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Determination of risk of diarrhoeal diseases in some areas of Serampore, Hooghly, West Bengal through potable water quality monitoring

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Abstract
The epidemiology of diarrhea has been one of the most elusive problems in tropical countries. Scarcity of good quality water is considered as one of the major causes of enteric disease. A pilot study was undertaken to determine the quality of usable water from different drinking water sources like tap, tube well, stored and pond in some areas of Serampore, Hooghly, West Bengal. Samples were subjected to physico-chemical tests as well as enumeration of total coliform had also been undertaken. Altogether, 52 samples (15 tap water, 15 tube well water, 15 stored water and 17 pond water samples) have been collected and analyzed from different sources in the studied locality. Highest load of fecal coliform has been observed in pond samples (115-4800cfu/ml) followed by stored (10-2050cfu/ml) and tap/tube well (10-185cfu/ml).All the stored and pond water samples were found to be coliform positive, whereas 26% of total tap water samples were found to be coliform contaminated.

Keywords: Diarrhea, Endemicity, Epidemiology, pH, Salinity, TDS, *Vibrio* sp.

1. Introduction
Acute Diarrhoeal disease is one of the important causes of childhood morbidity of the world including India. Recent global estimates of mortality revealed that five children per thousand per year in developing areas and countries died as a result of diarrhoeal illness in the first five years of the life [1]. Water - borne diseases include cholera, typhoid, shigellosis, polio, and hepatitis A and E. Human beings and animals can act as hosts to the bacterial, viral, or protozoal organisms that cause these diseases. Millions of people have little access to sanitary toilet [2-5]. In India about one third of the pediatric wards remain occupied by diarrhoeal cases alone. According to the latest report, the state of West Bengal alone per annum accounts for near about 20 lakh cases [6] and several thousand deaths occur every year in different districts of West Bengal. The epidemiological factors responsible for the endemicity of the disease are lack of safe water supply, poor environmental sanitation and improper disposal of human excreta, and proximity to surface water. Quite a number of pathogens cause diarrhoeal diseases; mostly they are of water borne (Fig. 1). Understanding disease epidemiology of diarrhea in an endemic focus there is a necessity for the knowledge of pattern of diarrhoeal illness with regard to drinking water supply structures and microbial risk assessment in catchments areas of drinking water reservoirs. Accordingly, the present study has been undertaken as a preliminary one to monitor the macro-ecosystem of environmental determinants in relation to existence and spread of enteric infections in an endemic foci of West Bengal with respect to drinking water microbial status.

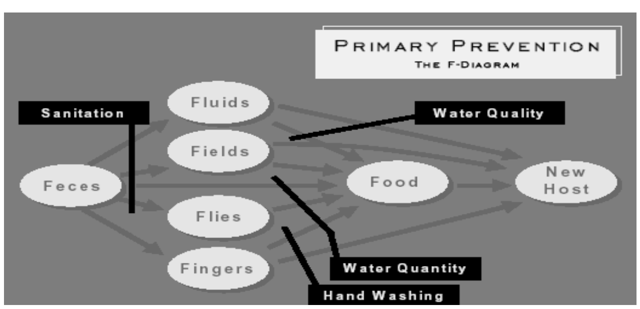


Fig 1: Pathways of Diarrhoeal disease transmission.

2. Materials and Methods

A. Selection of study area: The study areas were randomly selected in areas of Serampore of district Hooghly, West Bengal (Fig. 2).

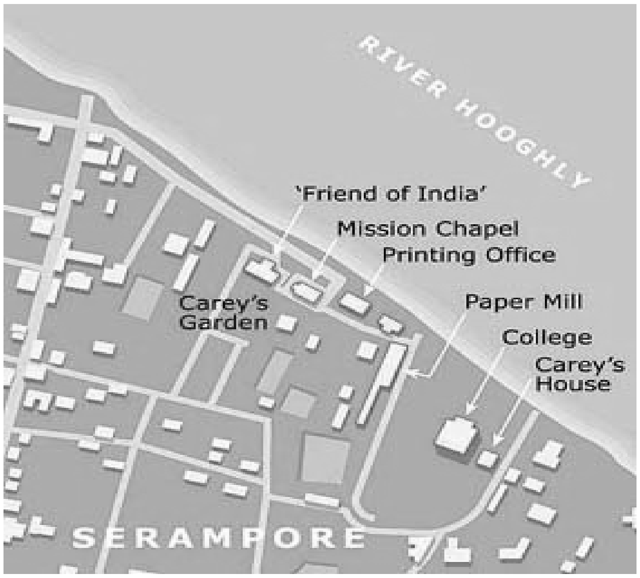


Fig 2: The study areas in Serampore, Hooghly

Enteric diseases were caused by enteric pathogens and as such there is a possibility of presence of pathogenic bacteria mostly transmitted through water. So water samples were collected to detect the causative agent of diarrheal diseases under the influence of environmental factors [7].

Period of study: The project work was accomplished between November 2012 to March 2013. During the course of the work seasonal variation of early winter, entire winter period and pre-summer period was encountered. So it was a welcome opportunity to address the transmission potential of pathogenic bacteria in relation to seasonal variation, if any.

B. Types of source of collection of sample: As per objectives, water samples were collected from four different types of sources like tap water, ground water, stored water and pond water. Tap water is supplied by local municipality. Stored water is important source where tap or ground water is not available. Pond water is used for bathing, washing utensils and clothes etc.

C. Collection of the sample: Water samples were collected in conventional sterilized Tarson glass containers of 250ml. Normally 100ml water sample was collected for experiment. Then it was brought to the laboratory for necessary tests.

Water Quality Test: The following tests were performed based on the physical, chemical, biological properties of water.

I. Physico-chemical Test

Salinity, conductivity, TDS, pH have been measured by using the probe of Thermo, Orion at the sample collection point.

II. Microbiological analysis

TBC –In the test, 100µl raw sample was inoculated on NA medium. Total bacterial count (TBC) was undertaken only after the over- night incubation of those inoculated plate at 37ºC.

TCC - In the test, 100µl raw sample was inoculated on CC medium. Total coliform count (TCC) was undertaken only after the over- night incubation of those inoculated plate at 37ºC. Red and blue colonies were considered as coliform.

TEC - In the test, 100µl raw sample was inoculated on CC medium. Total *E.coli* count (TEC) was undertaken only after the over- night incubation of those inoculated plate at 37º C. Blue colonies were counted.

Results

From Serampore, all together 52 water samples were collected among which 15, 15, 15 and 7 water samples were collected from Tap, Tube well, Stored and Pond water respectively **(Table-2).**

The physico-chemical properties of 52 water samples depicts that irrespective of any source, samples are mostly alkaline in nature. However, the pH variation in pond water samples ranged between 7.18-9.53 that supports to the fact that chlorination as well as disinfection process were lacking. Except a few main sources, most of the tap, tube well, stored water was observed with, very low salinity range (varying between 0 to 0.3 ppt salinity) **[Table-1]**

Rather pond water samples were observed with higher salinity (range between 0.1 to 0.9 ppt salinity). In most of the cases tap, tube well, stored water were found to be less turbid, where as few main sources along with pond water showed higher turbidity **[Table-1]**

Altogether 27 (51%) samples were found to be fecal coliform positive. Deposition of fecal coliform was found to be highest in pond samples (100%) followed by stored (60%), Tap (40%), and tube well (33%) waters.

Among fecal coliform positive samples, pond samples showed the highest load of fecal coliform (varied between155 to 4800 cfu/ml). **[Table-2]**

Out of 52 water samples, 18 samples were found to be contaminated with *E.coli*. Here also, prevalence of *E.coli* was highest in pond (100%), followed by tube well (33%), tap (26%), and stored (13%) waters. **[Table-2]**

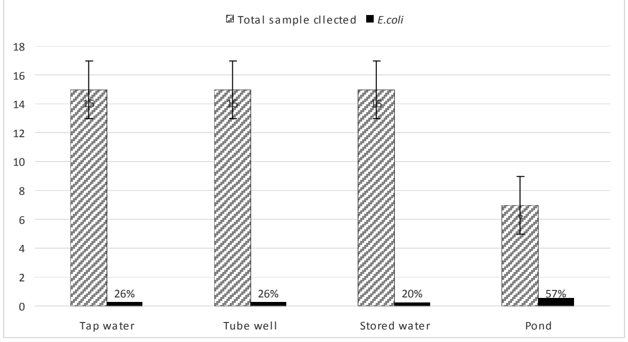
Table 1: Physico-chemical properties of collected water samples

Sources	pH	Salinity	TDS	Conductivity
Tap water	7.75 - 8.74	0 - 1.4	157 - 529	330 - 2720
Tube well	7.35 – 8.84	0 - 1.2	141 - 1158	287.3 - 2353
Stored	7.81 – 9.28	0 - 0.3	138 -348	281 - 711
Pond	7.18 – 9.53	0.1 – 0.9	150 -865	306 - 1760

Table 2: Fecal coliform positivity in the collected water samples

Sources	Total no. of samples collected	No. of fecal coliform positive water samples	TCC (cfu/ml)	*E.coli* isolated
Tap water	15	6(40%)	5-60	4(26%)
Tube well	15	5(33%)	10-185	4(26%)
Stored water	15	9(60%)	10-2050	3(20%)
Pond	7	7(100%)	115-4800	4(57%)
Total	52	27(51%)		15(28%)

Fig. 3. ***E.coli* count in different studied water samples**



3. Discussion

Water-borne diseases are “dirty-water” diseases, caused by water that has been contaminated by human, animal or chemical wastes. *E. coli* is the most commonly reported diarrheagenic microbe [8]; Worldwide, the lack of sanitary waste disposal and of clean water for drinking, cooking, and washing is to blame for over 12 million deaths a year [9].

Diarrhoeal disease, the major water-borne disease, is prevalent in many countries where sewage treatment is inadequate. Instead, human wastes are disposed of in open latrines, ditches, canals and water courses, or they are spread on crop land. An estimated 4 billion cases of diarrhoeal disease occur every year where proper sanitation facilities are lacking [1]. Besides it has been reported that the bacterial burden in drinking water causes disease among those who may be at increased risk of infection and serious illness from exposure to microbial pathogens, such as the elderly, children, and persons who are immunocompromised by infection, malignancy, or chemotherapy [10].

In the present study, we have monitored different water samples irrespective of their sources. The selected zone of the study area was a diarrheal prone area where from diarrheal disease has been reported frequently. Accordingly the aim of project was to detect the causal agent as well as transmission vehicles of diarrhoeal dynamics in that particular area. Among the total collected samples pH, varied from 7.18 to 9.53 obtained, a distinct zone of alkalinity, which reciprocate the favourable environment of fecal coliform less practice of chlorination, along with higher turbidity, helps the water samples to retain the bacterial community, as a part of bacterial contamination.

Present investigation provides ample evidence that water supply may not directly affect the human health constantly. Main sources, like tap or tube well have always shown, as evidenced from the present observation, least prevalence of fecal coliform along with physico–chemical requirements within desired limits. Though, some of the main water sources (placed beside public toilet or waste dumping ground) were with high TDS. However, those main sources with high TDS were generally processed before drinking. In contrast, way of storing of water and subsequent usage contributes significantly to possible occurrence of the infective disease in diarrhoea prone areas [11]. Although attention from time to time based on community awareness is paid only for drinking water storage but the same is not true for water of washing purposes. Even this second source (i.e. stored water used for washing) can be the possible route of transmission of diarrhoeal outbreak, because at the time of washing hands and mouth some portion of water is unavoidably entered into the mouth [12].

Earlier studies have shown that if the microbial quality of stored household water is significantly improved, diarrhoeal disease can be significantly reduced by adding chlorine to water stored in a household vessel in the developing countries. Simple and low cost systems for addition of chlorine to collect household water stored in a dedicated, narrow-mouth plastic container with a valved spigot have typically reduced water borne microbes by > 99% and reduced community diarrhoeal disease by as much as 20–50%, which can be reciprocated in Indian context also [13].

Presence of fecal coliform in main water sources like tap water, tube well water support the fact of either lack of chlorination in water supply or ground water contamination [14]. On the other hand, behavioural practices, such as covering with proper lids, unsafe handling, improper washing of storage vessels lead to the contamination at stored water condition.

Presence of *E.coli* in drinking water supply is not a very usual phenomenon, where from the cholera outbreak can be triggered up.

Therefore from this present study, two salient factors have been identified which can be addressed to reduce diarrhoeal morbidity - proper chlorination of potable water and appropriate handling of stored water especially for hand and mouth washing.

4. Acknowledgement

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