Status of drinking water contamination in Mountain Region, Nepal

SK Rai,[1,2] K Ono,[3] J-I Yanagida,[3] M Kurokawa[4] and CK Rai[2]

[1]Nepal Medical College and [2]Shi-Gan Health Foundation/Nat'l Inst of Trop Medicine, Kathmandu, Nepal; [3]Kobe Tokiwa University & [4]Kobe Institute of Health, Kobe, Japan

Corresponding author: Prof. Shiba Kumar Rai, Department of Microbiology, Nepal Medical College, Attarkhel, Jorpati-7, Kathmandu, Nepal; e-mail: drshibakrai.2009@gmail.com or drshibarai@nmcth.edu

ABSATRACT

Status of drinking water contamination was studied in three mountainous districts in Nepal. A total of 43 water samples (Sankhuwasabha: 11, Rasuwa: 12 and Dolpa: 20) were tested for the presence of total coliform (TC) and *Escherichia coli* as fecal coliform bacilli using commercially available test system called Colilert (Japan). Of the total, 85.7% (36/43) were positive for TC whereas 67.4% (29/43) were positive for *Esch. coli*. The fecal contamination rates (as indicated by the growth of *Esch. coli*) in Sankhuwasabha, Rasuwa and Dolpa Districts were 81.8% (9/11), 75.0% (9/12) and 65.0% (13/20), respectively. Most of the water samples collected in district headquarter towns namely Khandbari, Dhunche and Dunai, respectively) showed *Esch. coli* compared with those collected in remote villages areas.

Key words: Drinking water, fecal contamination, mountain region, Nepal

INTRODUCTION

Consumption of drinking-water contaminated with human and animal feces is the major cause of various water-borne diseases (diarrhea, dysentery, typhoid fever, hepatitis and others) caused by various pathogenic bacteria, viruses and parasites. Diarrhea alone causes four percent of all deaths and five percent of health loss to disability, mostly among children in developing countries.[1] Around two thirds of the world's populations underserved by water live in Asia.[2] One third of Asians do not have access to safe and sustainable water supply. Even worse, one half do not have access to improved sanitation. Many countries in Asia including Nepal reportedly have increased the drinking water supply coverage but there is great problem in both water safety and sustainability.

According to "WHO guidelines for drinking water quality", *Escherichia coli* (fecal coliform bacilli) must not be detectable in any 100 ml sample water of (1) all water directly intended for drinking, (2) treated water entering the distribution system, and (3) treated water in the distribution system; and outbreak control measure and investigative action (increase in the concentration of free chlorine to greater than 0.5 mg/litre throughout the system and drinking of boiled water) must be taken immediately if they are detected.[3] However, drinking water quality in most of the developing countries is not achieved/maintained. The reported data from Nepal have showed high rate of drinking water contamination[4-7] as well as soil.[8,9] This has resulted into the endemicity and/or frequent outbreak of various waterborne diseases in the country. As a result, the killer diarrheal diseases rank second in the list of "top-ten diseases".[10] In this short communication, we report the drinking water contamination rate in three remote mountainous districts in Nepal.

MATERIALS AND METHODS

These water samples were collected in Sankhuwasabha (in eastern part) (n=11), Rasuwa (in central part) (n=12) and Dolpa (in western part) (n=20) Districts (Fig. 1) and tested during the District Health System Study visit (June to October 2009). A total of 43 water samples (were tested for the presence of total coliform (TC) and *Escherichia coli* (the accurate indicator of fecal contamination) using commercially available test system called Colilert (IDEXX Laboratory, Tokyo, Japan). The test system consists of the tubes with dry powder media with two indicators, namely, orthonitrophenylgalactoside (ONPG) that gives yellow color upon the growth of TC bacilli whereas another indicator 4-methylumbelliferyl-B-D-glucuronide (MUG) gives bluish fluorescence under 365 nm of UV light in a dark environment upon the growth of *Esch. coli* (fecal coliform). Water sampling and testing was done as described by the manufacturer. As there was no incubator available, the tubes (samples) wrapped in vinyl bags were placed in the groin area during sleeping for overnight (incubation at 35^0C). The tubes showing yellow color were regarded as TC positive and TC positive tubes showing blue fluorescence under 365 nm of UV light were regarded as *Esch. coli* positive (Fig. 2).

RESULTS AND DISCUSSION

Of the total 43 water samples collected in three mountainous districts (Sankhuwasabha: 11, Rasuwa: 12 and Dolpa: 20), 85.7% (36/43) were positive for TC and

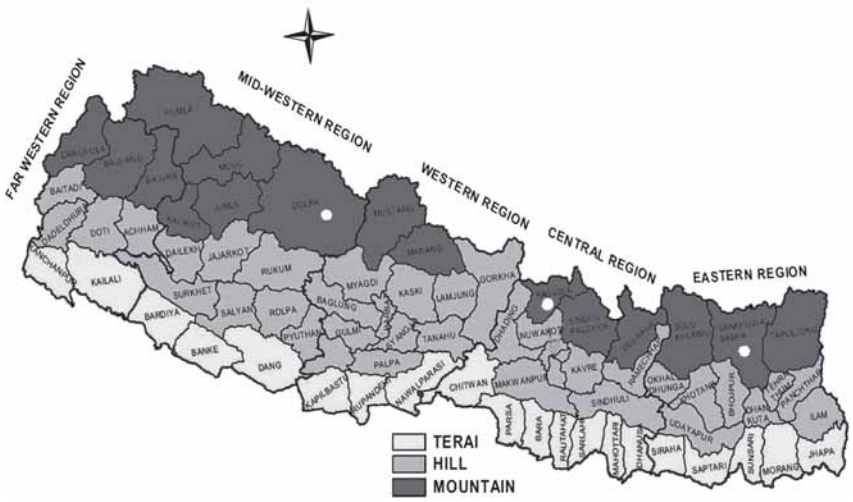

Fig. 1. Map of Nepal showing water sampling mountainous districts (Sankhuwasabha, Rasuwa and Dolpa).

67.4% (29/43) for *Esch. coli.* All samples collected in Sankhuwasabha and Rasuwa Districts were positive for TC whereas in Dolpa District, the positive rate was 65.0%. Whereas the *Esch. coli* positive rate in Sankhuwasabha was highest 81.8% (9/11) followed by positive rate in Rasuwa (75.0%; 9/12) and Dolpa Districts (65.0%; 13/20), respectively (Fig. 3).

It is recognized that in the great majority of rural water supplies, especially in developing countries, fecal contamination is widespread.[3] Most of the water samples in rural villages (away from Dunai Bazaar, the District Headquarter) of Dolpa Districts, however, were negative for both TC as well as *Esch. coli* (2/8; 25.0%). On the contrary, except one all water samples collected in Dunai Bazaar (district headquarter) were positive (11/12 = 91.7%) for TC as well as *Esch. coli* indicating that the water was fecally contaminated. Low contamination rate in rural villages could be due to the very dry environmental condition that causes rapid drying of feces killing all microbes present. Similalry, also the most of the water samples collected in District Headquarter towns of two other districts (i.e. Khandbari of Sankhuwasabha and Dhunche of Rasua Districts) showed *Esch. coli* compared with those collected in the village areas. However, the difference was not very high as in the case of Dolpa District.

The higher fecal contamination rate in the district headquarters appeared to be attributed to source contamination, no proper treatment of water, no physical integrity of the distribution system, unplanned urbanization, no sewerage system and poor hygienic / sanitary practice. This is true even in the Kathmandu Valley (the capital city and other two big cities)[4-6,11] where outbreaks of diarrheal diseases including cholera occur often.[12,13] A yearly minimum death of 30,000 and morbidity of 3.3 episodes per child has been estimated due to diarrhea alone.[14] It is further aggravated by the occasional supply (flow) of water in the distribution system; as a result, when there is no water supplied in the distribution system, leaked sewage water enters into the water supply system and pushed to each of the households served when water is supplied.

Altogether, over 70% of the water sources (piped and/ or natural spout/well) in these three mountain districts were positive for *Esch. coli*; a great risk for the outbreak of waterborne diseases like diarrheal disease, typhoid fever and others at any point of time. Despite of being aware of the risks of diarrheal disease associated with drinking unpurified water, nearly two-third (65%) of the people in the community do not boil water regularly.[15] In many occasions, however, boiling of water is not practicable also particularly in rural mountainous village settings. The burning example is the diarrheal disease outbreak that occurred last summer in Bajura and adjoining remote and poverty stricken mountainous districts (including the Dolpa) in western Nepal which took

Fig. 2: Commercially available water test system. Out of five samples (tubes) four are positive for TC bacilli (left) and of those four, three are *Esch. coli* bacilli positive (right)

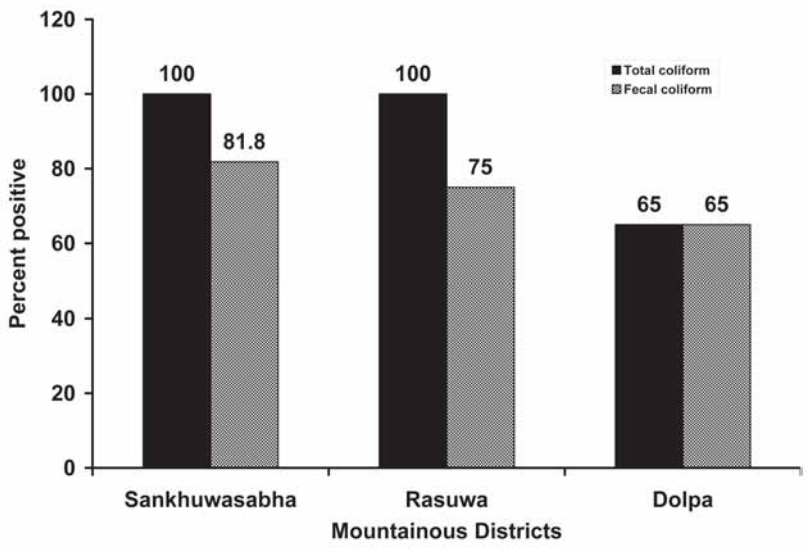

Fig. 3: Status of drinking water contamination in three mountainous districts in Nepal (fecal coliform means *Esch. coli*)

hundreds of lives. A high rate of drinking water contamination in Kathmandu Valley as well as in *Terai* area has also been reported.[4-7] High rate drinking water contamination has also observed in other Hilly districts and *Terai* areas (data not shown).

Keeping in view of impact of waterborne diseases on health, poverty and development, "millennium development goal target 10" calls for the world to halve, by 2015, the proportion of people without sustainable access to safe drinking water and improved sanitation.[16] As the safe water supplies immediately and dramatically improve people's health and improve their livelihoods reducing the poverty, safe and sustainable drinking water supply and improvement in hygienic and sanitary practice must be emphasized in order to meet the MDG goal by the year 2015. Present findings clearly indicated that the water source/supply in these mountainous areas is fecally contaminated and the water must be boiled / purified for drinking purpose.

Acknowledgement

Water samples were collected during the District Health System (DHS) study entitled "*Assessment of System Needs, Tools and Requirements of the District Health Services in the Mountain Region*" (June to October, 2009) conducted by Shi-Gan Health Foundation supported by WHO. In Dolpa District, Dr. S Gunawan and Mr. R Haluwai from WHO also joined the team. The DHS study team members namely Mr. R Ghimire, Mr. GR Subedi, Mrs. U Bhandari and Mr. B Chaulagain and locals in the districts cooperated in the collection of water samples.

REFERENCES

1. WHO. http://www.who.int/water_sanitation_health/diseases/diarrhoea/en/
2. ADB/UNDP/UN ESCAP/WHO. Asia water watch 2015 - are countries in Asia on track to meet target 10 of the Millenium Development Goals? 2005.
3. WHO. Guidelines for drinking-water quality, 3rd edition (incorporating first & second addenda), Vol. 1 - Recommendations, Geneva 2008.
4. Adhikari RK, Rai SK, Pokharel BM, Khadka JB. Bacterial study of drinking water of Kathmandu, Neal. *J Inst Med (Nepal)* 1986; 8: 313-6.
5. Ono K, Rai SK, Chikahira M *et al*. Seasonal distribution of enteropathogens detected from diarrheal stool and water samples collected in Kathmandu, Nepal. *Southeast Asian J Trop Med Public Health* 2001; 32: 520-6.
6. Ghimire G, Pant J, Rai SK, Choudhary DR, Adhikari N. Bacteriological analysis of water of Kathmandu Valley. *J Nepal Assoc Med Lab Sci* 2007; 8: 45-7.
7. Atreya K, Panthee S, Sharma P. Bacterial contamination of drinking water and the economic burden of illnesses for the Nepalese households. *Int'l J Environ Health Res* 2006; 16:385-90.
8. Rai SK, Uga S, Ono K, Rai G, Matsumura T. Contamination of soil with helminth parasite eggs in Nepal. *Southeast Asian J Trop Med Public Health* 2000; 31: 388-93.
9. Shrestha A, Rai SK, Basnyat SR, Rai CK, Shakya B. Soil-transmitted helminthiasis in Kathmandu, Nepal. *Nepal Med Coll J* 2007; 9: 166-9.
10. MoHP (Ministry of Health and Population), Government of Nepal - Fact-Sheet 2007.
11. Rai SK, Shrestha HG, Nakanishi M *et al*. Hookworm infection recorded at an University Teaching Hospital in Kathmandu, Nepal over one decade period. *Japanese J Trop Med Hyg*1997; 25: 81-4.
12. Karki A, Tiwari BR. Prevalence of acute diarrhoea in Kathmandu Valley. *J Nepal Med Assoc* 2007; 46: 175-9.
13. Ise T, Pokharel BM, Rawal S, Shrestha RS, Dhakhwa. Outbreaks of cholera in Kathmandu Valley in Nepal. J Trop Pediatr 1996; 42: 305-7.
14. Pokhrel D, Viraraghavan T. Diarrhoeal diseases in Nepal vis-à-vis water supply and sanitation status. *J Water Health* 2004; 2: 71-81.
15. Kovalsky AN, Lacey SE, Kaphle UR, Vaughn JM. Risk perception and water purification practices for water-borne parasitic infections in remote Nepal. *Trop Doct*or 2008; 38: 229-31.
16. UN Millennium Project Task Force on Water and Sanitation, Final Report, Abridged Edition. New York, UN Millennium Project and Stockholm International Water Institute 2005.