusion

Water intended for drinking and household purposes must not contain water-borne pathogens. Because the most numerous and the most specific bacterial indicator of faecal pollution from humans and animals is *E. coli,* it follows that *E. coli* or thermo tolerant coliform organisms must not be present in 100 ml samples of any water intended for drinking (WHO, 1993).

From laboratory investigation, it was found that almost all the water sources and storage vessels are highly contaminated by *E. coli.* The average range of *E. coli*/ml indicated that traditional storage practice and unsanitary behaviour were the main cause of such contamination.

Water destined for human consumption should be free of coliform. The health implications of waterborne coliform contamination cannot be overemphasized. The presence of coliform in water is an indication and has been associated with water-borne epidemics in humans (Mackenzie et al., 1995).

Microbiologically unsafe drinking water is a serious public health problem affecting a very large segment of the population of the study slum. Failure to provide adequate protection of drinking water will expose the slum community to the risk of outbreaks of diarrheal diseases. Those at greatest risk of water-borne diseases are infants and young children, people who are debilitated or living under unsanitary conditions, the sick and the elderly. The potential consequences of microbial contamination are such that its control must always be of paramount importance and must never be compromised.

According to water quality guidelines for drinking water, the result obtained from laboratory investigation indicated that the various water sources were of poor microbiological quality and unacceptable for human consumption due to faecal pollution. This indicates the potential risk of water-borne diseases for consumers and calls for prompt intervention to mitigate the socio-economic and health impact of water-borne diseases in these slum communities.

Providing safe water for all is a long-term goal. The lack of safe water and hygienic facilities for the poor is a major problem particularly in slum areas. Extreme poverty and poor understanding of basic hygiene has severely limited access to, and use of, safe water and hygienic sanitation. So, the Government along with other organizations has to take necessary step by improving safe water and sanitation facility in the slum community for achieving better living for the future.

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