Measuring Behavioral Outcomes When Promoting Household Water Treatment and Storage

Discussion paper prepared for the January 22-26, 2007, E-Conference Hosted by the USAID/Hygiene Improvement (HIP)

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This paper is a draft and will be revised based on comments and insights gained during the January 22-26, 2007, E-conference.

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Introduction

Household water treatment and safe storage (HWTS) interventions can result in changes in water quality that can help reduce child morbidity and mortality associated with diarrheal disease. The International Network to Promote Household Water Treatment and Safe Storage, with a Secretariat based at the World Health Organization in Geneva, recognizes that there are different conceptual and programmatic dimensions to point of use water treatment. These dimensions include:

- performance of water treatment and storage systems;
- water quality;
- financial targets;
- coverage;
- behavioral outcomes; and
- health impact.

Each one of these dimensions provides useful information for consumers, project managers, and donors, and can be monitored and evaluated once acceptable indicators are defined and tools to collect data are developed. The HWTS Network constituted a Monitoring and Evaluation Working Group to define the indicators and develop the needed tools. USAID is part of this working group and offered assistance in the definition of the indicators and tools. This document, which focuses on behavioral outcomes, is a first response to that commitment. It has been drafted by the Hygiene Improvement Project (HIP), a USAID-funded intervention specializing in behavior change at scale to promote three key hygiene practices: hand washing, safe storage and treatment of water, and safe disposal of feces. Similar documents on the remaining dimensions of HWTS may be prepared in the future. Annex 1 to this report offers a table of indicators proposed by Susan Murcott (2005), a member of the HWTS Network, for the different dimensions.

Report Objectives and Structure

The document was written to serve as the basis for a discussion on which indicators can best measure the impact of efforts to promote household water treatment and storage practices. It takes into account the larger concerns of program implementers interested in behavior change interventions, including the HWTS Network, but also focuses on the needs of USAID to have valid indicators that can be collected easily and economically by different interventions. These interventions are implemented by different types of USAID grantees and partners, such as the beneficiaries of the Child Survival and Health Grants program, and also by data collection efforts intended to generate trends for the larger development community such as Demographic and Health Surveys. This paper will be used to generate discussion through a HIP-sponsored e-conference on Measuring Behavioral Outcomes for Household Water and Treatment Storage, to be held January 22-26, 2007.

This document has a background section; it presents a conceptual framework that can be used to guide the presentation of indicators and then proposes indicators that can be used. Many of the indicators proposed are not new, as HIP does not intend to reinvent the wheel. The list is intended to be focused and practical, and is therefore not exhaustive. By the same token, the list is not prescriptive. Rather, it is to be used to elicit discussion among and input from e-conference participants.

Some of the indicators to measure practices are the results of discussions that have brought together the CDC, USAID and USAID-funded intervention such as the HIP and POUZN (Point-of-use Water Disinfection and Zinc Treatment project) during the course of 2006. The hope is that the discussion will foster the elaboration of recommendations that may be presented on USAID's behalf to participants at the June 2007 meeting of the International Network to Promote Household Water Treatment and Storage, likely to be held in Accra, Ghana.

Two of the behavioral outcome measures that HIP's January e-conference will focus on are: 1) the number of liters of water treated; and 2) the percentage of households practicing effective household water management. Effective household water management is defined as:

- Presence of chlorine residual in a household drinking water storage container;
- Presence of a covered ceramic water filter in an accessible spot in the kitchen, with filter in place and water in the lower container; and/or
- Presence of multiple SODIS bottles exposed to full sunlight.

The document concludes with a series of questions that the e-conference will attempt to address. It asks conference participants to determine if indicators to measure point-of-use (POU) interventions must include indicators to measure behavioral determinants as well as behavioral outcomes. It also asks participants to offer ways to refine the two indicators listed above.

The e-conference should help arrive at a consensus on which indicator(s) should be retained, how the indicator(s) should be strengthened to have sufficient validity and reliability, and where it/they could be tested in the 6 to 12 months following the June 2007 HWTS Network meeting. E-conference participants are welcome to comment on the other programmatic dimensions suggested by the HWTS Network; however, HIP will focus on them at a different time—perhaps another e-conference.

Background

The Evidence Base for Water Disinfection and Safe Storage

Diarrhea is considered the third largest cause of morbidity and mortality among infectious diseases, after respiratory infections and HIV/AIDS (Clasen et al., 2006). Different reviews have demonstrated the impact that water treatment at the source and in the household can have on diarrheal disease, as many diarrheal agents are potentially waterborne (Esrey et al., 1985; Fewtrell et al., 2005). More recently, there has been evidence suggesting that household interventions are more effective in preventing diarrheal disease than interventions at the water source (Clasen et al., 2006). Despite the progress that countries may be making towards achieving the Millennium Development Goal in the water and sanitation sector, 1.1 billion people worldwide still lacked access to improved water supplies as of 2002 (WHO/UNICEF, 2006). In settings that do not have access to improved water sources and may not have such access in the near future, household water treatment and storage options offer an alternative that can reduce diarrheal disease. This is true despite the fact that given the multiple pathways to diarrheal infections, improvements in water quality by itself will not completely interrupt the spread of disease.

Water Disinfection and Storage Options

Baffrey (2005) noted that "A pristine water source can become microbially contaminated by improper transport, storage and use practices in the home." Thus, the option to treat water immediately before intended use may be more effective than treating at source in preventing diarrheal disease. To further increase effectiveness, it is recommended that water treatment be implemented in conjunction with safe water storage, meaning the use of protected containers that restrict physical access prior to actual use. Water specialists may consequently speak of household water treatment and safe storage technologies (Baffrey, 2005).

Three treatment interventions have been developed to improve the microbial quality of water and they can be offered alone or in combination. The three interventions are:

- physical removal of pathogens (through filtration, adsorption or sedimentation);
- chemical treatment of water to kill or deactivate pathogens usually with chlorine either as a solution, in tablets or using a combined flocculent with timed release chlorine like Procter & Gamble's product, PuR; and
- disinfection by heat (boiling) or ultraviolet radiation using solar disinfection (SODIS) or an artificial lamp (Clasen et al., 2006; Baffrey, 2005).

Table 1 lists the current recommendations concerning storage to maintain the quality of water treated at the household level. These recommendations may be associated with specific household water treatment options. The table breaks down the recommendation by its source.

Table 1 – List of recommended storage options for treated water to avoid recontamination

Source of Recommendation	Recommendation
CARE/Centers for Disease Control Health Initiative (no date)	Plastic containers with a narrow mouth, lid, and a spigot
Baffrey (2005)	Ceramic filter specific: raw water poured into a covered top container sitting on top of bottom container where treated water is collected; spigot attached to bottom container. Top and bottom containers may be made of steel, plastic or clay.
Hygiene Improvement Project (2005)	If no plastic container with a spigot is available, use 10-30 liter containers with narrow mouth, tight fighting lid, and handles for easy lifting and carrying. Preferably mounted on stable base to prevent overturning

Recent Implementation Experience

Murcott (2006b) has argued that most POU/HWTS technologies are no more than 10 to 20 years old, and most implementation efforts have occurred for 10 years or less, barely scratching the surface of need. The extent of major HWTS applications may be wide (53 countries), but it is not deep relative to the total population in need of safe drinking water.

Given the importance of household water treatment and storage, numerous interventions have been implemented to date, proposing different alternatives to consumers. Population Services International (PSI), for example, offers three different products to treat water at the household level. They include: a dilute chlorine solution developed by the CDC, which can be manufactured in country and can provide a safe water solution for a family of six for an estimated amount of a penny or less per day; easy-to-use water treatment tablets produced by Medentech; and Procter & Gamble's product called PuR, which combines flocculation and disinfection for areas where people take their water from surface or muddy sources. PSI has social marketing programs for distributing chlorine solutions in 24 countries and uses local organizations to sell and distribute products for regular and emergency use.

Murcott (2006b) indicates that there are three commercial technologies that permit particle removal from water:

- Ceramic filters (pore size between 0.2 and 1 micron) permitting the removal of bacteria and protozoa, of which two varieties are available (candle and pot filters);
- Sand filters, which permit the removal of bacteria and parasites when well designed; and
- Ultra-filtration (pore size about 0.02 microns, which permits the removal of bacteria, protozoa parasites and viruses.

Based on a survey of HWTS Network members, Murcott (2006a) concluded that there are 23 countries where ceramic filters are available and promoted, and 25 countries using biosand filters.

The Swiss Federal Institute of Aquatic Science and Technology (EAWAG) suggests that solar water disinfection (SODIS) process is a simple technology to improve the microbiological quality of drinking water. SODIS uses solar radiation to destroy pathogenic microorganisms that cause water-borne diseases. SODIS is ideal to treat small quantities of water. Contaminated water is filled into transparent plastic bottles and exposed to full sunlight for six hours. Sunlight treats the contaminated water through two synergetic mechanisms: radiation in the spectrum of UVA (wavelength 320-400nm) and increased water temperature. If the water temperature rises above 50°C, the disinfection process is three times faster (http://www.sodis.ch/Text2002/T-TheMethod.htm).

The Solar Disinfection (SODIS) Foundation sponsored a meeting in Quito, Ecuador, in 2005, which led to the creation of the Alliance for the Promotion of Safe Water and Hygiene for the Families of Latin America, with activities promoting multiple types of water treatment implemented in both the Andean Region (Bolivia, Ecuador and Peru) and throughout Central America and the Caribbean, working through the Central American Network for Safe Water. Murcott (2006a) concluded that there are 34 countries where SODIS is promoted.

The Center for Affordable Water and Sanitation Technology in Calgary, Canada, has also been very active in promoting POU technologies including sedimentation, filtration, and disinfection. The Massachusetts Institute of Technology, through its Department of Civil and Environmental Engineering, has been involved in POU activities in six countries in Latin America, one in Africa, and another in Asia. The AED component of the USAID-funded POUZN project will promote ceramic filters in India. And HIP works on the premise that consumer choice will facilitate adoption of POU treatment and storage practices. HIP is already working in Nepal and will soon initiate POU activities in four regions of Madagascar through a wide range of water and sanitation partners. At present, the USAID Mission in Madagascar supports PSI's promotion of *SurEau* water treatment solution and may add other options as additional geographic regions are added on.

The development community working in the water and sanitation sector needs common, valid indicators to track the impact of their promotional efforts. The indicators must be useful to understand the effectiveness of promotional efforts across POU technological options. So they should facilitate both aggregation and comparison across interventions. The following sections offer choices that program managers and donors can use to track POU interventions and present them for discussion purposes. These indicators focus on behavioral outcomes and sustained use. The presentation of indicators starts with a conceptual framework and presents criteria that can be used to select indicators.

Guiding Concepts and Associated Indicators

In this section, the following concepts are discussed:

- the process by which communication interventions can affect behavior;
- a typology of behavioral determinants;
- issues pertaining to sustainability and the need for evaluations to measure not absolute but incremental change; and
- examples of the type of behavioral determinants that may come into play and be activated by POU promotional interventions.

Behavioral Determinants

Typology and Process of Influence

The line of causality suggested by Hornik (2002) is that communication permits exposure to promotional messages; those messages affect behavioral determinants and these, in turn, affect behavior. Kincaid et al. (2005) have provided a classification of communication activities as well as a classification of behavioral determinants and a description of how this influence process operates. According to the authors, there may be instructional, directive, nondirective and public communication activities. Any of these activities can have an impact on behavioral determinants external to the individual (named environmental factors) as well as on determinants internal to the individual (including, skills, knowledge, psychosocial factors and intentions to perform a given behavior). It is important to recognize that communication activities will affect individuals directly and indirectly through social norms on the one hand and institutional changes on the other. Institutional changes may create a favorable environment that may in turn facilitate the adoption of practices by individuals. By the same token, as more and more individuals engage in a given promoted practice, the perception of social norms may change, thus helping to motivate others to follow the social trend.

Based on these principles, we can deduce that any evaluation of the effectiveness of a communication intervention will have to take into account:

- exposure measures;

- measures of changes in the behavioral determinants (to understand if the communication activities have been effective in changing behavior); and
- the extent to which individuals have adopted promoted practices.

Capturing Incremental Change to Better Target Promotional Efforts

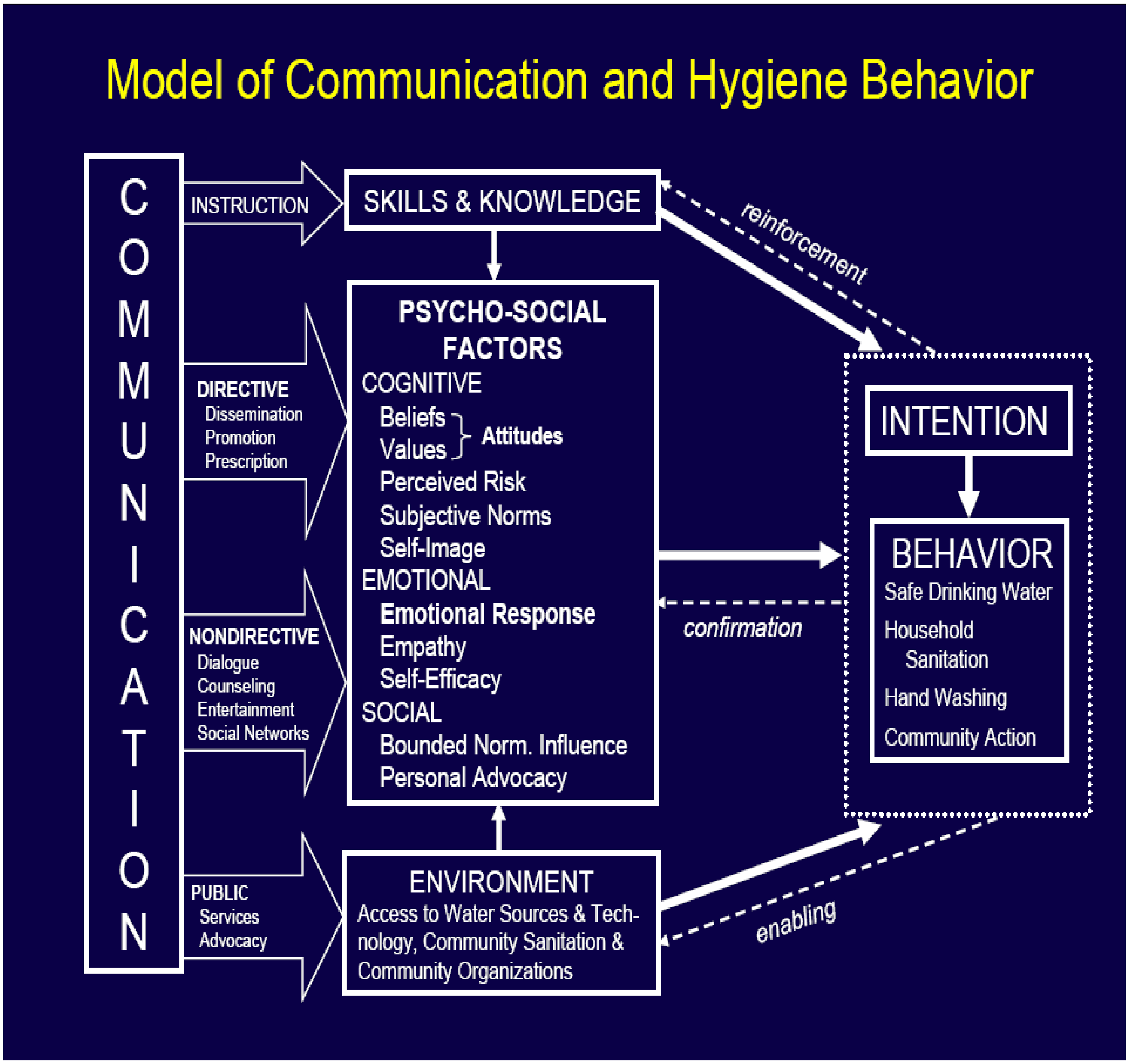
Conceptually, we can distinguish complete adoption from incremental change. A communications program may promote different hygiene practices. In the case of POU, they may be related to both water treatment and water storage. Complete adoption in this context would be defined as the adoption of the entire package of interventions that were promoted: water treatment practices plus the accompanying water storage practices. Incremental change may be defined as partial adoption. Individuals may adopt one set of practices and not the other, or adopt some component(s) of one practice but not the complete behavior for either water treatment or safe storage.

Even though water treatment and water storage should be adopted as a package, it is possible that communication interventions effect partial adoption or incremental changes. Consequently, an evaluation of these interventions should be able to capture this, even when program implementers will conclude that partial adoption is incorrect. From a communications perspective, it is crucial to determine how much change an intervention is generating, and explore what factors facilitate and hinder the adoption of the full model. If elements of the full model are more difficult to adopt, future behavior change interventions will need to focus on those “hard-to-change” components.

Sustainability

Sustainability is an important aspect of behavior change in general. Behavior change efforts around HWTS are no exception. Within sustainability two issues must be considered: the sustainability of interventions themselves and the sustainability of changes in HWTS practices. If interventions are designed to specifically sustain promotional efforts, by integrating them to normal ongoing promotional efforts implemented by participating partners, for example, evaluations of these interventions must capture the impact that they have in sustaining practices.

A chart representing the role of communication in behavior change proposed by Kincaid et al. (2005) is presented below.



Field Examples

Kincaid et al. (2005) indicated that a study conducted in Guatemala identified multiple predictors of engaging in (self-reported) water treatment practices. These predictors include: knowing that unsafe water can cause diarrhea (defined as a cognitive variable), a parental concern about children having diarrhea, a preference for the rich and natural taste of boiled water, the confidence that one can treat water correctly (defined as emotional variables), the perception that the treatment of unsafe water is necessary, and discussing such an action with a partner and friends (defined as social influence variables). It must be remembered that these data are based on study participants who self-reported exposure to water treatment messages.

Figueroa et al (2005) also reported the role played by psychosocial factors in predicting water treatment practices in Pakistan. The study concluded that social norms, desired attributes in drinking water, and what researchers define as "positive attitudes" about water treatment are statistical predictors of water treatment practices. In this study, examples of good attitudes would include agreement scores with statements such as: “Good health depends on what people do to keep healthy and not God,” “Turbid water is not good for drinking,” “It is necessary to treat even tap water,” and “I only trust water that I have treated myself.”

Indicators to Measure Behavioral Determinants

The following are examples of generic indicators that would be useful in evaluating behavior change communication interventions. These are borrowed from other programmatic areas in the health sector and adapted to the water and sanitation sector (Bertrand et al., 2002). They include both measures of exposure as well as measures of the psychosocial factors discussed above.

Percent of target audience (e.g., child caretakers) who:

- recall hearing or seeing a specific message;
- know a product (e.g., a given chlorine solution) or a practice (e.g., solar disinfection);
- perceive a risk in a given behavior (e.g., leaving turbid water untreated) that are confident that they can correctly perform a practice;
- believe that the practice has a positive consequence (e.g., effective removal of water content that can make get people sick); and
- believe that a significant person (spouse, friends, relative) approves of the practice.

Behaviors

This section discusses a definition of behavior, the need for evaluations to reflect the behavioral focus of interventions, and a classification of users of HWTS.

Definition of Behavior

Program implementers and donors alike will be interested in determining the effectiveness of behavior change intervention in changing behaviors. A behavior would be defined as an overt action performed by an individual under a given set of circumstances (e.g., treating water for human consumption) in response to certain stimuli (e.g., thirst). As such, water treatment would be different from water transportation or storage.

Program and Evaluation Focus: One or More Behaviors

A behavior change intervention would address one or more behaviors. Yet, it is generally assumed that the more focused the behavior promoted, the more likely that the promotional effort will be effective. Behavior change interventions targeting individuals on POU issues may address each one of the behaviors associated with household water management as indicated above: transport, treatment, and storage. If a promotional effort addressed only one of the elements such as transport, the evaluation should address just transport. If it addressed any combination of the three, such as treatment and storage, it should address both of those elements.

If families have access to protected water sources, concerns about how the water is transported from the source to the house and how the water is stored in the house would be of interest to institutions implementing appropriate water management practices. If the water is obtained from an unprotected source and is treated in the house, household water treatment and storage would then become important. Evaluations must reflect program content.

Classification of "Users" of HWTS

A classification of users of HWTS can de developed based on different criteria. Such criteria would include: a time dimension for level of use, the level of compliance with technical recommendations, and the consistency with which the practices are performed.

- The time dimension for the **level of use** would be broken down into groups of **"ever," "current," "irregular,"** and **"sustained" users.** The "ever" users would include both users that have performed the practice at one point but have abandoned it as well as current users. By definition, "current" users would be those who are performing the practice at the point of measurement. There may be some overlap between these categories. "Irregular" users would be those that perform the practice on and off. "Sustained" users would be those users who have performed the practice consistently over a given period of time. Murcott (2006b) has proposed, for example, that a period of one year be considered to determine if a user might qualify as a sustained user.
- The **level of compliance** with technical recommendations may allow us to speak of **partial vs. full users** as well as **correct vs. incorrect users**. Because HWTS includes more than one practice, it could be possible that users have adopted one component (e.g., water treatment) and not the other (e.g., water storage). We may classify them as partial users when they have adopted just one component of the system, and full users when they have adopted both of them. Correctness may be associated with different aspects of each component. For example, when using a sodium hypochlorite solution packaged in bottles, recommendations may instruct user 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 it and wait 30 minutes before drinking" (Lantagne et al., 2005). Chlorination users changing the amount of solution or using non-standard containers could be incorrect users, whereas those that followed instructions fully would be considered correct users.
- The **level of consistency** with which the practice is performed may allow us to speak of **inconsistent vs. consistent users**. An inconsistent user would be one who performs the practice sometimes, but not all of the time. A regular user would be one who performs the practice all of the time.

Program implementers and funders would most likely be interested in current users that are performing suggested practices correctly. If this is the case, the challenge for evaluators would be <u>how</u> to measure correct use at one point in time. The method of how one might do this will be discussed in the following section.

The information obtained through such measures can then be used to construct rates. Murcott (2006b) suggest using two such rates: rate of adoption, and rate of sustained use. The rate of adoption would be calculated dividing the number of households using HTWS after one month by the number of households targeted. As indicated earlier, the rate of sustained use would be calculated dividing the number of households using HWTS after one year by the number of targeted households. These definitions will have to be adjusted to reflect the fact that any research to generate such rates would be done using samples. Consequently, the qualifier sample households would have to be added to the numerator and denominator in both calculations.

Measures of Behaviors

Criteria for Choosing Indicators

Program implementers and donors are also interested in ensuring that the measures of behaviors are technically sound and that they are useful for program management purposes. Because these measures help fine tune programs, they should be:

- **valid:** measurements should reflect true reality;
- **reliable:** repeated measures should provide the same conclusions;
- **easy to obtain:** data can be gathered quickly or may already be collected;
- **economical:** should not consume resources that can be used for implementation; and
- **practical:** can help make programmatic decisions.

Further discussion here is only on the first two, validity and reliability, given the self explanatory nature of the last three.

Validity: Objective measures are preferable to subjective ones, and are considered to be more valid. In that sense, measures based on observations are preferred to measures that rely on self reports. Fowler (1995) argues that "respondents will distort answers in ways that will make them look better or will avoid making them look bad." Inaccuracies from self reports may also occur because answers may put respondents at risk, or even because accurate answers may not be the way that respondents want to think about themselves.

Reliability: Behaviors are circumstantial and may change from day to day. How do we know what we observe one day is what normally happens in a household? Webb et al. (2006) did a study of 588 households in four rural Guatemalan communities over 36 months and studied the repeatability of specific hygiene practices within the household. One of the practices observed during the study was that of covering the household's interior water storage container. This practice was added, as a line item, into a drinking water index. Three other indices were constructed, addressing food cleanliness, household cleanliness and personal hygiene. Spot checks were used to observe the hygiene practices. Spot checks are defined as the observation of a predetermined set of conditions that occurs at one point in time during a home visit. A couple of conclusions of this study are worth mentioning here. One is that "indicators of hygiene practices assessed by spot checks are subject to substantial day-to-day variations within households over long periods of time."

The repeatability, or lack thereof, of a different set of hygiene practices was also observed by Cousens et al. (1996). In this study, researchers observed 200 mothers and their 2 to 36 month old children in Burkina Faso three times at weekly intervals. The attention focused on events surrounding defecation, including, among others, child defecation in the compound's yard, the way the caretaker cleaned a child after defecation, and hand washing by the caretaker after leaving a latrine. There are three study conclusions that are related to variability of behavior over time. One is that child defecation in the yard increased from 5% to 16% (p=.01) from the first to the last observation. The second is that that the proportion of occasions when the child's bottom was observed to be washed declined over the course of the three observations from 95% to 85% (p=.01). And finally, hand washing after leaving the latrine declined over the course of the three observations from 35% to 22% (p=.05). These declines suggest the possibility that variations may be due to the presence of the observer and that those observed are changing their practices as they get used to the presence of the observer. This phenomenon is known as reactivity. Nevertheless, the variations may also be due to the fact that individuals do not necessarily perform the same behaviors systematically over time. Consequently, observer reactivity and behavior repeatability may be factors affecting the findings.

Three Alternatives for Measuring Behaviors

Three alternative indicators to consider for measuring behaviors for POU are: 1) the volume of sales of POU products, 2) the number of liters of water treated, and 3) the percentage of households practicing effective household water management. The advantages and disadvantages of these options based on the criteria suggested are presented below.

Some of the POU technologies proposed are products that can be used for treating a certain number of liters of water. As such, consumers would have to buy them frequently in order to systematically use them to treat drinking water. Chlorine solutions and PuR, the flocculent-disinfectant produced by Procter & Gamble, would be examples of these products. In a search for easy-to-obtain data to measure behavioral outcomes, **volume of sales** represents a viable alternative and represents Alternative Indicator 1.

This indicator meets some of the criteria mentioned above. Volume of sales is information easy to obtain, and also economical. Distributors of the products would generally keep sales records and may be willing to share them with program managers and donors. Although reliable, they may not necessarily be valid, particularly if consumers have used the products incorrectly, either as a result of under dosage or over dosage. An important limitation of this method is that it is only applicable to POU options that are product-based. It cannot be used to track POU technologies such as SODIS or boiling.

Volume of sales can be used, however, to obtain another figure: **the number of liters of water treated**. This indicator would be Alternative Indicator 2. This indicator is yet another indirect measure of behavioral outcomes. Such a figure is an attractive indicator for many, as it may allow the evaluator to combine the result of practices across HWST options, and in so doing, permit comparisons across sites and projects implemented through different implementing agencies.

Although "number of liters of water treated" is a practical measure, it is a limited one. The only water treatment technology that would lend itself easily to providing the needed information for such an indicator would be chlorination. If one bottle of sodium hypochlorite solution can be used to treat, for example, 10 liters of water, then obtaining the number of liters of water treated can be calculated by multiplying the volume of sales by 10. Calculating the number of liters of water treated for the other water treatment technologies would require more laborious work. One first step would require determining the number of liters of drinking water consumed daily by a typical household in a given population. For precision purposes, the number would be better derived through household visits. An average number of daily liters of water consumed would be derived, and that number would be multiplied by the number of households using a water treatment technology.

There are three important limitations associated with this indicator. One is that it is a measure of quantity as opposed to a measure of quality. The second is that it ignores the other element of HWTS: water storage. The third is that it does not address the extent to which the practice may be performed correctly. For these considerations, the results of this indicator may not be valid, regardless of how reliable and easy to obtain it might be.

A third possible indicator worth considering is **the percentage of households practicing effective household water management**. This indicator has been under development and was recently submitted to donors and implementers for consideration by Rainey (2005). This indicator proposes to collect objective information that may include water quality testing when possible. It also proposes to conduct spot checks of equipment/supplies used to treat water, including whether the technology is under use at the time of the home visit, as well as characteristics of household water storage vessels. The use of a water test will most likely resolve reliability and validity considerations. The author proposes the use of the orthotolidine test for this purpose.[1] In addition, the reliance on observations reduces respondent bias. Rainey (2005) proposes that the indicator be defined by the following elements, some of which may be applicable depending on the technology used:

1. The presence of chlorine residual in household drinking water storage container;
2. The presence of a covered ceramic water filter in an accessible spot in the kitchen, with filter in place and water in the lower container;
3. The presence of multiple SODIS bottles exposed to full sunlight;
4. The presence of a water storage vessel covered or closed with a solid cap or lid; and
5. The presence of a water storage vessel with a narrow mouth and/or a tap for removing water from the container.

This indicator takes into account both the water treatment as well as the water storage aspects of HWTS. In addition, it does not rely on self reports. However, this indicator excludes boiling as a HTWS practice. The exclusion is based on the fact that there is evidence suggesting boiled water may be recontaminated based on how it is handled subsequent to treatment. In addition, because the indicator relies on observation, it may be considered more valid than self reporting. It does, however, rely on spot checks, which may not be completely reliable, since, as pointed out earlier, practices may vary from day to day.

Water treatment at the household level is most likely related to the fact that the source of drinking water commonly used for the family is not safe, or if it is, the person within the household responsible for managing drinking water perceives that it is not safe for drinking. The definition of the indicator above may need to be more explicit, at least with respect to the source of drinking water, and read: **percentage of households without access to a safe drinking water source practicing effective household water management.** This would be a modification of Alternative

[1] The orthotolidine test uses a popular chemical to monitor water, including swimming pool water, for the presence of chlorine residual. Orthotolidine solution turns yellow when added to chlorinated water. The darker it turns, the more chlorine is in the water.

Indicator 3. If the behavior change interventions will be targeting precisely this type of household, the indicator should reflect this and so should the evaluation. A crucial element in behavior change communication is the need to target specific audiences, and to tailor messages to them in order to increase their effectiveness. If the evaluation looks at the general population, instead of the specific target audience for whom the communication interventions were designed, it may come to inappropriate conclusions about the effectiveness of that intervention on behavioral outcomes. As Hornik (2002) pointed out, "If evaluations are unable to focus their studies on the people most likely to be affected, they risk missing effects."

The fact that boiled water may be recontaminated due to how it is stored may not be sufficient cause for eliminating boiling as a practice to be included in the indicator. An evaluation would need to know if in improper storage of boiled water, or any treated water for that matter, is occurring as it offers a challenge for behavior change strategists to go back to the drawing board, decide how to focus the intervention or promote the right storage practices. Lantagne (2006) suggested that adding boiling as one element of the indicator would simply require following the boiling chain to the end and ask: Have you boiled water? Did you do it today? Where is the boiled water? (And determine from the observation.)

As far as measurement is concerned, an instrument constructed to track the proposed indicator should include questions to address reliability concerns. In the specific case of solar disinfection, it may be important not only to observe whether or not households have bottles of water exposed to sunlight, but also whether they have enough bottles to repeat the process at least once. One of the constraints for adopting solar disinfection as a household treatment practice may be lack of access to plastic bottles. This in fact is one of the findings that emerged from qualitative research recently conducted by HIP in Madagascar (de Negri, 2006). If a family must have five one-liter bottles per day to satisfy the family drinking water needs, and if they used the treatment plastic bottles as storage containers for the treated water, they should have at a minimum of 10 one-liter bottles available in the house to repeat the disinfection practice at least once. Consequently, checking whether the household possesses a set of one-liter bottles in addition to those used for exposing water to sunlight may be an important item to include when examining safe storage containers.

There may be similar issues associated with other water treatment technologies, and conference participants are encouraged to suggest ways of improving the reliability of the data obtained through instruments to collect information for the indicator suggested.

Research Design Issues

One crucial question for evaluations is whether the effects that are detected can be attributed to the intervention. Hornik (2002) argued that a good evaluation of a public health communication program must satisfy two criteria at the same time: a) it must respect the nature of how the program is expected to affect health behavior; and b) it must make it likely that attribution of effects to a program is not confounded by other influences. These are internal and external validity issues.

Some programs are implemented over time in different sites. For example, a program may be implemented over three years in Ethiopia and Madagascar, and over five years in Peru and Nepal. Program managers may be interested in tracking changes annually in practices across sites. For this purpose, it may be assumed that annual surveys would be sufficient. However, a given progression from one year to the next in any given site (e.g., increase of 15% to 25% in practices) does not imply that it is the result of an intervention. It may be assumed, yet not demonstrated. The only way in which causality can be determined is by using appropriate research designs.

Hornik (2002) argues that there are four issues that must be addressed by evaluations of health communication programs:

- use of controls;
- time periods of treatment;
- matching the study population to the target population; and
- units of treatment and analysis.

Researchers may be tempted to argue in favor of using randomized experimental designs, or randomized control studies to use terms common to epidemiologists. But in the phase of programs that would require using mass media to have impact at a large scale, such designs may not be possible. Hornik (2002) presents the case that there are alternatives to the ideal evaluation design that may provide answers to both internal and external validity concerns. These designs are:

- after-only designs;
- pre-post designs;
- true and constructed cohort designs;
- interrupted time series designs;
- parallel time series designs with convincing narratives connecting exposure and outcome variables;
- comparison area or group designs; and
- designs that allow modeling of the process of influence.

The purpose of this document has not been to review each one of these designs. That is precisely the purpose of Hornik's reflection. However, the author of this paper wants to alert e-conference participants to the fact that a full research protocol may be required to assess progress against an indicator, and that research design would be part of that protocol. The advantages and disadvantages of specific research design alternatives should be part of the discussion prior to development of the research protocol. Pros and cons about specific research design alternatives should also be part of the discussion we should engage in during this e-conference.

Questions for the E-Conference Discussion

The behavioral determinant indicators under discussion are:

Percent of target audience (e.g., child caretakers) who:

- recall hearing or seeing a specific message;
- know a product (e.g., a given chlorine solution) or a practice (e.g., solar disinfection);
- perceive a risk in a given behavior (e.g., leaving turbid water untreated) and are confident that they can correctly perform a practice;
- believe that the practice has a positive consequence (e.g., effective removal of water content that can make get people sick); and

- believe that a significant person (spouse, friend, relative) approves of the practice.

The behavioral indicators under discussion are:

- Number of liters of water treated; and
- Percent of households without access to a safe drinking water source practicing effective household water management.

The following are questions that the e-conference should try to address, and the author invites participants to focus on these questions when providing input throughout the conference.

- What are the strengths and limitations of the indicators listed above for measuring behavioral determinants? (Please address each indicator separately).

- Are there better ways to measure behavioral determinants that can reduce the vagueness of those proposed and make them more explicit and less generic?

- What are the strengths and limitations of each of the two behavioral indicators presented for POU projects that are actually being implemented? (Please address each indicator separately.)

- The current indicators under discussion focus on water treatment and treat safe storage either partially or indirectly. Should safe storage be included in the definition of effective household water management in addition to the three treatment methods? If so, how should it be expressed and measured?

- What refinement of the two behavioral indicators highlighted above is still needed? Please offer specific suggestions for refining them.

- What opportunities exist within your programs or in programs that you are aware of to pre-test the indicators that result from this discussion in the near future?

  E-conference participants are encouraged to approve these indicators, correct them, and/or suggest alternatives.

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Annex 1 – List of Indicators for All Programmatic Dimensions Associated with HWTS Promotion

Programmatic Dimension	Indicator
Technology Performance	Average influent and effluent concentration(s) US EPA maximum contaminant level Rated service flow rate in L/min or l/day (gpm or gpd) General operation, maintenance requirements including, but not limited to: - Frequency of component change or service to system - User responsibility - Parts and service availability Conformity to the ANSI/NSF 53 for the specific performance claims as verified and substantiated by test data
Water Quality	Concentration of substances/chemicals of concern such as CFU E. coli or thermotolerant coliform bacteria/100ml
Financial Targets	# of water disinfection products sold Profit margin Subsidies provided Growth rate Market share # of individuals employed nationally and internationally Amount spent per economic value generated
Behavioral Outcomes	**Behavioral Determinants** % of target population that: - knows that water source is not safe for drinking - knows that safe water prevents diarrhea - agrees that water needs to be treated to make it safe for drinking - agrees that the technology is effective in making water safe for drinking - agrees that chlorine-based or chemical additive treatment products are safe\ - agrees that one can make the time to treat water at home - agrees that water treatment is among the priorities at home - has confidence in treating household water for drinking - likes the taste of treated water - feels good about providing treated water for all members of household - thinks others in the community treat their water consistently - report others have recommended to treat water at home - advocates water treatment to others in the community **Water Treatment** # of households that report having treated water for drinking in the house # of households that show treated water in the house # of households with a negative E. coli test in their treated water # of households with positive test for chlorine residual among self-declared chlorine users

	Water Storage # of households that store water in: - narrow-mouth container, covered with a hard cap and with a tap or - wide-mouth container with a hard cover and a tap or - jerry can with tap made out of hard material or same bottle used for solar disinfection **Water Serving** # of households serving water: - directly from (proper) container without using any device to draw water from container, or - using a ladle or a cup with a handle without touching the water, and keeping water drawing tool covered from dust and hands and stored in a fixed place out of reach of children
Coverage/Impact	**Reach and Users** % of targeted households reached/trained % of regular users among household reached/trained (acceptance level) % of regular users among targeted population (overall acceptance level) % of irregular users among household reached/trained % of non-users among household reached/trained **Market Penetration** Market penetration for one-time purchase of HWTS units Market penetration for recurrent purchase of HWTS units **Adoption and Sustained Use** Rate of adoption = # of households using HWTA after 1 month/ # of households originally receiving HTWS Rate of sustained use = # of households using HWTS after 1 year/ # of households originally receiving HWTS
Health Outcomes	% of the target population with diarrheal disease within established time frame

Sources: Baffrey, 2005; and Murcott, 2005