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## PROMOTION OF HOUSEHOLD WATER TREATMENT AND SAFE STORAGE IN UNICEF WASH PROGRAMMES

January 2008

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### **Why is household water treatment and safe storage an important intervention for preventing disease?**

Unsafe drinking water, along with poor sanitation and hygiene, are the main contributors to an estimated 4 billion cases of diarrhoeal disease annually, causing more than 1.5 million deaths, mostly among children under 5 years of age (WHO 2005). Because diarrhoeal diseases inhibit normal ingestion of foods and adsorption of nutrients, continued high morbidity also contributes to malnutrition, a separate cause of significant mortality; it also leads to impaired physical growth and cognitive function, reduced resistance to infection, and potentially long-term gastrointestinal disorders. Contaminated drinking water is also a major source of hepatitis, typhoid and opportunistic infections that attack the immuno-compromised, especially persons living with HIV/AIDS.

Outbreaks of acute watery diarrhoea (AWD) add to the disease burden and require costly diversion of scarce health and other resources to minimize fatalities. Diseases associated with contaminated water also exact a heavy economic load in the developing countries, both on the public health care system for treatment and on persons affected for transport to clinics, medicines and lost productivity. They also adversely impact school attendance and performance, particularly for girls and young women who must care for and assume the duties of ill parents and siblings.

As part of its Millennium Development Goals, the United Nations expressed its commitment by 2015 to reduce by one half the people without sustainable access to safe drinking water. Current estimates are that there are still 1.1 billion people without this access (WHO/UNICEF 2006). Considerable progress is being made in expanding the coverage of “improved water supplies” such as protected wells and springs, boreholes and household connections. However, results from a recent assessment in six pilot countries, found that 31% of drinking water samples from boreholes exceeded WHO guideline values (GV) and national drinking water standards in the pilot countries for faecal contamination, the leading source of infection and disease (Rapid Assessment of Drinking Water Quality -RADWQ 2006). At the household level, contamination of stored water is even more common. In one of the pilot countries, only 43.6% of samples from stored water were in compliance with the WHO guideline value and national standards, and more than half of household samples showed post-source contamination. This is consistent with a large body of research world wide that has shown that even drinking water which is safe at the source is subject to frequent and extensive faecal contamination during collection, storage and use in the home (Wright 2004).

Treating water at the household level has been shown to be one of the most effective and cost-effective means of preventing waterborne disease in development and emergency settings. Promoting household water treatment and safe storage (HWTS) helps vulnerable populations to take charge of their own water security by providing them with the knowledge and tools to treat their own drinking water. This document summarizes some of the leading approaches for treating water in the home, provides evidence of their effectiveness and cost effectiveness in development and emergency settings and it outlines how promotion of HWTS can be incorporated with UNICEF programmes.

**Based on the evidence, UNICEF has made HWTS an important programme priority.**

## How effective and cost-effective is HWTS?

Because it prevents recontamination of water in the home, treating water at the household level is more effective than conventional improvements in water supplies in ensuring the microbiological quality of drinking water at the point of consumption (Sobsey 2002). This translates into improved health outcomes. In a systematic review of 15 intervention studies for the World Bank, Fewtrell and colleagues (2005) reported that household-based water treatment and safe storage was associated with a 35% reduction in diarrhoeal disease compared to a statistically insignificant 11% for conventional source-based interventions. A more recent and comprehensive Cochrane review covering more than 38 randomized, controlled trials and 53,000 people in 19 countries found that household-based interventions were about twice as effective in preventing diarrhoeal disease (47%) than improved wells, boreholes and communal stand pipes (27%) (Clasen 2006a).

While household water treatment offers superior health gains, the economic advantages over conventional improvements in water supplies are equally compelling. The cost of implementing water quality interventions varies as per table\* below:

	Water treatment Method	Cost/person/year
1.	Solar Disinfection	US\$0,63
2.	Chlorination	US\$0.66
3.	Ceramic Filters	US\$3.03
4.	Combined Flocculation/Disinfection	US\$4.95
5.	Installing & Maintaining Wells, borehole and Communal Tap Stands in Africa	US\$1.88

\* (Clasen 2007). The combination of lower cost and higher effectiveness renders household-based chlorination the most cost effective of water quality interventions to prevent diarrhoea, with a cost effectiveness ratio in Africa of US\$53 per disability-adjusted life year (DALY) averted, compared to US\$123 for conventional source-based interventions.

When health cost savings are included in the analysis, implementing low-cost HWTS interventions actually results in net savings to the public sector; in other words, the intervention more than pays for itself (Clasen 2007). A recent WHO-sponsored analysis also concluded that household-based chlorination was among the most cost-beneficial of the various options for pursuing the MDG water and sanitation targets, yielding high returns on every dollar invested mainly from lower health care costs but also increased productivity and value of school attendance (Hutton 2007). Finally, there is considerable evidence that the target population is willing and able to pay for some or all of the cost of household-based water treatment products (Ashraf 2006), leveraging public sector and donor funding and allowing it to be more focused on the base of the economic pyramid. In summary, (i) the up-front cost of providing low-cost household water treatment is about half that of conventional source-based interventions, (ii) most or all of that cost can be borne directly by the beneficiary, not the public sector, and (iii) the public sector will nevertheless recover more than the full cost of implementation from reduced health costs for disease treatment.

## Is household water treatment just for emergencies?

Outbreaks of infectious diseases and other emergencies occasioned by flooding and drought impose a heavy health burden in most developing countries and divert scarce health and economic resources away from continued national and regional development strategies. Because of its potential for rapid and targeted deployment, household-based water treatment can be an effective intervention in response to such epidemics and emergencies. Boiling, point-of-use chlorination, solar disinfection and sachets combining flocculation/disinfection have been shown effective in reducing transmission of cholera and

other diarrhoeal disease in outbreaks and emergencies (Conroy 2001; Doocy 2006). A recent assessment of the water, sanitation and hygiene response to the acute water diarrhoeal (AWD) outbreak in Ethiopia found household-based water treatment and hygiene promotion to be the most effective interventions (UNOCHA 2007).

There is also evidence that such epidemics and emergencies provide an opportunity for increased adoption and long-term use by the target population (Ram 2007; Clasen 2006). There is overwhelming evidence that HWT prevents recontamination of water in the home, treating water at the household level is more effective than conventional improvements in water supplies in ensuring the microbiological quality of drinking water at the point of consumption (Sobsey 2002), therefore **HWTS is not just for epidemics and emergencies.**

### **What technologies and approaches exist?**

A study commissioned by the WHO identified 37 different products, technologies and approaches that are used for the microbiological treatment of drinking water in the home (Sobsey 2002). Only a few of these approaches have been rigorously assessed for the microbiological performance and health impact.

**Chlorination.** Chlorination is the most widely-practised means of treating water at the community level; apart from boiling, it is also the method used most broadly in the home.

The source of chlorine can be sodium hypochlorite (such as household bleach or electronically generated from a solution of salt and water), chlorinated lime, or high test hypochlorite (chlorine tablets) which are usually available and affordable. The sodium hypochlorite solution is packaged in a bottle with directions instructing users to add one full bottle cap of the solution to clear water (or two caps to turbid water) in a standard-sized storage container; agitate; and wait for 30 minutes before drinking.

Chlorine must be added in sufficient quantities to destroy all pathogens but not so much that taste is adversely affected.

In addition to sodium hypochlorite solution packaged in bottles, the tablets formed from dichloroisocyanurate (NaDCC), a leading emergency treatment of drinking water, and novel systems for on-site generation of oxidants such as chlorine dioxide, also have a role in household water treatment. At doses of a few mg/l and contact time of about 30 minutes, free chlorine inactivates more than 99.99% of enteric pathogens, the notable exceptions being *Cryptosporidium* and *Mycobacterium* species. Its impact in reducing diarrhoeal diseases has been documented (Arnold 2006).



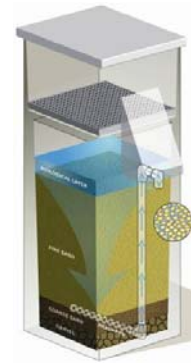
**Filtration.** Household filters potentially present certain advantages over other technologies. They operate under a variety of conditions (temperature, pH, turbidity), introduce no chemicals into the water that may affect use due to objections about taste and odour, are easy to use, and improve the water aesthetically, thus potentially encouraging routine use without extensive intervention to promote behavioural change.



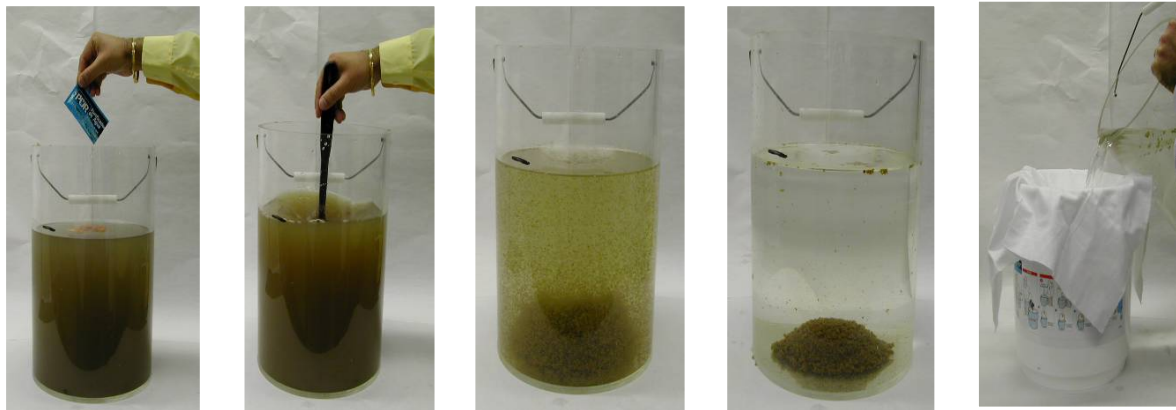
Higher quality ceramic filters treated with bacteriostatic silver have been shown effective in the lab at reducing waterborne protozoa by more than 99.9% and bacteria by more than 99.9999%, and their potential usefulness as a public health intervention has been shown in development and emergency settings (Clasen 2004; 2006).

The improving quality of locally-fabricated silver coated ceramics is particularly promising as a sustainable and low-cost alternative (Brown 2007).

Slow-sand filters, which remove suspended solids and microbes by means of a slime layer (schmutzdecke) that develops within the top few centimetres of sand, are capable of removing 99% or more of enteric pathogens if properly constructed, operated and maintained (Hijnen 2004). A simpler but more advanced version, known as the “bio-sand” filter, was specifically designed for intermittent use and is more suitable for household applications. It has been tested both in the laboratory and the field (Stauber 2006) and is being deployed widely in development settings by the Center for Alternative Water and Sanitation Technologies ([www.cawst.org](http://www.cawst.org)) and by different organisations in various countries

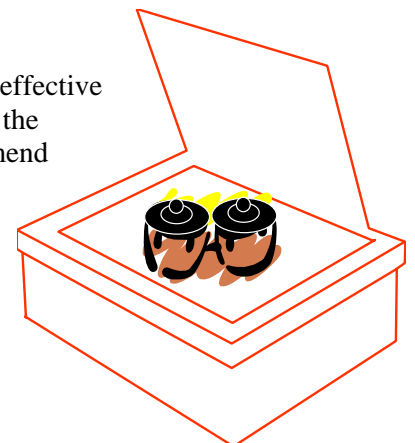


**Combination Flocculation and Disinfection.** A particular challenge for most household-based water treatment technologies is high turbidity. Solids can use up free chlorine and other chemical disinfectants, cause premature clogging of filters, and block UV radiation essential in solar disinfection. While



turbidity can often be managed by pre-treatment or even simple sedimentation, flocculation/coagulation using common substances such as alum can be an effective and relatively low-cost option. Such forms of assisted sedimentation have been shown to reduce the levels of certain microbial pathogens, especially protozoa which may otherwise present a challenge to chemical disinfectants. However, disinfection is still required in most cases for complete microbial protection. Certain manufacturers have combined flocculation and time-released disinfection in a single product that is sold in sachets for household use. One such product has been shown to reduce waterborne cysts by more than 99.9%, viruses by more than 99.99% and bacteria by more than 99.99999% (Souter 2003). Unlike the other methods of household water treatment discussed above, it has also been shown to be effective in reducing arsenic, an important non-microbial contaminant in certain settings. Field studies have shown such flocculation-disinfection products to be effective in preventing diarrhoeal diseases (Reller 2003).

**Boiling and Solar Disinfection.** Boiling or heat treatment of water with fuel is effective against the full range of microbial pathogens and can be employed regardless of the turbidity or dissolved constituents of water. While the WHO and others recommend bringing water to a rolling boil for 1 minute, this is mainly intended as a visual indication that a high temperature has been achieved; even heating to pasteurization temperatures (60° C) for a few minutes will kill or deactivate most pathogens. However, the cost and time used in procuring fuel, the potential aggravation of indoor air quality and associated respiratory infections,





the increased risk of burn, and questions about the environmental sustainability of boiling have led to other alternatives.

Solar disinfection, which combines thermal and UV radiation, has been repeatedly shown to be effective for eliminating microbial pathogens and reduce diarrhoeal morbidity (Hobbins 2004) including epidemic cholera (Conroy 2001). Among the most practical and economical is the “Sodis” system, developed and promoted by the Swiss Federal Institute for Environmental Science and Technology (<http://www.sodis.ch>). It consists of placing low turbidity (<30NTU) water in clear plastic bottles (normally 2L PET beverage bottles) after aerating it to increase oxygenation and exposing the bottles to the sun, usually by placing them on roofs. Exposure times vary from 6 to 48 hours depending on the intensity of sunlight. Like filters, thermal and solar disinfection do not provide residual protection against recontamination. Accordingly, householders must have a sufficient number of bottles to allow them to cool and maintain treated water in the bottles until it is actually consumed.

### **How can HWTS be scaled up?**

Successful scaling up requires leveraging existing commercial structures, donor funding for campaigns (but not product subsidies), Ministry of Health (MoH) support, community-based approaches, collaboration by all partners. Most importantly, HWTS is not about products and technologies but community mobilization, social marketing and behaviour change; it is therefore important to have a rigorous communication plan in place involving all partners and channels of communication. A recent report identified some of the challenges of scaling up HWTS and emphasized the need to engage all stakeholders in a collaborative effort to increase coverage and uptake (Clasen 2008). It also identified some of the opportunities for scaling up HWTS, including government commitment to promote awareness and generate demand; the use of school<sup>1</sup>, clinics<sup>2</sup> and NGOs<sup>3</sup> to encourage uptake and behaviour change; and partnerships with social marketing organizations<sup>4</sup> and the private sector to expand access and coverage. Like most other household-based water interventions, however, the provision of facilities/products must be accompanied by an extensive behavioural change programme to stimulate adoption and continued utilization by householders. Effective and robust implementation strategies for rolling out the adopted HWTS approach are very important for successful scaling up.

### **Implementation Strategies for Selected Approaches to Household Water Treatment**

**Chlorination:** Various strategies have been adopted for treating water at household using chlorination in about 19 countries and the following are recommended for successful and sustained implementation at household level:

- ◆ vary implementation according to local partnerships and underlying social and economic conditions,

<sup>1</sup> O'Reilly, CE, Freeman MC, Ravani M, Migele J, Mwaki A, Ayalo M, Ombeki S, Hoekstra RM, Quick R. The impact of a school-based safe water and hygiene program on knowledge and practices of students and their parents — Nyanza Province, western Kenya, 2006. *Epidemiol Infect* 2007; doi:10.1017/S0950268807008060

<sup>2</sup> Parker A, Stephenson R, Riley P, Ombeki S, Komolleh C, Sibley L, Quick R. Sustained high levels of stored drinking water treatment and retention of hand washing knowledge in rural Kenyan households following a clinic-based intervention. *Epi Infect* 2006; 134(5):1029-36.

<sup>3</sup> [http://www.who.int/household\\_water/resources/Freeman.pdf](http://www.who.int/household_water/resources/Freeman.pdf)

<sup>4</sup> Stockman LJ, Fischer TK, Deming M, Ngwira B, Bresee J, Quick R. Awareness and use of WaterGuard among mothers in Malawi: lessons learned from a national survey, 2005. *EID* 2007; 13(7): 1077-1080.

- ◆ promote the disinfectant solution at national and sub-national levels through social marketing campaigns, in partnership with the local or international NGO with experience on social marketing for instance Population Services International (PSI),
- ◆ encourage local production/marketing by working with private sector, led by a local manufacturing company to ensure availability at and affordability by the community for sustained usage at household,
- ◆ work with ministry of health or local NGOs for implementation at the community level providing the necessary training and training materials to build local capacity – note that the CDC has developed an implementation manual which may provide technical assistance to organizations promoting chlorination of drinking water at household level (CDC 2001) ([www.cdc.gov/safewater](http://www.cdc.gov/safewater)).

### **Filters**

**a) BioSand Filtration (BSF):** The BSF has been implemented through two main strategies.

- In the NGO model, employed in Nicaragua, Cambodia and other countries, the cost of the filters is subsidized, and an NGO promotes the use of the BSF in the community and provides the filters.
- In the micro-entrepreneur model, used in Kenya, the Dominican Republic and other parts of Cambodia, local entrepreneurs construct the BSF, receive training and start-up materials, and then develop micro-enterprises to sell filters within their communities (Brown 2007). The micro-entrepreneur model with credit facility being provided for households or NGO is encouraged to ensure sustainability.

**b) Ceramic Filters:** Despite the simplicity of the filter design, there has been a wide variation in its success rate in different countries. The variation has been attributed to poorly planned implementation strategies that were often times too short and did not consider cultural and societal issues and misunderstanding of the implementation processes needed to bring the filters to a community in a sustainable way. However, the following strategies have produced better results:

- Integration of the filters into the community by leveraging and integrating cultural values, running educational programs, and emphasizing local capacity building, affordability, with designs simple enough to be made by community potters,
- local manufacturing at a factory managed by technically qualified international or local NGO [e.g. International Development Enterprises (IDE), Resource Development International (RDI)] and operated by a women's pottery cooperative who are paid per filter produced,
- community-based, small-scale implementation in concert with other water, sanitation and hygiene interventions and education
- unsubsidized direct sales to users, distribution through local contracts, vendors, national network of vendors, retailers, sales to other NGOs and government agencies .

**Solar Disinfection:** Since 2001, local NGOs in seven countries in Latin America—as well as in Uzbekistan, Pakistan, India, Nepal, Sri Lanka, Indonesia, and Kenya—have disseminated SODIS by training trainers, educating users at the grassroots level, providing technical assistance to partner organizations, lobbying key players, and establishing information networks. SODIS is best promoted and disseminated by local institutions with experience in community health education. As a zero cost technology, it is of no interest to the private sector. Creating awareness of the importance of treating drinking water and establishing corresponding changes in behavior requires a long-term training approach and repeated contact with the community. The Swiss Federal Institute for Environmental Science and Technology has developed an implementation manual, and provides technical assistance to NGOs implementing SODIS (<http://www.sodis.ch>).

**Flocculation and Chlorination:** Affordability can be an issue with commercial flocculants/disinfectant products. Strategies that promote the use of locally available and affordable materials are being encouraged:

- flocculation/coagulation using commonly available substances such as alum and bleach with training on application of adequate amount of disinfectant. for complete microbial protection
- encouraging local production/marketing of combined flocculation and time-released disinfection in a single product that is sold in sachets for household use by working with private sector, led by a local manufacturing company to ensure availability at and affordability by the community for sustained usage at household level.

National-level commitment is essential to advance HWTS. With technical and other support from the WHO, UNICEF and others, National Stakeholders Forums on HWTS have been held in Kenya, Ethiopia<sup>5</sup> and the Philippines during 2007. Each involved more than 100 delegates from national and regional government, UN organizations, NGOs, research institutions and the private sector. All three forums recommended the formation of a national steering or technical committees on Household Water Treatment and Safe Storage, led by the Ministry of Health and consisting of representatives of each of the stakeholder groups present at the Forum. The Kenya Steering Committee has already implemented the recommendation and the members of the committee were in Ethiopia forum to support the meeting. The Committees in Ethiopia and the Philippines were asked to consider and adopt an action plans for advancing HWTS in the context of national policy priorities, to seek donor support for the initiative, and to take other action to encourage the scaling up of HWTS through a collaborative effort involving public sector, civil society and the private sector. WHO and UNICEF can help to organize such national-level initiatives by providing technical and other resources for presenting the research results around HWTS, summarizing the technology options, and discussing strategies for expanding coverage and uptake at the national level.

### **How can I scale up HWTS in my country programme?**

The following are some suggested actions:

- Find out about existing initiatives and experience in your country or in neighbouring countries
- Organise a learning and planning seminar on how the country office will roll out HWTS with support from the Regional WASH Adviser, WES HQ and professional institutions and/or NGOs experienced in social marketing.
- Work with the WHO office in the country, Government ministries (ministries of health and water resources), national and international NGOs, private sector and other stakeholders to organize a national stakeholders' forum/advocacy meeting on household water management to advocate for national support for HWTS. Engage all stakeholders in a collaborative effort to increase coverage and uptake
- Join and engage in the Home Water Treatment and Safe Storage Network [www.who.int/household\\_water](http://www.who.int/household_water)
- If applicable, carry out pilot project working with partners identified above
- Identify and leverage existing commercial structures, donor funding for campaigns (but not product subsidies)
- Promote partnerships with social marketing organizations and the private sector, even if they are partners with whom you have not worked before

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<sup>5</sup>This document was prepared by UNICEF's Water, Environment and Sanitation Section in New York with contributions from Tom Clasen of LSHTM.



- Encourage a multi-technology approach, that is, do not promote only one product or technology, but try to develop a market for a range of products at a number of price-points so that consumers can choose the one that suits them
- Promote the use of schools and clinics to encourage uptake and behaviour change
- Accompany provision of facilities/products by an extensive behavioural change programme to stimulate adoption and continued utilization by householders
- Involve Communication for Behaviour and Social Change (CBSC) and communication colleagues from UNICEF, seek integration with health and nutrition messages, and use events such as CHD's to promote and advocate
- Carefully link the promotion and provision of home water treatment products during emergencies to on-going use of HWTS after the emergency is over, and after direct provision of products ends.

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