Original article

A survey of bacteriological quality of drinking water in North Gondar

Mengesha Admassu[1], Mamo Wubshet[1], Baye Gelaw[2]

Abstract

Background: The high prevalence of diarrheal disease among children and infants can be traced to the use of unsafe water and unhygienic practices. The over all concept adopted for microbiological quality is that no water intended for human consumption shall contain E. coli in 100 ml sample. But, a 1-10 E.coli count per 100 ml is acceptable that needs regular sanitary checks for un chlorinated water.

Objectives: To assess the extent of bacterial contamination among protected and unprotected water sources.

Methods: A cross-sectional study on drinking water quality in North Gondar region was conducted from May to June 2000. Water samples were taken for bacteriological analysis.

Results: Analysis of protected springs, protected wells and water lines showed that 35.7%, 28.6% and 50% of the water samples had E. coli, respectively. On the other hand, 50% of the unprotected wells and springs had a fecal coliform count of 180 and above.

Conclusions: The majority of the drinking water sources are either of unacceptable quality or grossly polluted. Regular quality control mechanisms need to be in place to ensure safety of drinking water. [*Ethiop.J.Health Dev.* 2004;18(2):112-115]

Introduction

High incidence of childhood diarrhea, helmenthiasis, trachoma and the overall high mortality rates are associated with poor environmental sanitation (1,2). Sanitation with good hygiene, acts as a fundamental 'Primary barrier' by ensuring that faecal matter is disposed of safely, and does not spread in the environment. Once in the environment, however, there are many ways in which infected faecal matter can be spread. Safe water supply can support a number of can act as 'secondary barrier', which prevents further spread of contamination and infection to new hosts (1,3).

The World Health Organization estimated that up to 80% of all sicknesses and diseases in the world is caused by inadequate sanitation, polluted water or unavailability of water (4). Approximately three out of five persons in developing countries do not have access to safe drinking water and only about one in four has any kind of sanitary facilities. A review of 28 studies carried out by the world bank gives the evidence that incidence of certain water borne, water washed, water based and water sanitation associated diseases are related to the quality and quantity of water and sanitation available to users (5,6).

In Ethiopia over 60% of the communicable diseases are due to poor environmental health conditions arising from unsafe and inadequate water supply and poor hygienic and sanitation practices (5). About 80% of the rural and 20% of urban population have no access to safe water. Three-fourth of the health problems of children in the country are communicable diseases arising from the environment, specially water and sanitation. Forty six percent of less than five years mortality is due to diarrhea in which water related diseases occupy a high proportion. The Ministry of Health, Ethiopia estimated 6000 Children die each day from diarrhea and dehydration (3).

In Ethiopia water is inadequate, 3-4 lit/capita /day, and distance traveled to fetch water is 3-8 km (7). Regular examination of water quality for the presence of organisms, chemicals, and other physical contents provides information on the level of the safety of water. Frequent examinations of fecal indicator organisms remain the most sensitive way of assessing the hygienic conditions of water. Indicator organisms of faecal pollution include the coliform group as a whole and particularly Escherichia coli, streptococcus feacalis and some thermo tolerant organisms such as clostridium perfringens (8). The overall concepts adopted for microbiological quality is that no water intended for human consumption shall contain E coli in 100 ml sample. Treated water entering the distribution system should be 0 faecal coliforms and 0 coliform organisms per 100 ml of water. This study was conducted to assess the quality of drinking water and investigate the possible causes that influence their potability.

Methods

The study was cross-sectional and conducted in North-Gondar Administrative Region, from May to June 2000. A total of 70 water samples were taken for bacteriological analysis. The sampling strategy was

[1]Department of Environmental Health, Gondar University College, P.O. Box 196, Gondar, Ethiopia; [2]Department of Laboratory Technology, G.U.C, Gondar, Ethiopia

based on capturing all types of water sources used by the community. Since some types of water sources, like unprotected wells in rural area and unprotected springs in urban areas are very few in numbers we took equal number of samples from each type of water sources.

Water samples were collected at the randomly selected urban and rural areas of the North Gondar Zone. The set of water samples taken were as follows: 14 samples from protected springs (rural); 14 samples from protected wells (urban and rural); 14 samples from unprotected springs (rural); 14 samples from unprotected well (urban and rural); and 14 samples from pipe water line (urban).

The method of sample collection at each source was according to the WHO Guidelines for Drinking water quality assessment (8). Five hundred ml of water sample from each source was collected, labeled and kept in icebox during transportation and analyzed in the laboratory. Samples were analyzed using standardized bacteriological methods for water quality analysis (9) to determine the degree of contamination.

All Samples were analyzed for total bacterial count, fecal coliform and E. Coli in Gondar College of Medical Sciences laboratory. Moreover, to keep the validity of the analysis, as a control, randomly selected samples, one from each source, were taken to Bahar-Dar Regional Laboratory and analyzed following the same procedure.

The result was interpreted using WHO Guidelines for drinking water (8). Checklist was prepared to get specific information to be answered by one of the elder persons in the study area. This is to associate the extent of contamination of water sources, constructing organization (if protected) and willingness to protect (if unprotected). Constructional and relevant sanitary aspects of observations were also carried out while the sample collector collects samples at each site.

The following operational definitions were used in the study:
Protected spring - a spring that is properly covered by stone masonry with one or two boxes, and a distribution site some where near the protection or collection boxes.

Protected well - a well that is properly covered by stone masonry, internally plastered at least 3 meters above and with pump at the top.

Water line- a type of pipe connection system having a protected and disinfected water source at the initial point of the distribution system.

Results
Seventy water samples were taken from the five types of water sources. Most of the protected springs, 64.29% were constructed with collection box and the rest, 35.7%, were without collection box. All the sampled protected wells were found to be with pump. Maintenance and disinfection was carried out by 64.29% of the protected springs and wells, but this was not performed regularly. The water-line disinfection is not carried out regularly.

Analysis of protected springs demonstrated that 71.43%, of the samples had all kind of indicator bacterias. Fifty percent of the positive samples had fecal coliforms, of these 35.7% had E. coli. Fifty percent of protected wells had all kinds of indicator bacteria. Moreover, the same proportion (28.6%) of the samples had both E.ccoli and fecal coliform. However, 50% of the samples are free from any kind of bacteria. On the other hand, analysis of water line demonstrated that 57% of the samples had indictor bacteria, 50% fecal coliform and E.coli. Only 43% of the water line samples had no coliform (Table 1).

Table 1: **Bacteriological analysis of protected spring, protected well and water line in North Gondar Administrative Region, May-June, 2000 (n=14)**

Type of organisms	Water sources					
	Protected spring		Protected well		Water line	
	No.	%	No.	%	No.	%
Total indicator bacteria	10	71.4	7	50	8	57
Faecal coliform	7	50	4	28.6	7	50
E.coli	5	37.72	4	28.6	7	50
Had no any kind of bacteria	4	28.6	7	50	6	43

Unprotected wells and springs demonstrated that 75% of the samples taken from both sources were contaminated by fecal coliforms, especially E, Coli. Fifty percent of the samples in both cases had a coliform count of 180 and above per 100 ml. No sample in both cases had a coliform count of less than 10 per 100 ml. The least oliform count seen was 13 coliform per 100 ml (Table 2).

None of the water line samples had zero coliform count per 100 ml, 21% had 18 and above coliforms per 100 ml. Twenty one percent of the samples also had 1-3 coliforms per 100 ml. E.Coli was found in 35.71% of the samples.

Table 2: **Bacteriological analysis of unprotected well, unprotected springs and water line in North Gondar Administrative Region, May-June, 2000 (n=14)**

Distribution of coliforms	Type of organisms						
	Unprotected well		Unprotected spring		Water line		No organisms
	E.coli	Non E.coli	E.coli	Non E.coli	E.coli	Non E.coli	
0	-	-	-	-	-	-	-
1-9	-	-	-	-	2	3	6
10-15	3	1	3	1	3	-	-
>50	9	1	6	4	-	-	-
Total	12	2	9	5	5	3	6

Discussion

Fecal pollution of drinking water introduces a variety of intestinal pathogens (4,9). The presence of indicator organisms calls a need for further survey, investigation and examination of drinking water sources.

The site from where water is collected can be a source of disease. If the site is unprotected there is a risk that women and children collecting water from these sources will be infected (10, 11). In this study the majority of the rural areas were using unprotected sources and some protected ones but not regularly disinfected and maintained. Observation showed that the unprotected wells mostly found in towns are constructed very near or down to latrines (10). This implies the risk of contamination is very high.

In the case of ground water, like protected springs, wells and protected water connection systems, it should be possible to achieve very low levels of contamination (9). However, the study result indicated that protected water sources are subjected for a high level of fecal contamination in almost all cases. Some of the protected water sources are said to be chlorinated though not regularly done. In regularly checked water sources the E.coli count should have been almost zero per 100ml (9). This fact is only observed in 6(14.3%) of the protected water sources.

A study conducted in Jimma also showed very high nitrate concentration in protected springs indicating the presence of organic pollution (12). A similar study conducted in Uganda, in tropical slum areas, the predominant source for drinking water is protected springs. Nevertheless, tests carried out on these water sources revealed that it was unsafe for drinking mainly due to fecal contamination and hence the residents are exposed to a wide range of diseases (8).

One of the possible reasons might be a constructional defects on casing, concrete covers, fences, diversion ditches, and protection of eye of springs and other plumbing accessories (1). Furthermore, lack of regular supervision, disinfection and proper maintenance might be the reasons for contaminating protected water sources (3).

The high level of E.coli can also be explained by the fact that poor sanitation habit and hygiene education influences the use of protected water supplies. Study conducted in Bangladesh revealed that 95% of the urban population had access to safe drinking water and 35% of the population had access to sanitation. But data on the level of hygiene education was much lower (7). As a result health impact reduction in diarrhea was marginal. In addition, analysis of 144 water and sanitation projects worldwide concludes that sanitation has great impact than water supply (7).

All water sources are grossly polluted. The type of coliform exhibited is a fecal type specifically of human origin. The effect, therefore, is attributed to constructional defects, poor sanitation, low level of hygiene education, poor supervision and maintenance and irregular disinfection.

We would like to recommend the following important points:
proper sanitary survey, design and implementation of water and/or 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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