8. Evaluation of a Community-Based Intervention Using Simultaneous Epidemiological and Water Quality Indicators: Bolivia

The population most threatened by waterborne diseases are the economically disadvantaged, whether they are located in urban or rural areas. Because this segment of the population typically receives water intermittently, regardless of the method of delivery (piped systems, water tank trucks, or hand hauling), the households are obligated to obtain sufficient quantities of water when it is available, and then store it in containers for subsequent use when the delivery system is inoperative or unavailable.

Virtually every type of tank or container imaginable is being utilized for household water storage, and almost none currently in use adequately protect the contents from contamination. Studies have shown that even if the water is microbiologically safe upon its placement in such makeshift containers, it is quickly contaminated during storage and use, primarily by contact with human hands or contaminated utensils that are used to withdraw water, as well as by dust, animals, birds and insects when the vessel is inadequately covered (Tuttle 1995; Hammad, 1985). Under these circumstances, even when the water is initially disinfected, the subsequent contamination is often so great that it nullifies the disinfectant.

The water is generally not disinfected by the household for a number of reasons. It is too costly to boil water. Boiling a sufficient quantity of water for drinking, food preparation, infant formula, weaning foods, dishwashing and hand washing (estimated to be about 40 liters for a family of five) costs from $150/year to as much as $250/year. This is far beyond the financial capacity of the threatened populations. Boiling ten liters of drinking water can even be too costly an endeavor for the typical impoverished family (Gilman, 1985). Boiling has the added disadvantage in that it does not provide protection if the water is re-contaminated during storage and handling. Chemical disinfectants can be considerably less expensive and some of them, like various chlorine compounds, provide a residual disinfectant capacity that can help protect against recontamination. Unfortunately such disinfectants are not readily available in most of the threatened communities and most households and community leaders are not aware of how important disinfecting the drinking water is to human health.

A recommended intervention is for the households to obtain and utilize one or two suitable water storage containers in which to disinfect and store the essential quantities of water that need to be free of pathogens, with the containers of a design that will protect the contents against re-contamination.
To determine the effectiveness of this intervention in the improvement of water quality in the home, the prevention of diarrheal diseases, and its acceptability by the community, an investigation was carried out in a peri-urban area of Montero, Bolivia over an eight month period (Quick and Venczel, 1995). The population was randomly assigned as either control (using traditional containers and no disinfection) or intervention (receiving two special water containers, disinfectant and education as to its proper use and storage) families.

The intervention was introduced to the intervention families, with a local health volunteer responsible for education of individuals concerning storage and dosification of the disinfectant, proper use and maintenance of the containers, and promotion of the use of the treated water for various household purposes. The same health volunteers were trained to carry out active diarrheal disease surveillance, visiting families on a weekly basis. Fecal samples of cases were examined to determine etiology. Water samples were taken to determine chlorine and fecal contamination levels in both source and stored water of all families on a monthly basis for six months. At the same time that samples were taken, a sanitary survey was conducted through observation of household conditions.

The microbiological results reflect a striking difference between stored water of intervention and control families. After the intervention was introduced, the water of intervention families had a median level of 0 E. coli colonies/ml, whereas water of control families had median levels of 50-841 colonies/ml. This difference was statistically significant at the p<0.0001 level. The source water (from individual wells) did not differ between groups, with a median E. coli level between 56 and 1,140 colonies/ml.

The results of the active diarrheal surveillance demonstrate the positive impact the intervention had in reducing the incidence of diarrheal disease. The intervention families had an average of 1.25 episodes of diarrhea/month, while the control group had an average of 2.20 episodes/month (p<0.001). The relative risk indicated that families without access to the intervention had twice the risk of experiencing diarrhea as families with the intervention (C.I. = 1.6-2.5). Therefore, 43% of all cases of diarrhea in this community could be prevented by the use of this simple intervention.

A stratified analysis of several co-variables indicated that the families that benefitted most from the intervention were those with a low socio-economic status (<US$ 250/capita/year). In addition, the families who allowed animals to roam freely, and enter the house had significantly fewer cases of diarrhea when the intervention was used, compared to control families.

This study demonstrated that the intervention was effective in the prevention of diarrhea. This effect was not equal across all age groups, with those less than one year old, and between
5-14 showing a greater decrease in cases. This result could be explained by the control that mothers have in the habits of small babies (diet, what they touch and ingest), and in children >5 years they can be taught the importance of drinking the special water and are not as likely to be placing dirty items in their mouths. The results of the microbiological quality of the water are impressive, considering the poor quality of the source water. The families using the intervention consumed water that generally met the water quality guidelines of PAHO/WHO. Other investigations which have studied water quality improvements have shown an average decrease in diarrheal diseases of 20%. This study has demonstrated a reduction in the families using the intervention of approximately 40%. This result is most likely due not only to the intervention itself, but the educational component which reinforced improved hygiene behavior and water handling practices. This is feasible because the intervention requires only a small initial investment, a few minutes a day on the part of the household, and it is sufficiently simple to carry out that it can be accomplished by any of the family members from children to the elderly. Furthermore it does not involve significant change in the lifestyle or culture of the family but only minor changes in doing things that for the most part are already being done, but doing them in a more effective and sanitary manner. In addition the required infrastructure support is usually already in place and where not, only slight adjustments are necessary to assure that support. The intervention is community based: the knowledge can be transferred horizontally from one community to another and a revolving fund can be established to obtain a multiplier effect. In addition, it serves as a spearhead to initiate complementary community interventions of sanitation, health education and personal hygiene.

The potential of this simple and low cost water treatment and storage method to provide safe water and thus reduce exposure to waterborne pathogens has been demonstrated. However this is only one step towards the successful implementation of this system in high risk areas of the world. The volition of the people themselves which stems from their a priori recognition that contaminated water and unsafe storage leads to poor health, is tantamount for the sustainability for such a program. Proper hygiene education, and frequent household visits by local health personnel to demonstrated and reinforce correct use, storage, and maintenance of the disinfectant and containers is essential. Thus, community mobilization in the planning and implementation of the program should consider: the method of payment for both the disinfectant of containers, the method of disinfection distribution and its frequency, and operation and maintenance of on-site disinfection equipment. Cooperation with the private marketing sector can be an effective strategy to help assure sustained availability of containers and disinfectant to every family. The communication media, such as radio, television and newspaper have an important role to play in the promotion and education regarding the importance and means of disinfecting of household water and assuring its safe and sanitary storage and use.
With data from the demonstration projects, PAHO determined that the annual cost for both the water containers and the water disinfectant range between US$ 1.50 and US$ 4.00 per household. The variation in cost is primarily due to the number (1 or 2) and the cost of water container and the method used to distribute the water disinfectant to the household.

Cost estimates were made for the various components of this intervention (containers, salt, energy, disinfection units, operation and maintenance) in several countries and a cost benefit study was carried out in Bolivia. A prevention effectiveness model for a Bolivian community of 10,000 in which the intervention was assumed to reduce diarrheal incidence by 20% showed prevention of 600 cases of diarrhea, 100 hospitalization and 5 deaths during a three year period (Mintz, Tauxe and Reiff, 1995)