Journal of Human Environment and Health Promotion

Print ISSN: 2476-5481 Online ISSN: 2476-549X

Well Water Disinfection in Calamities: The Experiences from Rural Kerala, India

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ARTICLE INFO

Article type:
Short communication

Article history:
Received: 20 March 2020
Revised: 4 May 2020
Accepted: 27 May 2020

DOI: 10.29252/jhehp.6.2.8

Keywords:
Well water disinfection
Calamities
Kerala
Perception
Lacuna
Chlorination

ABSTRACT

Background: Wells are the main source of water supply in rural areas. Bleaching powder is the most effective and inexpensive method for well water disinfection. In the great floods of 2018 in South India, community volunteers (ASHA) were trained on promoting preventive measures (e.g., well water chlorination) and use of boiling water.
Methods: This cross-sectional survey was conducted on 101 households in the field practice area of the Rural Health Training Center of a teaching institution in Central Kerala affected by flood to assess the extent of the correct method of well water disinfection during September 2-12, 2018.
Results: All the wells were disinfected by chlorination using bleaching powder, and most of the wells (86%) were super-chlorinated. To determine the amount of the required bleaching powder, the well water volume was calculated by guesswork in 91 households (89%). All the households used a bleaching powder solution rather than directly sprinkling the powder.
Conclusion: According to the results, effective health awareness campaigns, community participation, and the use of appropriate technologies could change the behavior of the community. All the households practiced well water disinfection with some minor lacunas.

1. Introduction

Disasters are associated with increased morbidity and mortality due to communicable diseases. After a natural calamity, infections experience a rising trend due to contaminated food and water if appropriate health interventions are not planned.

Wells are the main source of water supply in rural areas [1]. After natural calamities, the risk of waterborne diseases increases due to the lack of the disinfection of water sources. During natural calamities such as floods or earthquakes, the need to disinfect wells even on a massive scale augments [2,3]. Bleaching powder is often recommended as the most effective and cost-efficient method of well water disinfection [4].

The state of Kerala in South India was devastated by the August flood in 2018 and cumulative rainfall of 2,307 millimeters, which was 41% higher than the normal rainfall received. As water levels receded, water wells were contaminated, giving rise to sanitation issues [5]. Sewage from sewers, septic tanks, cesspools, and pit privies contaminated these wells. Consequently, the prevention of disease outbreaks such as typhoid, dysentery, infectious hepatitis, and other diseases associated with floodwaters became the major objective of the relief work in the mentioned area [6].

The World Health Organization (WHO) recommends a method for the disinfection of wells, which involves the measurement of the water volume in wells by assessing the depth (h) and diameter (d) of the well using local methods and its substitution in the equation $v = 3.14 \times d^2 \times h \times 1000/4$.

In this equation, the depth diameter is measured using a

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How to cite: Saji JA, Samuel Johnson AK, Cherian KM. Well Water Disinfection in Calamities: The Experiences from Rural Kerala, Indi *J Hum Environ Health Promot*. 2020; 6(2): 97-100.

rope and a heavy stone tied to the rope, which are dipped to reach the bottom of the well [7].

Approximately 2.5 grams of high-quality bleaching powder is required to disinfect 1,000 liters of water, which requires the approximate dose of 0.7 milligram of chlorine per liter of water. The bleaching powder required for the disinfection of water wells is placed in a bucket and converted into a paste, and the contents are stirred properly to allow sedimentation within 5-10 minutes. When the lime settles down, the supernatant solution (i.e., chlorine solution) is transferred to another bucket, and the chalk or lime is discarded. The bucket containing the chlorine solution is lowered to a specific distance below the water surface, and the well water is agitated by moving the bucket violently vertically and laterally. This process should be repeated several times, so that the chlorine solution would mix intimately with the water inside the well, and the contact period of one hour is allowed before the water could be used [8, 9]. In the mentioned area, the process had to be repeated twice per week on Wednesdays and Saturdays for two months.

As a post-flood recovery activity to prevent communicable diseases, the health system sought the help of community volunteers (ASHA), local teachers, and philanthropic organizations. The volunteers were trained on preventive measures, including well water chlorination and promoting the use of boiling water, oral rehydration solution for diarrhea, and leptospirosis prophylaxis drugs.

Changing environmental and climatic conditions could lead to more frequent natural disasters, which adversely affect the health outcomes in developing countries. This survey aimed to ensure that correct methods were followed for disinfection and provide corrective steps if needed. The lacunas in well water disinfection were identified and will be stressed upon in the health awareness programs during disasters in the future.

2. Materials and Methods

This cross-sectional survey was conducted on 101 households in the flood-affected field practice area of the Rural Health Training Center of an educational institution in Central Kerala to assess the extent of the correct method of well water disinfection.

The Rural Health Training Center is located in Konni, a province in Central Kerala in Southern India. Konni is a rural land locked area with lush green lands, rivers, and areas of thick forests. The devastating floods of 2018 affected this area and cause an enormous havoc. This teaching hospital caters to the population in Konni, which accounts for approximately 27,800. (Figure 1.)

After the floods, the health care staff trained the community health volunteers (CHVs), village heads, and other community leaders on well water disinfection based on the WHO recommendations, and the CHVs and others were asked to disseminate this information to their designated households.

A pre-tested questionnaire was used to assess whether the well water disinfection practices were followed correctly via interviews by the trained health staff with the head of the households. If the head of the household was not available, the next available adult member of the family would be interviewed. If the participants responded incorrectly, they would be instructed on the correct methods by the health workers. The present study was conducted during September 2-12, 2018.

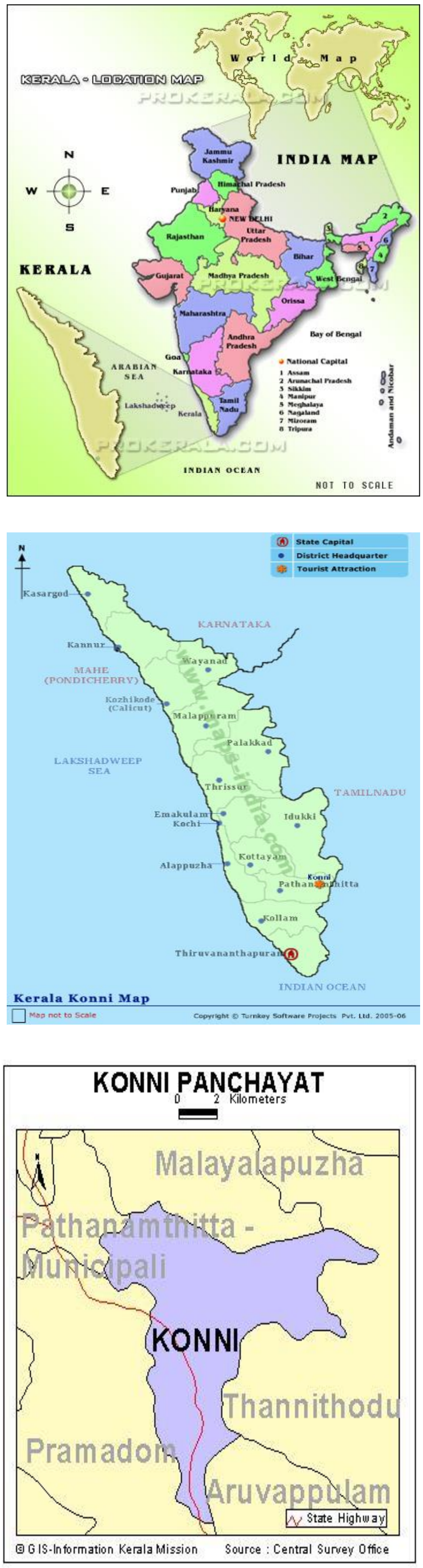

Figure 1: Study Area of Konni depicted on Map

The implemented process was followed by the widespread dissemination of the correct information on well water disinfection through the forums of self-help groups by the CHVs, community volunteers, and door-to-door visits. Furthermore, a group discussion was conducted in a self-help group discussion session in order to identify the bottlenecks for the disinfection of the wells.

2.1. Data Analysis

Data analysis was performed in the Microsoft Excel software. Rates, ratios, and proportions were tabulated. Informed consent was obtained from all the participants.

3. Results and Discussion

In total, 101 households participated in the survey. Most of the wells (69%) were fully submerged in the flood, while 20% were partially submerged. All the wells had a boundary wall, and only two wells (2%) had their boundary wall damaged by the floods. In addition, most of the wells (83%) were emptied before reuse, and only a few (12%) had their well water tested before use. All the wells were disinfected by chlorination using bleaching powder, while most of the wells (86%) were super-chlorinated. To estimate the amount of the required bleaching powder, the volume of well water was calculated by guesswork in 91 households (89%). (Table 1.)

All the households used a bleaching powder solution rather than directly sprinkling the powder. Before disinfection, the bleaching powder solution was preserved for 5-10 minutes by the majority of the households (55%), with the mean duration of 12.76 minutes. All the households used the supernatant solution, which was lowered to a specific distance below the water surface, followed by agitation in the well. All the households used five 2.5 grams per 1,000 liters for the super chlorination and chlorination of the estimated well water volume. The five grams were equivalent to one matchbox as demonstrated in the community. The community volunteers from the public system helped in the disinfection of 94 wells (93%).

Some of the feedback received from the discussion in the disapproval of the disinfection of the wells in the future included phrases such as 'bad taste', 'pungent odor', 'taking longer for cooking', 'headaches', 'damaging the fibers and color of clothes (not good for washing clothes), 'not good for hair', and 'soap (not lathering well).

Even after the large-scale planned health awareness programs that have been driven by the public health system, the results of this survey indicated some lacunae in the well water disinfection practices. Contaminated wells pose significant high health risks. *E. coli* and rotavirus could contaminate well water, along with other fatal substances such as lead and nitrate. Consequently, communicable diseases could spurge up, resulting in morbidity and mortality immediately, during, and after floods due to improper management. This highlights the need to follow the correct practices for the disinfection of water wells.

In the present study, most of the water wells (69%) were fully sunken in the flood.

Submerged wells pose a greater risk of communicable diseases, and immediate attention is required to disinfect these water wells using proper methods.

Table 1: Practices of Households for Well Water Disinfection (n=101)

Parameter	N	%	95% CI
Emptying and Cleaning of Wells before Reuse	84	83	74 - 89%
Super-chlorinated Wells	87	86	77 - 92%
Chlorinated Wells	14	14	07 - 22%
Well Water Tested before Use	12	12	06 - 19%
Estimation of Amount of Bleaching Powder			95 % CI
Calculated Volume of Well Water Using Rope and Inch Tape	10	10	04 - 17%
Guessed Volume of Well Water	91	90	81 - 94%
Use of Bleaching Powder Solution	101	100	94 - 99 %

The public health authorities have taken utmost care in this regard as was observed in the current research.

The commitment and passion of the health system in the prevention of an epidemic of communicable diseases after the flood in the studies region were confirmed in the present study. According to the findings, most of the wells were disinfected by the community volunteers who had been trained by the public health system. The use of the supernatant solution of bleaching powder by all the households and practice of super chlorination by most of the households indicated the effectiveness of the health awareness campaigns in the present study. Similar to our findings, Agarwal *et al.* (2018) have witnessed that most countries work with their citizens to overcome calamities [5].

Health workers have identified a commonly used object known as 'matchbox' for measuring the amount of bleaching powder to show the appropriate use of the technology. The five grams used in the current research were equivalent to one matchbox as demonstrated to the community. All the households in our study used this technique for the measurement of five and 2.5 grams per 1,000 liters for the super chlorination and chlorination of the estimated amount of well water.

According to the current research, very few households assessed the volume of the well water using the prescribed method, which could be due to the fact that in disasters, people are eager to carry out the disinfection process rather than find the means to determine the correct volume. The study area has a lateritic soil; when wells are dug, well rings are created using this lateritic soil, to avoid dug well collapse. These rings pave the way to guess the amount of water by counting the number of the rings, with each ring suggesting 1,000-1,500 liters of water. This estimation method is probably correct since the head of the household usually knows the total number of the well rings in their own well. When deducting the total number of the rings from the well rings that are visible above the water level, the volume of the well water could be estimated roughly. As this is a common practice in this rural area, most of the households have practiced this estimation method of well water.

By 1913, Plummer *et al.* (2007) established that no other processes of water purification have proved so astounding for the disinfection of water by chlorination using bleaching powder or lime hypochlorite [9]. The method is inexpensive, easy to use, and quick to function, and considerably safe with reliable outcomes, covering a broader field compared to the other systems of water purification. In the present study, the well water disinfection was performed by chlorination using bleaching powder to disinfect all the wells. On the other hand, the amount of the required bleaching powder was estimated by calculating the volume of the well water by guesswork in 90% of the households, which might have led to the overuse or underuse of the required amount of bleaching powder, as well as hesitancy in the use of bleaching powder as a disinfectant. In addition, comments such 'bad taste', 'pungent odor', 'taking longer for cooking', and 'bad for clothes' might have resulted from the overuse or underuse of the required amount of bleaching powder.

According to our findings, the correct method of preserving the bleaching powder solution for 5-10 minutes was practiced by only 55% of the households. The waiting time contributes to the chemical reaction to generate chlorine gas, which is needed for the disinfection process [7]; this was observed to be lacunae in the present study and must be stressed in health awareness campaigns.

In the current research, only a few households (12%) had their well water tested before use. Strengthening the water quality surveillance systems is another area which must be considered by the public health system as the need for high-quality water surveillance systems and its impact on public health have been stressed by Plummer *et al.* (2007) [9]. The provisions for testing needs should also be made available at accessible locations on the site of calamities, and special attention must be paid to water testing in these areas.

4. Conclusion

Since well water is the main source of water supply in rural areas, the correct methods of disinfection must be practiced properly in these areas, especially after calamities. According to the results, effective health awareness campaigns, along with community participation and the use of appropriate technology could change the behavior of the community in this regard. In this study, all the households practiced well water disinfection with some minor lacunas. Some of the identified lacunas were guesswork in the estimation of the volume of well water, the improper preservation time of the bleaching powder solution formation, and lack of water testing. These lacunas could be stressed in the health awareness campaigns for calamities in the future for better compliance.

Authors' Contributions

The corresponding author A.K.S.J, conceived the project. A.K.S.J., and K.M.C., were involved in the field survey. The analysis of the data was conducted by the J.A.S., and A.K.S.J., The manuscript was drafted by J.A.S., and K.M.C., revised the manuscript. All the authors approved the final manuscript for publication.

Conflict of Interest

The Authors declare that there is no conflict of interest.

Acknowledgments

Hereby, we extend our gratitude to the field staff of the Rural Health Training Center for conducting this study. We would also like to thank the administration of the Rural Health Training Center for assisting us in this research project.

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