Seeking Safe Storage: A Comparison of Drinking Water Quality in Clay and Plastic Vessels

Ogutu P, Garrett V, Barasa P, Ombeki S, Mwaki A, and Quick R

INTRODUCTION

Several point-of-use water treatment interventions have shown the beneficial health effect of drinking water treated and stored in narrow-mouthed, spigoted plastic vessels designed to reduce chlorine decay and limit recontamination.1,2 However, more than 90% of the 43 000 households targeted by the Nyanza Healthy Water Project in western Kenya, Africa, preferred traditional, wide-mouthed clay vessels.3 In laboratory- and village-based evaluations, we compared chlorine decay and disinfection rates in turbid surface water treated and stored in locally available clay vessels and plastic jerry cans.

We evaluated 3 vessel types: (1) wide-mouthed, 20-L clay vessels; (2) narrow-mouthed, 20-L clay vessels with lids and spigots (modified clay vessel); and (3) narrowmouthed, 20-L plastic jerry cans with lids (Figure 1). We treated water with 1% sodium hypochlorite and measured free chlorine levels with colorimetric comparators. We assessed the microbiological quality of treated and untreated water with the membrane filtration technique and culture media selective for *Escherichia coli*. (4)

FIGURE 1— Vessels used in laboratory and village evaluations in western Kenya.

In the laboratory evaluation, we determined that the chlorine dose necessary to achieve a free chlorine level greater than 0.20 mg/L for 24 hours or longer was 16 mL. We then treated 20-L water samples in each vessel with 16 mL of 1% sodium hypochlorite (8 mg/L); measured free chlorine levels after 0.5, 4, 8, 12, and 24 hours; and cultured water after 0.5 and 24 hours.

In the village evaluation, 10 of 20 volunteer households were randomly selected to receive new, modified clay vessels. The remaining 10 used their own freshly cleaned traditional clay vessels. Within each group, 5 households also were selected to receive plastic jerry cans. We then filled each vessel with 20 L of river water, treated it with 16 mL of 1% sodium hypochlorite (8 mg/L), and measured free chlorine levels and cultured water after 0.5 and 24 hours.

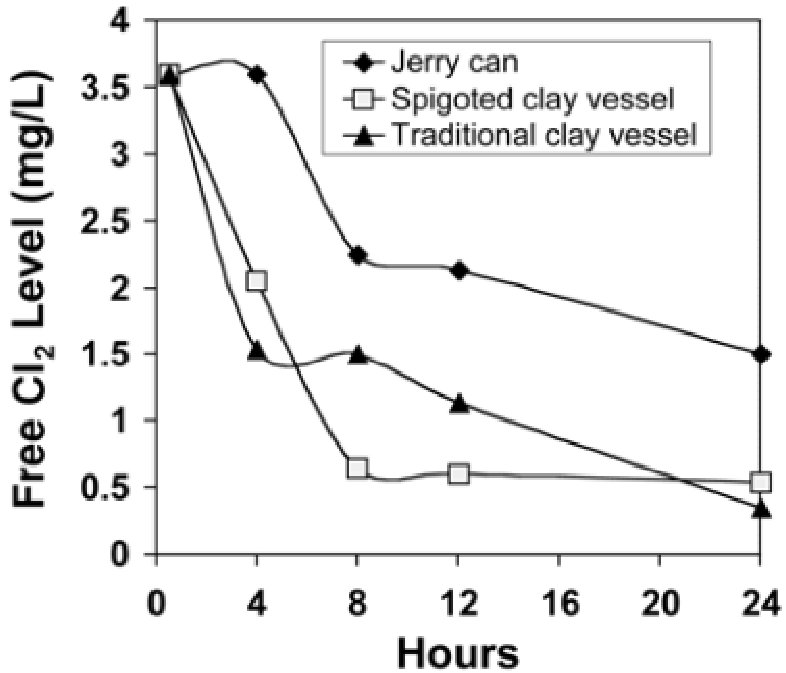

FIGURE 2— Free chlorine (Cl2) levels in river water treated with 16 mL (8 mg/L) of 1% sodium hypochlorite solution, by time interval: Laboratory study, Ariri, Kenya, May 2000.

In the laboratory evaluation, untreated river water had a baseline E coli count of 100 colony-forming units (CFUs) per 100 mL. After treatment, the free chlorine decay rate was 4% per hour in the plastic jerry can, 8% per hour in the modified clay vessel, and 9% per hour in the traditional clay vessel (Figure 2). After 24 hours, the free chlorine level was highest in the jerry can; however, all vessels had a free chlorine level greater than 0.2 mg/L. E coli (range = 5-21 CFU/100 mL) was recovered from water from each vessel 0.5 hours after treatment. E coli was not recovered from water from any vessel 24 hours after treatment.

TABLE 1- Median Free Chlorine Levels and Escherichia coli in River Water After Treatment With 16 mL (8 mg/L) of 1% Sodium Hypochlorite Solution: Village Study, Homa Bay, Kenya, May 2000

Vessel Type	0.5 Hour After Treatment			24 Hours After Treatment		
	Median Free	No. (%) of	Median E coli,	Median Free	No. (%) of	Median E coli,

	Chlorine,	Samples		Chlorine,	Samples	
	mg/L (Range)	With E coli	CFU/100 mL (Range)	mg/L (Range)	With E coli	CFU/100 mL (Range)
Traditional clay vessel (n = 10)	3.4 (2.0–3.5)	0/10 (0)	0 (0)	0.2 (0.1–0.4)	2/10 (20)	0 (0–20)
Modified clay vessel@ (n = 10)	2.0 (1.4–3.5)	0/10 (0)	0 (0)	0.2 (0.0–0.7)	0/10 (0)	0 (0)
Plastic jerry can (n = 10)	3.5 (2.1–3.5)	1/10 (10)	0 (0–2)	0.25 (0.1–0.7)	0/10 (0)	0 (0)
Total (N = 30)	**3.4 (1.4–3.5)**	**1/30 (3)**	**0 (0–2)**	**0.15 (0.0–0.7)**	**2/30 (7)**	**0 (0–20)**

Note. CFU = colony-forming unit.
@With spigot and lid.

The results indicate that jerry cans and clay vessels can achieve adequate chlorine levels to disinfect turbid, contaminated source water in laboratory and household settings. The village evaluation findings suggest that disinfected water stored in traditional clay vessels is at risk for recontamination, which may result from contact with hands during water retrieval. Previous studies have found that water stored in wide-mouthed vessels typically becomes contaminated, and wide-mouthed storage vessels have been implicated in transmission of cholera.(5,6) The finding that water stored in modified clay vessels had no detectable E coli 24 hours after treatment suggests that water recontamination was reduced by use of the lid and spigot. The effectiveness of these vessels will be best defined by a health outcome assessment, which is under way.

ACKNOWLEDGMENTS

P. Ogutu, V. Garrett, P. Barasa, S. Ombeki, A. Mwaki, and R. E. Quick all contributed to the evaluation design, data analysis, and writing of the paper.
This project was supported by a grant from the CARE-CDC Health Initiative (CCHI). We thank Patricia Riley, Luke Nkinsi, Reema Jossy, and Lori Buhi of CCHI and Dr Adam Koons and George Kidenda of CARE Kenya for their support of this project. We thank Gwen Ingraham for her editorial assistance. We are especially grateful for the cooperation and enthusiasm of the community members of Ariri village.

FOOTNOTES

Peer Reviewed
Accepted for publication June 5, 2001.

REFERENCES

1. Mintz ED, Reiff FM, Tauxe RV. Safe water treatment and storage in the home: a practical new strategy to prevent waterborne disease. JAMA.1995;273:948-953.
2. Quick RE, Venczel LV, Gonzalez O, et al. Narrow-mouthed water storage vessels and in situ chlorination in a Bolivian community: a simple method to improve drinking water quality. Am J Trop Med Hyg.1996;54:511-516.
3. Makutsa P, Nzaku K, Ogutu P, et al. Challenges in implementing a point-of-use water quality intervention in rural Kenya. Am J Public Health.2001;91:1571-1573.
4. Mates A, Shaffer M. Membrane filtration differentiation of E coli from coliforms in the examination of water. J Appl Bacteriol. 1989;67:343-346.
5. Deb BC, Sircar BK, Sengupta PG, Sen SP, Saha MR, Pal SC. Intra-familial transmission of Vibrio cholerae biotype El Tor in Calcutta slums. Indian J Med Res.1982;76:814-819.
6. Swerdlow DL, Malenga G, Begkoyian G, et al. Epidemic cholera among refugees in Malawi, Africa: treatment and transmission. Epidemiol Infect. 1997;118:207-214.

This article has been cited by other articles:

- Mintz, E., Bartram, J., Lochery, P., Wegelin, M. (2001). Not Just a Drop in the Bucket: Expanding Access to Point-of-Use Water Treatment Systems. Am J Public Health 91: 1565-1570
- Makutsa, P., Nzaku, K., Ogutu, P., Barasa, P., Ombeki, S., Mwaki, A., Quick, R. E. (2001). Challenges in Implementing a Point-of-Use Water Quality Intervention in Rural Kenya. Am J Public Health 91: 1571-1573

Suggested citation:

Ogutu P, Garrett V, Barasa P, Ombeki S, Mwaki A, and Quick R*,* Seeking Safe Storage: A Comparison of Drinking Water Quality in Clay and Plastic Vessels . October 1, 2001; Vol 91, No. 10.