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Household Water Treatment and the Millennium Development Goals: Keeping the Focus on Health

THOMAS F. CLASEN
London School of Hygiene & Tropical Medicine

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Waterborne diseases such as diarrhea are a major killer in low-income settings, particularly of young children. For those without access to safe drinking water, household water treatment, such as boiling, chlorinating, and filtering water in the home, when combined with safe storage (HWTS) can significantly improve water quality and prevent disease, thereby contributing to the child survival and other health priorities encompassed within the Millennium Development Goals (MDGs). There is uncertainly, however, about whether HWTS should count toward the MDG water target, which promotes "sustainable access to safe drinking water". This paper reviews the relevant research and concludes that it should not. Although HWTS can significantly improve water quality, it does not improve water quantity and access—key aspects of the MDG water target that are essential for optimal improvements in health and development. A policy that excludes HWTS from the MDG water target will discourage governments from diverting scarce public resources from comprehensive and long-term improvements in water supplies. At the same time, the health-oriented MDGs provide a sufficient case for scaling up effective and appropriate HWTS among target populations. Moreover, a health-based strategy for HWTS will help ensure that promotion of the intervention is driven by measurable improvements in outcomes rather than inputs, thus encouraging advances in both hardware and programmatic delivery that will make HWTS more effective, appropriate, and accessible to vulnerable populations.

Background

Waterborne diseases are a major killer, particularly of young children. Diarrhea represents the largest share of this disease burden, causing an estimated 4 billion cases and 1.9 million deaths each year of children under 5 years, or 19% of all such deaths in developing countries (*1*). Unsafe drinking water also contributes to more than 25 million cases and 250,000 deaths annually of enteric fevers (typhoid and paratyphoid), as well as to much of the disease burden from cholera, poliomyelitis, and hepatitis A and E (*2*).

An estimated 884 million people worldwide lack access to improved water supplies (*3*). Even improved sources, however, such as protected wells and communal stand posts, often fail to deliver safe drinking water in settings with poor sanitation due to infusion of fecal contamination (*4*). Moreover, water that is microbiologically safe at the source or other point of distribution is subject to frequent and extensive fecal contamination during collection, transport, and storage in the home (*5*).

For these reasons, the World Health Organization (WHO) and others have called for alternatives that can accelerate the health gains associated with improved water supplies, especially among rural populations who are at greatest risk of waterborne disease because of poor quality sources and reduced access to treatment. One such alternative is household water treatment and safe storage (HWTS) (*6*). However, an important limitation on scaling up targeted and effective HWTS is uncertainty about the role the intervention should play in national development strategies. These strategies, and the funding necessary to pursue them, are driven not only by national priorities, but also by international targets such as the Millennium Development Goals (MDGs). Thus, whether HWTS is embraced by national governments will be determined, to some extent, on whether and how it is counted toward the MDGs.

Water and the Millennium Development Goals

The essential role of water in development is widely recognized (*7*). In the current framework for human development, which is expressed in the MDGs, water is fundamental. The UN Millennium Task Force on Water and Sanitation carefully analyzed the contribution of water toward each of the MDGs, including eradicating extreme poverty and hunger (goal 1), reducing child mortality (*4*), and combating major diseases (*6*), concluding that "for many of the targets, it is difficult to imagine how significant progress can be made without first ensuring that poor households have a safe, reliable water supply and adequate sanitation facilities" (*8*).

One reason water in so central to human development is that plays multiple roles. For some of these, such as basic hydration through direct ingestion, the *quality* of water is critical. Ensuring water quality is essential in preventing waterborne disease, and the *Guidelines for Drinking-Water Quality* reflect the need for the highest level of water quality (*9*). However, for other purposes, such as personal and domestic hygiene and irrigation of crops, quality can be compromised to some extent in favor of *quantity* and *access*. Many of the potential gains in development from improving water supplies—those noted above but also education (goal 2), gender equality (*3*), and maternal health (*5*)—depend on improvements in quantity and access, not just quality. This more holistic perspective on water is also consistent with the health literature, which has come to distinguish among water interventions based on improvements in quality, quantity, and availability (*10–13*).

This multifaceted character of water is also reflected in the only MDG target that specifically addresses water. Target 10 of Goal 7 seeks to "reduce by half the portion of people without sustainable access to safe drinking water" (*14*). The 2005 report of the MDG Task Force on Water and Sanitation eventually defined safe drinking water as "water that is safe to drink and available in sufficient quantities for hygienic purposes" (*8*). This and the previous international water goals such as Mar del Plata and Vision 21 make clear that the MDG water target was intended to address not only water quality, but also quantity, access, affordability, long-term availability, and environmental sustainability.

HWTS, the JMP, and the MDG Water Target

When the Inter-Agency and Expert Group on MDG Indicators looked for a source of existing data from which to monitor

Phone: +44 (0)20 7927 2916; e-mail: thomas.clasen@lshtm.ac.uk.

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the progress on the water target, they chose to use assessments of "improved water supplies" assembled biannually by the WHO/UNICEF Joint Monitoring Programme on Water and Sanitation (JMP) (*15*). However, JMP assessments use indicators based on service levels rather than direct assessments, since they rely on national household-level surveys that currently do not include assays of water quality. The JMP acknowledges that its current monitoring strategy does not capture the full intent of the MDG water target (*16*).

The JMP's methodology for water and sanitation assessments has evolved since they first began collecting and publishing their reports in 1975, and they are continuing to explore approaches that provide more reliable data (*3*). One question that they continue to consider is whether HWTS, perhaps in combination with indicators of quantity and access, are more likely to ensure quality and thus potentially count toward the MDG water target. In its 2005 report, the JMP first cites studies on the effectiveness and cost-effectiveness of HWTS and the potential contribution it can make (*17*). While cautioning that HWTS does not preclude the need for infrastructural improvements, it hinted strongly at opening the door to HWTS: "in principle, the population applying correct household water treatment methods should be included among those considered to have access to safe drinking water" (*17*).

The potential inclusion of HWTS in the target was also suggested by the JMP's recommendation, starting in 2006, that standard questions on HWTS practices be added to the household surveys (*18, 19*). This would allow it to collect the data necessary to begin including it in its assessments. In 2008, the JMP first included some preliminary results from these questions in its report and once again acknowledged the potential contribution of HWTS toward the MDG water target. The report also notes that work is underway to "explore issues related to household water treatment technologies, with a view to evaluating their potential role in providing measurable access to a safe and sustainable drinking water supply" (*20*).

Benchmarking HWTS against the MDG Water Target

HWTS is a water quality intervention only. Except perhaps where a household can use HWTS to render some nearby unimproved water safe for drinking, HWTS will not generally affect the quantity or availability of water. As quantity and access have been shown to provide important health and other gains (*8*), the full benefits of "sustainable access to safe drinking water" will not be realized unless HWTS is used in settings where sufficient water quantity and access are present.

However, even as a water quality intervention, HWTS has some shortcomings. While HWTS has shown to improve quality of drinking water, most of the evidence to date is from relatively short-term, research-driven efficacy trials (*21, 22*). Studies of boiling—by far the most common means of household water treatment —as it is actually practiced in the home, confirm that that HWTS is effective in improving drinking water quality compared to the source (*24–26*). However, a significant portion of the samples of reportedly boiled water had low to moderate levels of fecal contamination, probably due to unsafe storage. A recent field study in Cambodia also showed that biosand and ceramic filters fell short of producing water that consistently met WHO drinking water guidelines on both microbiological and chemical parameters (*27*).

There are other reasons to question whether HWTS, in actual practice, ensures that water is "safe" as contemplated by the MDG water target. First, apart from boiling, many of the most common HWTS options are not effective against all classes of infectious agents. Important waterborne pathogens, such as *Cryptosporidium* oocysts and *Giardia* cysts, are resistant to chlorine disinfection (*28*). Most filtration media that operate at gravity pressures are largely ineffective against viruses (*28*). Although some higher cost water treatment products use a multibarrier approach to address all classes of waterborne microbes, none of these are currently used at scale among low-income populations (*29*).

Second, the microbiological performance of many common HWTS methods can be adversely impacted by water conditions that householders may not be able to assess, much less control. Only boiling and a few commercial water treatment products have been shown to meet international standards for microbiological water purifiers (*28*). The microbiological performance of some methods, such as chlorine, is adversely impacted by water temperature, pH, and chlorine demand; filters can underperform due to excess turbidity, chemical contaminants, improper cleaning, field failures, and poor maintenance (*29*).

Third, unlike improved water sources, ensuring the quality of water from HWTS products requires daily or other frequent effort, and often expense, on the part of householders. Recent field assessments of HWTS programs demonstrate the challenge of securing such correct, consistent use in actual practice (*30, 31*).

Fourth, there is evidence that HWTS is reaching the target population inequitably, raising questions about its potential to provide "access". Adoption of HWTS products is higher among urban, higher-income, better-educated populations (*23*). In Africa, South-East Asia, and Latin America, the wealthiest quintile of the population is about twice as likely to practice microbiologically effective HWTS methods than the poorest quintile. There is also evidence of unequal uptake of socially marketed chlorine products that favors higher income, urban householders (*32*). Of course, the same kind of disparity obtains in the case of "improved" sources, and especially household connections (*3*).

Finally, it is not clear that HWTS methods are "sustainable", i.e., provide a robust, long-term solution that is not environmentally hazardous. Systematic reviews have observed that the protective effect of some interventions diminished with study length (*13, 22*), though Hunter found filters to deliver sustained protective effects (*33*). Questions have been raised about the environmental impact of boiling, though there are no estimates to date of the environmental sustainability of boiling or any other HWTS method (*34*).

HWTS and Health

For these reasons, the evidence does not warrant counting HWTS toward the MDG water target. At the same time, the intervention does have the potential to make substantial contributions to health, especially if targeted to vulnerable populations who are unlikely to benefit in the near term from safe, reliable water supplies.

Despite the difficulty in securing access and correct, consistent use, there is evidence that HWTS can be more effective in preventing diarrhea than conventional improvements in water supplies (*12, 13, 21*). There is also evidence from blinded trials that much of the reported impact is due to placebo effect and reporting bias (*21, 35*), though others report a protective effect from some HWTS interventions even after discounting the effect estimates by the likelihood of bias and challenge of sustained use (*33*). Large populations in Asia may already be benefiting from a cultural propensity to use boiled water in preparing food and beverages (*36*). Counting HWTS toward health targets instead of the water target ensures that HWTS will be scored toward the MDGs only to the extent it actually delivers health gains, thus shifting the burden to implementers to actually demonstrate the health impact of the intervention. To the extent that the reported health benefits of HWTS are exaggerated or unsustained, they will not deliver health gains and thus will not count toward the MDGs.

By focusing on achieving health gains, the emphasis for HWTS shifts from inputs (hardware and software) and outputs (coverage) to outcomes (reductions in disease). This will help ensure that the intervention is targeted to the populations who could benefit most—something that current data on coverage and equity show to be a major challenge (*23*). At the same time, a health-centered policy on HWTS will encourage research and implementation to focus on (i) demonstrating true underlying health gains, (ii) methods that reach an optimal balance of cost and microbiological performance, (iii) solutions that are acceptable, appropriate, and affordable among the target population, (iv) delivery strategies that succeed in reaching that population when they are most at risk and over the long-term, and (v) health benefits that are sustained.

Focusing on health outcomes rather than water coverage may also provide a more effective means of financing HWTS. An important trend in public health funding is toward pay for outcomes rather than inputs (*37*). There is already some evidence that HWTS is cost-effective, cost-beneficial, and can deliver significant cost savings, especially to health care systems, which actually exceed the cost of delivery (*38–40*). Effective HWTS may also deliver increases in productivity and school attendance (*41*). If this can be shown on a large scale, then experience in analogous household-based environmental interventions such as long-lasting insecticide-treated mosquito nets suggests that governments and donors will increase their investment in HWTS (*34*). The beneficiaries are also an important source of funding for HWTS. The widespread practice of boiling and certain other HWTS methods suggests that householders are willing to make their own investments in treating water at home if they perceive benefits (*23*).

Finally, a health-based strategy for HWTS is likely to increase the scalability of the intervention. This is for at least three reasons. First, as noted, investments in the intervention are easier to justify if they yield demonstrated returns in health. Preventing waterborne disease has the potential for substantial reductions in morbidity and mortality and related health-care expenditures, as well as improvements in nutrition, productivity, school attendance, and physical and cognitive development (*38, 39*). Second, HWTS is currently an orphan within national governments, with conflicting paternity between the water and health ministries that results in a lack of ownership and few budgetary resources (*34*). By positioning the intervention clearly within the health sector, governments will be able to build it into health strategies and provide HWTS with the necessary professional expertise and financial resources. Third, and perhaps most important, a health-centered approach to HWTS will eliminate much of the conflict about the role of the intervention in water policy, and especially about diverting government resources away from long-term improvements in water supplies.

Placing HWTS squarely in health is also consistent with recent pronouncements by international organizations. Despite the JMP's intimations about counting HWTS alongside improved water supplies toward the MDG water target, both the WHO and UNICEF have mainly emphasized the health gains that can be achieved from effective HWTS (*38*). In 2008, the WHO stressed the potential contribution of HWTS in its *Guidelines for Drinking-Water Quality*, noting its potential for "rapid and significant positive health impacts in situations where piped water systems are not possible and where people rely on source water that may be contaminated, or where stored water becomes contaminated because of unhygienic handling during transport or in the home" (*28*). The WHO also recognized the health contribution that HWTS can make among people living with HIV/AIDS, both in providing safe drinking water for those on drug therapy and for the preparation of replacement feeds for mothers who are HIV+ and choose not to breastfeed in order to prevent transmission of the virus in breastmilk (*42*). In 2009, the WHO and UNICEF announced a seven-point strategy for the treatment and prevention of diarrhea among children that expressly includes HWTS (*43*).

Looking to 2015 and Beyond

Relying on service levels as indicators for the MDG water target, and using a dichotomous "improved vs. unimproved" classification, falls short in measuring progress toward "sustainable access to safe drinking water". The JMP is taking steps to implement a more robust approach that would capture the key information on quality, quantity, and access that are encompassed by the target (*3*). One such step is the development of reliable, low-cost methods to readily assess the microbiological quality of water in the field. As these methods are rolled out, they may make it possible to assess the actual safety of drinking water directly rather than relying on service-level indicators. This capacity would allow future assessments to reflect the contribution of HWTS in helping ensure the safety aspect of the MDG water target.

At the same time, the JMP is moving away from a binary typology in reporting on water supplies. In its 2008 assessment, it adopted a "ladder" approach, reporting separately on household connections from other improved water sources (*20*). Such disaggregation of the data not only presents a more complete picture of water supply conditions, but also encourages important incremental improvements (*44*). When water quality can actually be measured in the field, HWTS in combination with sufficient and accessible water supplies could represent such an incremental improvement and thus have a place among the rungs on the water supply ladder. However, it should never replace the goal of safe, adequate, and accessible water supplies that provide optimal gains in both health and development without shifting the burden of water quality to those who can least shoulder it.

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