Title: Point-of-Use Household Devices and Roles of Women in Flood and Cyclone Emergency: Bangladesh Experience

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Abstract

Asia has experienced the highest rates of flood related disasters in the world. Outbreaks of diarrhoea during flood emergencies have been a continued challenge for most of the developing countries. The paper presents studies of the use of point-of-use (POU) methods for ensuring the microbiological safety of drinking water during flood/cyclone emergencies. The data about POU at household level was collected during the flood emergency associated with Cyclone Sidr in 2007.

Cyclone Sidr was one of the fiercest cyclones to hit Bangladesh in over one hundred years. Department of Public Health Engineering (DPHE), UNICEF and NGOs distributed POUs widely in the affected areas. The distributed POUs mainly included: (i) water purification tablets (WPT) used widely, and (ii) newly introduced sachets combining flocculation and disinfection (PUR) in selected affected areas. The Environment and Population Research Centre (EPRC) conducted action research in affected areas of Patharghata and Sarankhala sub-districts of Bangladesh. The main objectives of the paper are to study effectiveness of the POUs and discuss ways to improve it. During POU distribution, housewives/female water managers of the PUR groups were provided with training including a demonstration and a bucket for water treatment. WPT recipients were not trained; but the method has been promoted in Bangladesh for many years. The government/NGO s rarely demonstrated POU methods among women. Approximately 200 households from each of the PUR and WPT groups were sampled to observe the treatment methods as practiced and to determine residual chlorine in the stored water. Point- prevalence of diarrhoea was estimated among 103 PUR, 105 WPT and 282 comparison children.

Housewives carried out the responsibility of POU in all visited households. Treated stored water was found among 72% of PUR and 10% of WPT households. Presence of residual chlorine (RCL) was observed in almost all treated stored water samples. About 97% of PUR and 24% of WPT women users could correctly describe the treatment method. The rates of point prevalence of diarrhoea in PUR and WPT households (irrespective of the presence of treated water) were less than those in comparison children. The relative risk was lowest in PUR households (RR= 0.23; 0.07-0.72 for PUR and RR=0.45; 0.19-1.03 for WPT).

High effectiveness of POU with both PUR and WPT among its users was reconfirmed. The rate of use of PUR was significantly higher than for WPT. PUR users showed significantly higher potentials for correct household treatment than WPT users. This shows that the training of women about PUR contributed to its acceptance, correct use and better results than WPT. Women are household water managers. Capacity of women should be improved with local contexts through normal, disaster and all periods. Timely and appropriate training/education of women about emergency POU is highly recommended, and could significantly reduce water-borne diseases in the aftermath of future disasters.

Keywords

Asia, drinking-water, point-of-use (POU), women, water-safety, effectiveness, diarrhoea, training

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Introduction

The frequency of natural disasters, particularly water-related-disasters, has increased markedly between 1990 and 2006 (1). The frequency of extreme floods is on the rise in Bangladesh, India and Pakistan (2). Research directly links rising greenhouse-gas levels with the growing intensity of rain and snow in the Northern Hemisphere, and the increased risk of flooding in the United Kingdom (3). Safe drinking supply water systems are often damaged in floods and cyclones. Qualities of both tube-well and pond water deteriorated significantly during and/or after 1991 cyclone (4) and floods in Bangladesh (5, 6). But almost all people in those affected areas drank water from flooded and/or not flooded tube-wells as well as, polluted pond/surface water depending on the access to sources and emergency situations. Post flood/cyclone diarrhoea epidemics have been common and continued challenges in Bangladesh and elsewhere (7, 8).

One of the universal emergency water and preventive health relief methods has been distribution of point-of-use chlorination devices at household level. This paper assesses the use of two kinds POUs as observed in the Cyclone Sidr. The data presented is a part of post-Sidr drinking water management study done towards the safe drinking water goal (9). Considering the facts that diarrhoeal and other water related diseases contribute significantly to health burdens, the rates of the climate related disasters are showing increasing trends and the recent WHO-UNICEF report claimed that Bangladesh may not reach the MDG drinking water target; it is of utmost importance that the POUs are further developed to meet the emergency water needs in current as well as changing contexts. Usually POUs are stock piled in disaster prone areas or are rushed to the affected areas by the Government and its development partners. The findings of this paper will have implications for both planning and implementation strategies about emergency safe drinking water in immediate and long term perspectives.

Key Issues and Challenges

Serious concerns have been reported about the performance, potency, acceptance, and adequate availability of POUs in Bangladesh (4, 6). Lack in distribution of POUs about reaching all affected populations are well recognized (4, 6, 9). But it is also important to determine the right kinds of POUs for distribution and invest in improving its effective use by the recipients so that the expected results are achieved. Many POUs are chlorine-based products and its efficiency about water disinfection can fall to questionable level, if not stored and handled properly (4). There are POUs which are meant to treat specified quality of water and so, it might show technically and/or socially unacceptable performances. Reportedly recipients swallowed POUs as opposed to treating water (4, 6). Also if distributed POUs were not used by the recipients (9), we need to reconfirm its importance in flood-prone areas like Bangladesh.

We could rarely locate literatures about existing needs for POUs or how to improve the effectiveness of POUs at household levels during emergency period. Asia is the most vulnerable regions to water related disasters. More than 80% of flood-related disasters occurred in Asia and a substantial number of those in Bangladesh (1). Bangladesh is considered to be one of the countries *"most vulnerable"* to the effects of global warming (10). Therefore it is important to study the scopes of most common drinking water relief practice, such as POU in order to adopt the lessons for safe drinking water in Bangladesh as well as in other similar situation perspectives.

Opportunities

The scopes of POU methods among water related disaster affected populations were studied in November 2007, when cyclone Sidr hit the southern coast of Bangladesh. The Sidr cyclonic storm of hurricane fell under Category IV tropical storm and was one of the 10 fiercest cyclones to hit the region of Bangladesh in the last 131 years between 1876 and 2007. Although the Government of Bangladesh widely communicated warnings over radio and televisions and was supported on that by local NGOs, mosques and civil societies, more than 3.1 million people in 28 southern districts were directly affected by the cyclonic storms. The Government of Bangladesh (GoB) official reports indicated a death toll of 3,295 people, with a further 871 missing and 1,491 injured. The GoB estimates that over 273,000 homes were destroyed and a further 650,000 houses were partially damaged. An estimated 2,274,264 acres of crops were damaged. Extensive damage to roads and public buildings was also evident. DTW are the main source of drinking water in coastal areas and in some of the badly affected areas the people could not use their DTWs due to salinity and used pond water instead. It has been reported that after Sidr dead animals, rotten trees and debris contaminated many of the ponds on which people depended for their drinking, washing, and cooking water. So the people of these regions were suffering from a lack of potable water for both drinking and other purposes.

Two kinds of POUs, PUR and commonly distributed WPTs (Aquatab/Halotab) were studied. PUR is a powdered mixture that removes pathogenic microorganisms and suspended matter, rendering previously contaminated water safe to drink. PUR was developed by Procter & Gamble (P&G) in collaboration with the US Centers for Disease Control and Prevention (CDC). PUR contains a chlorine disinfectant (calcium hypochlorite) for killing bacteria and an iron salt coagulant (ferric sulphate) for removing suspended matter, protozoa, and viruses. It also contains a buffer, clay and polymer to provide good coagulation and flocculation. All of the ingredients used in PUR are used to purify drinking water in the United States and other developed countries. The difference is that PUR provides these ingredients at the household level rather than in a centralized treatment facility. PUR is safe for long-term use by the entire family, including infants, and is considered an effective technology by the World Health Organization (WHO). PUR's application results in water quality that meets WHO guidelines. PUR comes in a 4 gram sachet labelled in English. Each sachet treats 10 litters of water. The sachets arrive from the manufacturing facility in cartons containing 20 strips of 12 sachets each, for a total of 240 sachets per carton. Each carton is 25 cm x 11 cm x 15.5 cm (length, width, height). Apparently the main instructional difference between the methods is in turbidity removal. PUR can work on any turbidity, while Aquatab is limited to more or less clear water (may be 5 or at most 10 NTU) and there was no mention of turbidity.

The Department of Public Health Engineering (DPHE), UNICEF and most of the government & non-government organizations distributed WPTs widely in various affected parts of the region. UNICEF-Oxfam distributed PUR in Patharghata Sub-district (Upazilla) of Barguna District and Sharankhala Upazilla of Bagerhat District. They distributed 15000 buckets and 120,000 sachets among 7500 families equally in Patharghata (3750 families) and Sharankhola (3750 families). The relief PUR included 15 sachets, two buckets, one piece of cotton cloth for filtration and a sticker on instruction about use method per family.

The distributed PUR per family was enough to treat about 160 litters of water in total; which means a family could use it over a period of 16 days at the rate of 10 litters per day. The partner relief NGOs called the families selected for PUR distribution on a separate day from the

distribution of other relief. Approximately 20 to 35 female representatives from the identified vulnerable families were called upon by the respective NGO to a nearby common point. The trained NGO partner staffs did the education sessions over about one hour in every group. The community female participants of the sessions were also requested to demonstrate the use of PUR after the demonstration by the staff. The buckets and sachets were distributed after the education sessions.

Combined observational and descriptive designs were adopted. For this particular formative research, a cross-sectional survey was done among sampled PUR, WPT and control households to observe the following; (i) efficiency of the POU methods used based on mainly residual chlorine concentration in mg/l (RCl) and small number of thermo tolerant coliform bacteria in cfu/100ml (TTC) in the POU treated stored water for drinking, (ii) use/acceptance of the POU treatment methods by interviewing the housewives/female caretakers of drinking water, and (iii) point prevalence of diarrhoeal diseases among the children and adults of the same PUR, WPT and control groups.

The sizes of the samples under PUR, WPT and control groups were determined based on the available samples, given resources and local conditions. The samples were selected based on the following criteria: (i) PUR group to include the households, which had PUR, treated water in the storage containers during the visits by the data collectors. Only those households with PUR treated water were interviewed. However, the number of households visited to locate the existing PUR treated water in their storage containers was counted to determine the rate of use of PUR among its recipients. (ii) WPT; the same criteria were assigned for the WPT groups. But as the rate of use of WPT was found low, those who had existing WPT treated water and could show WPT in their households (but no treated water) were also interviewed. (iii) Control groups included the households which did not receive or could not show PUR or WPT in their houses.

The TTC were measured by Wagtech Potatest FC Count Instrument and residual chlorine by Wagtech Photometer 5000. Water in the stored household containers were gently stirred and poured into sampling containers. The bottles were placed in a sample transportation ice box. The temperatures inside the ice boxes were maintained at about 4^0 C by using ice packs. The TTC samples were transported to the EPRC Field Laboratory within about 2 hours. The samples were immediately tested there using the methods mentioned

The occurrence of diarrhoea was measured based on point prevalence of diarrhoea. Prevalence measures the frequency of existing diseases. Point prevalence here referred to the proportion of the population that had diarrhoea during the 24 hours when interviewed. The populations in the PUR, WPT and Control households were sub-grouped into children within 5 years of age and population over 5 years of age.

Recommendations/Findings/Options/Questions

The study clearly reconfirmed that POU household device is an appropriate and effective approach for emergency water relief and preventive health, when used properly. We have found strong positive associations between: (i) POU treatment and presence of residual chlorine in stored drinking water and, (ii) POU and less diarrhoea point-prevalence. Therefore, we strongly recommend development, promotion and adequate distribution of POUs coupled with appropriate capacity building of its users (those who are responsible for the treatment) and creation of enabling environment for its proper use. Capacity of women (responsible for the treatment and emergency household water) should be built based on the local contexts, in

addition to POU promotional activities. Applied research about POUs at household level in emergency and other stages of disaster management under different socio-environmental conditions towards sustainable safe drinking water is suggested to contribute to the development of evidence-based programs.

The POU efficiency performance data was collected from the worst affected villages where the POUs were distributed. To locate the 131 water samples in stored water, 182 households were visited. One hundred percent of the visited 182 households had received PUR and could show it. Out of the 182 households, 131 had PUR treated water during the visit. The rate of effective use of PUR was 72%. One hundred and ninety three households were visited for WPT. Out of the 193 households, all claimed that they had received WPT but of those 126 showed it. And WPT treated water was found in 20 households. The rate of effective use of WPT was 10%. Therefore, the rate of effective use of PUR was significantly higher than that of WPT.

The frequency of presence of residual chlorine (concentration in mg/) in the housewife claimed treated and tested (by us) stored water samples are presented in Figures 1 and 2.

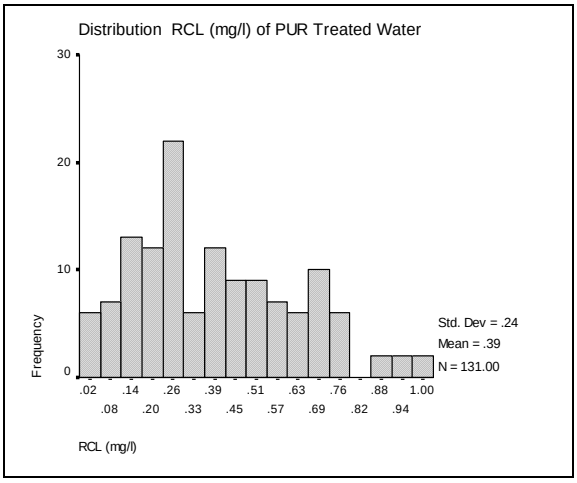

Figure 1

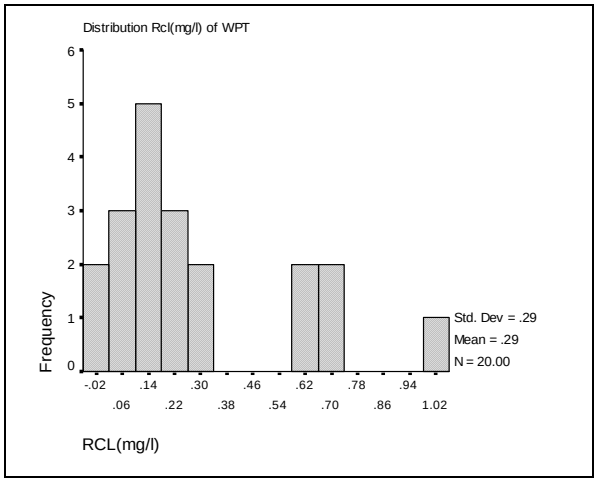

Figure 2

Figure 1 and 2: Concentration of residual chlorine found in all samples of PUR and WPT treated water

The minimum and maximum values of PUR were 0.02 mg/l to 1.0 mg/l and of those of WPT were 0.01 mg/l to 1.0mg/l (the detection limit of the instrument was 0-5 mg/l). The median values of RCL were 0.35 mg/l for PUR and 0.17mg/l for WPT. Eighteen water samples; 6 from WPT treated and 12 from PUR treated stored water were tested for TTC. Nil/none TTC were found in all of the treated samples. It may be pointed out that TTC is regarded as an indicator of pathogenic bacteria from fecal origin. Absence of TTC does not necessarily mean absence of all pathogenic microorganisms. Both the POUs were found highly efficient in terms of presence of residual chlorine.

Housewives of the 100% houses (POU and comparison) claimed that they were responsible for managing safe drinking water for their families. Also, hundred percent of POU recipients households reported that they were responsible for treating water with the POUs. They treated the water based on their felt need for water safety, perceived water quality (taste, colour, smell, etc). Ninety seven percent of PUR and 24% of WPT users could correctively describe the

treatment method. More than 90% of PUR and about 15% of WPT users reported satisfaction with its use.

Although about half of the (female) users of PUR/WPT were almost illiterate (reported no and up to 2 years of schooling); there was no significant difference between rates of effective use/present and not effective use/absent of PUR in stored water (Table 1). Even the rates of present (38%) and absent PUR (32%) in stored water did not vary significantly between the primary schooling and higher than primary schooling groups. But the rates of effective use of WPT were significantly different between the user group that had less than primary schooling (lower rate- 10%) and that had higher than primary schooling (higher rate- 85%).

Table 1: Level of schooling of housewives with POU in stored water samples

Variable	**PUR (%)**		**WPT (%)**	
	Present	Absent	Present	Absent
Households with samples (N)	131	51	20	173
Education:				
No Schooling	19	11	5	15
Primary (1-5 yrs)	43	57	10	54
> Primary	38	32	85	31

The result indicates that there was significant positive association between effective use of WPT and level of schooling, unlike PUR. It is possible that the training of women users about PUR use contributed to the labeling of associations between effective use of PUR and level of education; in addition to other factors. It is important to note that most or substantial proportion of women in developing countries like Bangladesh are illiterate or lack in adequate years of schooling/education to properly understand instructions printed on POUs or manufactured products. It is only recently that girl education/enrolment in Bangladesh has improved.

The rates of 24 hour prevalence of diarrhoea were 12.8%, 5.7% and 2.9% among comparison, WPT and PUR groups of children. The risk ratios were 1.0, 0.41 and 0.29 in comparison, WPT and PUR children. The Relative Risk was lowest in PUR children (RR=0.23; 0.07-0.73 for PUR and RR= 0.45; 0.19-1.03 for WPT). This reconfirms the water-borne diarrhoea prevention potentials of the POUs one again.

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