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Microbial quality of well water from rural and urban households in Karnataka, India: A cross-sectional study

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Summary
Objective: The objective of this study was to evaluate the microbial quality of the well water used as a drinking source in urban and rural households.
Methods: A total of 80 household well water samples were analyzed by the multiple fermentation tube method to determine the presumptive coliform count/most probable number of coliforms, and the isolates were identified using standard procedures, followed by susceptibility testing.
Results: Fecal indicator organisms, including *Escherichia coli* and *Enterococcus* spp. were isolated from 22 (27.5%) samples, and the majority (92.5%) of the water sources were contaminated with coliforms. A total of 170 bacterial isolates were obtained, including coliforms (70%), *Enterococcus* spp. (1.8%) and saprophytes (28.2%). A significant number of isolates were multi-drug resistant, which is a cause of concern. A comparison of the microbial quality of the water between urban and rural households revealed no significant differences.
Conclusion: It might be prudent to monitor the bacteriological quality of well water at the source in addition to resistance profiles of the isolates.

Introduction

Infectious diseases caused by pathogenic bacteria, viruses and parasites are the most common and widespread health risk associated with drinking water [1]. Nearly one-tenth of the global disease burden could be prevented by improving the water

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supply, sanitation, hygiene and the management of water resources [2].

Water quality is affected by fecal matter, domestic and industrial sewage and agricultural and pasture runoff, in addition to a lack of awareness and education among the users [3]. The detection of bacterial indicators in drinking water suggests the presence of pathogenic organisms that are sources of waterborne diseases [4]. Indicator microorganisms survive better and longer than pathogens, with uniform and stable properties, and may be easily detected using standard laboratory techniques [5]. These indicator organisms include *Escherichia coli*, thermotolerant (fecal) coliforms, total coliforms, fecal streptococci and *Clostridium perfringens* [6]. The two methods commonly used to detect coliforms in water include the multiple fermentation tube technique and the membrane filter technique [7].

In coastal Karnataka, well water is an important source of drinking and household water in both rural and urban areas. Studies [3,4,8—17] assessing the microbiological quality of drinking water have found varying rates of contamination (0—100%) with fecal coliforms and other heterotrophic bacteria. We conducted a cross-sectional study to analyze and compare the microbiological quality of well water in rural and urban households.

Methods

This pilot study was conducted in Udupi taluk (population—0.41 million) in Southern Karnataka, India, over a period of two months between July and August of 2009. Forty households each from rural and urban areas were selected through simple random sampling. ''Rural area'' refers to a place with a population of less than 5000 people, a population density of less than 400 people per sq. km and more than 25% of the male working population engaged in agricultural pursuits. It is widely believed that urban well water sources are of good quality due to the availability of disinfectants and awareness of the need for disinfecting water wells.

Informed consent was obtained from the head of each household before the water sample was collected. Well water sources (dug wells) used as the main source of drinking and household water were included in the study, and wells that were not in use or wells that were declared unfit for use were excluded from the study. All of the wells screened were used by single families. Municipal water sources or water from stored containers was not included in the analysis.

Sample collection

Following World Health Organization (WHO) guidelines [18], clean, heat-sterilized bottles of 200 ml capacity were used for the water collection. A stone of a suitable size was attached to the sampling bottle using a piece of string. The bottle was opened and lowered into the well; the bottle was completely immersed in the water, without touching the sides of the well and without hitting the bottom or disturbing any sediment. The bottle was filled and then removed by rewinding the string. Approximately 20—30 ml of water was discarded to provide sufficient airspace to allow shaking before the analysis to achieve a homogenous dispersion of the bacteria. After collection, the bottles were labeled with complete details, including the source of the water, the sample site, the address, and the date and time of collection, and delivered (within 2 h) to the laboratory in a light-proof insulated box containing ice packs. Before sampling the well water, 4—5 drops of aqueous sodium thiosulphate solution (100 g/l) was added to the sampling bottles to neutralize any residual chlorine. Because a complete history of chlorination (quantity, time since last chlorination) could not be elicited, all the sources were neutralized with sodium thiosulphate soon after collection, regardless of the prior chlorination status.

Method of analysis

The water samples were processed using the multiple fermentation tube method to determine the presumptive coliform count/most probable number (MPN) of coliforms based on standard methods [19]. Suspensions from positive tubes were subcultured on MacConkey agar and incubated at 37 °C for 24—48 h. The resulting colonies were identified following standard operating procedures [20]. The antimicrobial testing of the isolates against commonly used antibiotics was performed using Kirby-Bauer's disc diffusion method and was interpreted according to Clinical Laboratory Standards Institute (CLSI) guidelines [21]. The detection of extended-spectrum beta-lactamase (ESBL) production was performed with a phenotypic method using a double disc synergy test [22]. The microbial quality of the water samples was assessed based on WHO guidelines [6]. The results of rural and urban areas were statistically compared using the Chi-square test of association. The testing of the water samples was performed according to standard operating procedures, which were strictly followed in the pre-analytical, analytical and post-analytical phases. Analytical quality