Impact Evaluation of Low-Cost In-Line Chlorination Systems in Urban Dhaka on Water Quality and Child Health

Research team: Stanford University; International Center for Diarrheal Diseases Research, Bangladesh
Contacts: Amy J. Pickering, amyjanel@stanford.edu; Stephen Luby, sluby@stanford.edu

Background

Water- and sanitation-related illnesses are major causes of under-5 mortality in developing countries. Millenium Development Goal (Target 10) to halve the proportion of people lacking access to an improved drinking water source has influenced government and international funding priorities to focus on upgrading unimproved sources (Clasen 2010). The water MDG target was successfully met 2010, and experts have recently begun to question the longstanding belief that improved water sources characteristically supply clean water (Shaheed et al. 2013; Onda, LoBuglio, and Bartram 2012). In particular, piped water networks supplying intermittent water supplies (through unpressurized distribution systems), have been shown to provide variable water quality and have been linked to greater risk of waterborne disease (Kumpel and Nelson 2013; Shaheed et al.; Hunter, Zmirou-Navier, and Hartemann 2009). However, there are no published prospective studies evaluating the health impacts of treating water from improved sources in urban settings in low-income countries. In order to better target funding priorities, rigorous evaluations are needed to assess if there are substantive health benefits from disinfecting water from improved sources, such as piped networks.

Central treatment and delivery of water supply is prohibitively expensive for municipal governments in low-income countries to implement to their rapidly expanding low income urban populations in the near future. Investment in piped water networks requires capital for construction, rehabilitation, and long-term maintenance of piped water infrastructure—investments which have been persistently difficult for cities in low-income countries to make. Effective centralized treatment also performs best at delivering clean water to the tap when such systems are fully pressurized. In-home disinfection technologies such as chlorine products and filters have been developed and promoted in an attempt to address the shortcomings of shared water points in delivering high quality water at the point of use (POU). While POU technologies are efficacious when used correctly and on a consistent basis, it has proven difficult to motivate low-income households to adopt such technologies and maintain use over time (Luby et al. 2008).

Despite the historical difficulties in implementing city-wide and household-level approaches to safe water, little work has been done to explore decentralized water treatment technologies for urban areas. This intermediate space has great potential for the development of scalable and cost-effective solutions in urban low-incomes areas.

We propose to conduct a blinded, cluster randomized evaluation of automated chlorination at shared water points in Dhaka to evaluate the potential benefits on child health.

Research objectives

We will address the following research questions:

1. What is the impact of automated chlorination at shared water points on chlorine residual levels in household stored drinking water, microbial water quality of stored water, and user satisfaction?
2. What is the impact of automated chlorinated of drinking water on the longitudinal prevalence of under-five child diarrhea, respiratory illness, under-five child weight-for-age and child height-for-age, as well as selected biomarkers of inflammation and enteric infections?

Study design

We will conduct a blinded cluster randomized controlled trial to evaluate the health and economic impacts of having access to automatically chlorinated water. The unit of randomization will be shared water points that typically serve 5-50 households. We will enroll all households with at least one child under age five years accessing the water points. Households will be enrolled before installation of chlorine devices, and a baseline survey will be conducted of water quality and diarrhea. Following this baseline, households will be randomly assigned to control or treatment groups. The chlorination devices will be installed at the treatment group water points, while a placebo doser (delivering vitamin C) will be installed in the control group (study households would not be informed until the end of the study regarding which type of doser they received). All households will be surveyed every 2 months for a total follow up period of 14 months (7 survey rounds).

Treatment	***Control***
Automated chlorination	*Placebo doser*
(50 clusters, 500 children)	*(50 clusters, 500 children)*

Our primary outcome of interest will be longitudinal prevalence of diarrhea among children under the age of 5 years as reported by their primary caregiver. Secondary outcomes will include under-five child weight-for-age, height-for-age, longitudinal prevalence of respiratory illness, concentrations of C-reactive protein (CRP) and total immunoglobin G (IgG) among children under-five (general markers of infection), the mean number of enteric pathogens detected in child stool, self-reported cases of diarrhea requiring hospitalization, and the associated costs of seeking and obtaining treatment. Intermediate outcomes to assess success and compliance with the intervention will include levels of residual chlorine and levels of microbial fecal contamination at the handpump and in household stored drinking water, as well as user satisfaction and perceptions of the technology.