Distribution Agreement

In presenting this thesis or dissertation as a partial fulfillment of the requirements for an advanced degree from Emory University, I hereby grant to Emory University and its agents the non-exclusive license to archive, make accessible, and display my thesis or dissertation in whole or in part in all forms of media, now or hereafter known, including display on the world wide web. I understand that I may select some access restrictions as part of the online submission of this thesis or dissertation. I retain all ownership rights to the copyright of the thesis or dissertation. I also retain the right to use in future works (such as articles or books) all or part of this thesis or dissertation.

_____ _____

Anila Naz Date

Evaluation of the Provision of Hand-washing and Drinking Water Stations on Provider and Patient Knowledge and Practices in Zambia

By

Anila Naz
Degree to be awarded: Master of Public Health
Hubert Department of Global Health

_____

Robert Quick, MD, MPH
Committee Chair

_____

Roger Rochat, MD
Committee Member

Evaluation of the Provision of Hand-washing and Drinking Water Stations on Provider and Patient Knowledge and Practices in Zambia

By

Anila Naz
Bachelor of Medicine and Bachelor of Surgery
Dow Medical College, Pakistan
1994

Thesis Committee Chair: Robert Quick, MD, MPH

An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health in Hubert Department of Global Health
2011

Abstract

Evaluation of the Provision of Hand-washing and Drinking Water Stations on Provider and Patient Knowledge and Practices in Zambia

By Anila Naz

Back ground: Many health facilities in developing countries, particularly in rural regions, lack access to safe water supplies and hand-washing at facilities, placing patients and health workers at risk for health facility-acquired infections. In Zambia, only 46% of populations have access to improved drinking water sources and 43% using improved sanitation facilities in rural areas and high prevalence of diarrhoea in children under the age of 5 years. To address these problems hand-washing and drinking water stations were installed in 8 rural health facilities and evaluated their use by health workers for patient care and education.

Methods: An intervention trial with cross sectional sampling design was used. Primary baseline surveys were conducted which included a sanitary assessment of each health facility, surveys of knowledge and practices of health workers, exit interviews with clinic clients, and household surveys of clients for their knowledge and practices. We had tested stored water in clinics and households for residual chlorine as an objective measure of water treatment, and observed hand-washing technique in clients. It was followed by distribution and installation of the hand-washing and drinking water stations (consisting of 40-liter plastic buckets with spigots and lids, metal stands, chlorine solution, and soap) to the rural (CHAZ) health facilities as well as training of health staff in safe water and hygiene. After four months of the intervention a follow-up survey was conducted using the baseline survey instruments.

Results: At follow-up visit, of the 8 health facilities, 7 (87.5%) facilities were using installed water stations, chlorination of water was reported by 4 (50%) facilities and chlorine residuals were present in stored drinking water of 2 (25%) facilities. Compared to baseline a higher percentage of clinic clients were using improved water storage containers (19% vs. 61%), had detectable residual chlorine in their stored water (3% to 15%) and could demonstrate correct hand-washing procedure (42% vs. 65%).

Conclusion: This simple intervention had resulted in improvements in water treatment and storage practices in health facilities and households of health facility clients, and in the ability of clients to demonstrate proper hand-washing techniques.

Evaluation of the Provision of Hand-washing and Drinking Water Stations on Provider and Patient Knowledge and Practices in Zambia

By

Anila Naz
Bachelor of Medicine and Bachelor of Surgery
Dow Medical College, Pakistan
1994

Thesis Committee Chair: Robert Quick, MD, MPH

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in Hubert Department of Global Health
2011

Acknowledgements

To Linda Capewell, Epidemic Intelligence Service Officer at the Waterborne Diseases Prevention Branch, Centers for Disease Control and Prevention, Atlanta, whose hard work during the baseline survey for implementation of the intervention, data collection and assistance in collecting data in the follow-up evaluation made this study possible.

To Sandie Simwinga, program officer at Churches Health Association of Zambia, whose efforts as master trainer at the rural health facilities and community demonstrations in the field for the safe water and hand hygiene practices made this project successful.

To Mathias Tembo, Tropical Diseases Research Centre Zambia, for facilitating this project, for putting together the field team, and coordinating field visits. His assistance and efforts in implementing this project in both original eight facilities and additional 150 health facilities including Ministry of Health facilities are much appreciated and will make a difference in the lives of the Zambian people.

To Diana Kana, Denson Ngona , Innocent Chilu, Olipa Phiri and Shepherd Nehanda, whose assistance in conducting staff and client exit interviews at the baseline and follow up assessment was essential to the success of the project.

To Dr. Robert Quick for planning and designing this project, being an amazing mentor and providing guidance with patience throughout the entire research process. I will never forget your efforts to enable my visit to Zambia and connect me with so many people in the field. Your enormous experience and knowledge in the field of safe water and hygiene interventions is an inspiration for the students. I am grateful for the opportunity to work with you and will try to follow your excellent work practices.

To Dr. Roger Rochat for providing continuous support and encouragement as an advisor in order to complete my academic work in the field of Public Health.

To the people of Zambia, whose cooperation and willingness to adapt the safe water and hygiene practices learnt through this project made this intervention successful.

To my family and especially my husband for providing me full support in my decision and who made my journey possible in the field of Public Health. I would not have achieved this milestone without your love and assistance.

Table of Contents

List of Tables

List of Figures

Definition of Terms

CDC	Centers for Disease Control and Prevention
CHAZ	Churches Health Association of Zambia
DHHS	Department of Health and Human Services
DPD	N, N diethyl-p-phenylenediamine
HIV	Human Immunodeficiency Virus
MDG	Millennium Development Goal
PAHO	Pan American Health Organization
PEPFAR	United States President's Emergency Plan for AIDS Relief
PMTCT	Prevention of mother-to-child transmission services
POU	Point-of- Use water treatment
SWS	Safe Water System
TDRC	Tropical Diseases Research Centre Zambia
TOT	Training of trainers
unicef	United Nations International Children's Emergency Fund
WHO	World Health Organization

Chapter 1: Introduction

1.1 Background

Diarrheal disease is a leading cause of morbidity and mortality in developing countries accounting for approximately 1.8 million deaths each year mostly in children under 5 years old. Approximately 88% of diarrheal cases are caused by a lack of access to safe water, inadequate hygiene and insufficient sanitation facilities (Pruss-Ustun A, 2008). In 1972 about 950 million people lacked access to safe drinking-water supplies (White, Bradley and White). Since then considerable efforts have been made to make safe water supplies available, especially to the poor population in the developing countries (T. F. Clasen, 2009). The World Health Organization (WHO) estimates that in 2006 still 884 million people in the developing world lacked access to improved water supplies (T. F. Clasen, 2009). The lack of access to safe water in Zambia, a country that ranks in the bottom 10% of the human development index, is similar to other developing countries with only 58% of the population having access to improved water sources (C, 2004; Olembo L, 2004) and this access is further reduced to 46% in rural areas (unicef, 2008). This is accompanied by a rise in proportion of the population without access to good sanitation by over 10% from 26% in 1991 to 36.1% in 2006 (Report, 2008). In the 2001-2002, Demographic Health Survey Zambia, the two-week period prevalence of diarrhea in children under the age of 5 was 21% (D.H.S, 2001-2002).

The definitive solution to inadequate access to safe water is the universal provision of safe water supplies and adequate sanitary infrastructure, to the world's poor. However, this would be extremely expensive and will require an investment of tens of

billions of dollars and will take decades to save the vulnerable population (Banerjee, McFarland, Singh, & Quick, 2007). To address this problem alternative technical interventions have been developed including chemical treatment, solar irradiation, filtration, and combined approaches. One alternative is the Safe Water System (SWS). The SWS is an inexpensive point-of-use (POU) intervention consisting of three components: treatment of water using a locally produced 1.0% sodium hypochlorite solution, safe water storage, and improvement in hygiene (including hand-washing) and water storage/treatment practices through behaviour change communication. The SWS has been widely accepted as one of the most effective and cost-efficient methods for providing safe water in the developing world (Banerjee, et al., 2007; Mintz E, 2001). In Zambia, the socially marketed SWS water treatment product has the brand name Clorin.

Many health facilities in the developing world, particularly in rural regions, lack access to hand-washing or drinking water facilities. Consequently, health workers are unable to wash their hands between patients or provide safe drinking water for administration of oral medications. A pilot project in Kenya demonstrated that the provision of hand-washing and drinking water stations, consisting of 60-liter buckets with lids and taps, metal stands, WaterGuard solution and soap, along with an education program, increased water treatment and hygiene knowledge and practices in health workers and their patient(CDC, 2005; Parker et al., 2006). The program was expanded in 2006 and an evaluation suggested that the vast majority of health facilities maintained and used the stations in practice and teaching their clinic patients (Sreenivasan Nandini, November 9, 2009). The main impediment to further expansion of this program has been the lack of commitment of resources by the Ministry of Health for its dissemination. The

ministries of health typically lack resources for additional, evidence-based interventions beyond traditional public health programs. An alternative to ministries of health for diffusion of this type of innovation are networks of faith-based organizations, which, in some countries, manage a large proportion of health facilities. Zambia is one such country, in which 138 rural clinics are run by the Churches Health Association of Zambia (CHAZ). Department of Health and Human Services (DHHS) Center for Faith-Based and Neighborhood Partnership has provided a grant to conduct a pilot program of this intervention with CHAZ in early 2010.

1.2 Millennium Development Goal (MDG) 7

Safe drinking water and access to basic sanitation are the essential needs for the health of any population. This important issue is also included in the Millennium Development Goals (MDG). Therefore, Goal 7, target 10 of the MDG aims at halving by 2015 the proportion of people without sustainable access to safe drinking water and basic sanitation (WHO). Achieving this MDG will also contribute to other MDGs, such as MDG 4, for reducing child mortality.

1.3 Significance

Several studies have demonstrated that point-of-use water treatment and hand-washing with soap reduce the risk of diarrheal diseases (T. Clasen, Roberts, Rabie, Schmidt, & Cairncross, 2006). However studies also reported that point-of-use water treatment adds to the time and expense required of consumers (Mintz E, 2001), and significant reduction in the incidence of diarrheal disease requires change in behavior of

the consumers (Mintz E, 2001; Stanton & Clemens, 1987). Therefore it was also suggested that combination of elements of water storage, water treatment and health education into a single program will have a greater impact on public health (Mintz E, 2001). SWS can be used as a platform to facilitate the promotion of diarrhoea prevention strategies. To increase utilization and sustained use of the SWS, CARE explored alternative implementation strategies one of which was training health workers at health facilities to motivate their clients to adopt safe water system. From 2003-2008, CARE Kenya has implemented drinking water and hand-washing stations in 109 health facilities, educated health workers on proper hand-washing and water treatment and encouraged them to communicate this information to their patients (Parker, et al., 2006; Sreenivasan Nandini, November 9, 2009). An evaluation of this program demonstrated an increase in water treatment practices and knowledge of proper hand-washing procedure among clinic clients.

This project had modelled CARE Kenya, whose main approach has been to implement elements of an evidence-based intervention: the Safe Water System (SWS). The objective of the project was to implement and evaluate a safe water and hygiene program in rural health facilities in Zambia.

1.4 Objectives

1. Collect baseline data from health facilities and clients in target rural health facilities managed by the Churches Health Association of Zambia in Luapula, Copperbelt, Northwestern, and Southern provinces to be used for program evaluation purposes.
2. To install hand-washing and drinking water stations in target health facilities for proper hygiene among health workers and provide safe water.
3. To train health care providers regarding water treatment and hand-washing with soap.
4. To motivate health workers to train their clients on water treatment and proper hand-washing procedure.

Chapter 2: Literature Review

2.1 Burden of diarrheal diseases and role of water, sanitation, and hygiene in diarrheal diseases

Diarrhea is a leading cause of morbidity and mortality in children less than five years of age in low and medium income countries. The reported risk factors associated with high incidence of diarrhea include open defecation in the living area by children, lack of maternal handwashing before preparing food, and lack of attention to garbage and feces disposal. Failure to practice effective hygiene methods for personal and environmental protection results in continuous contamination of water resources including fecal contamination (S. Luby, 2001). The consumption of contaminated water is an important route of transmission of enteric pathogens in many regions of the world lacking infrastructure to guarantee water quality and safe management of human waste (Quick et al., 2002).

Water-related diseases continue to be one of the major health problems globally. The possible major strategy for tackling this problem is the provision of protected resources and better quality of water such as boreholes, standpipes or well. However, these facilities would be located at some distance from the home, requiring collection and transport from the source and subsequent storage of water within households (Wright, Gundry, & Conroy, 2004). Therefore, the risk of contamination could not be eliminated completely. The literature shows that progressive diverse simple alternative techniques have been studied in different countries among different settings ranging from focus on providing effective behavioral education, improving the storage of water and treating water to make it safe for drinking and hand-washing.

2.2 Intervention trials and studies for point of use (POU) water treatment methods

2.2.1 Community based Interventions

The first case-control study of the promotion of hand-washing in communities with a high incidence of diarrhea was published by Stanton and Clemens' in 1987(S. Luby, 2001; Stanton & Clemens, 1987). The intervention was an 8-weeks community based health education program focusing on three central messages: proper hand-washing before food preparation, defecating away from the house at a proper site, and suitable disposal of waste and feces. The education program included both small group discussions and larger meetings, with posters, games, and pictorial stories. Soap was not provided to the households. The intervention and control communities did not differ in defecation practices or in the prevalence of feces and garbage. Mothers in the intervention area were more likely to be observed washing their hands before preparing food (49%) than in the non-intervention areas (33%). The intervention communities had a 26% lower incidence of diarrhea ($p<.001$).

In 1989, Han and Hlaing, published the results of their study for hand-washing promotion conducted in Rangoon Burma. In this study mothers were asked to wash their hands after defecation and before preparing the three main meals. They reported 30% fewer episodes of diarrhea in the intervention households (Aung Myo & Thein, 1989). In two related community based studies for hand-washing promotion the noted reduction in diarrhea was 39% (Pinfold & Horan, 1996) and 62% (Shahid, Greenough, Samadi, Huq, & Rahman, 1996) respectively in the intervention communities as compare to the non-intervention communities.

The Centers for Disease Control and Prevention (CDC) and Pan American Health Organization (PAHO) developed the Safe Water System (SWS), a household-based approach for making water safe. It is simple, inexpensive, and easy-to-disseminate intervention to improve drinking water quality and hygiene in developing countries. It consists of point of use water chlorination, improved household water storage, and behavior change related to water handling (Parker, et al., 2006; Quick, et al., 2002). Field trials of SWS have demonstrated that regular use of the SWS results in a reduction of risk of diarrhea ranging from 21% -90% (Parker, et al., 2006). Through the use of this intervention, street vendors in Guatemala have improved the quality of water used to make beverages and wash utensils, and health workers in cholera wards in Guinea-Bissau have prevented contamination of bulk supplies of oral rehydration solutions (CDC; Quick, et al., 2002).

After seeing the successful application of this intervention, The Ministry of Health of Zambia invited the CDC to conduct a field trial to test its impact on water quality and health in the city of Kitwe. This was the first community-based implementation of this project in Africa and conducted in 1999. Ninety seven percent of the intervention households reported using disinfectant and 72-95% had measurable chlorine in their water. Significant increase in the safe storage of water from 41% to 89.2% along with 48% lower in the risk of diarrheal diseases was noted in the intervention households than for controls(Quick, et al., 2002).

Focusing at the point of use rather than point of delivery, treating water at the household level minimizes the risk of recontamination. Two recent systematic literature reviews and meta-analyses revealed that interventions to improve water quality at the

point of use are generally effective for preventing diarrhea (T. Clasen, Schmidt, Rabie, Roberts, & Cairncross, 2007; Fewtrell et al., 2005). Studies have also reported that hand hygiene is an important measure of preventing diarrheal diseases and nosocomial infections in community and clinical settings, respectively(Anna B, 2007). Several studies have also shown that regular hand-washing with soap had reduced the incidence of respiratory tract infections and diarrhea among children younger than five years. A quantitative systematic review documented that hand-washing lowered risk of respiratory tract infections, with risk reductions ranging from 6% to 44% respectively (Rabie & Curtis, 2006).

A randomized controlled trial to in a squatter settlement in Karachi, Pakistan reported 50% lower incidence of pneumonia in children less than 5 years and 53% lower incidence of diarrhea in children younger than 15 years in the households that received soap and hand-washing promotion (Luby SP, 2005).

However different studies have shown that community interventions where hand-washing with soap was promoted required frequent visits of the households by workers to encourage the community to continue their health related behavior (S. P. Luby et al., 2009).

To evaluate the effects of interventions to promote hand washing on diarrheal episodes in children and adults, a team conducted a review of literature including fourteen randomized control trials, where the focus of intervention was an institution (e.g. day-care centre), household or community. It compared interventions to promote hand washing or a hygiene promotion that included hand washing with no intervention to promote hand washing. Interventions promoting hand washing resulted in 29% reduction

in diarrhea episodes in institutions in high income countries and a 31% reduction in such episodes in communities in low- or middle-income countries (Ejemot, Ehiri, Meremikwu, & Critchley, 2008).

2.2.2 Health facility based Interventions

Many health facilities in the developing world, particularly in rural regions, lack access to hand-washing or drinking water facilities. Consequently, health workers are unable to wash their hands between patients or provide safe drinking water for administration of oral medications.

In 2002, U.S. government researchers in Uganda developed a “Basic Care Package”. This was done in partnership with the Ugandan Ministry of Health and Ugandan Non-profit organizations. This aim was to prevent most debilitating opportunistic infections among people living with HIV. Point-of-use safe water system was one of the five essential elements of the package. The other elements of the Basic Care Package were cotrimoxazole (a powerful antibiotic), insecticide-treated bed nets to prevent malaria, screening and management of sexually transmitted infections (STIs), prevention of mother-to-child transmission (PMTCT) services, and counseling (e.g. condom use and family planning). The package was simple to deliver at primary health care centers. As of December 2009, Uganda, Kenya, Nigeria, Ivory Coast and Ethiopia have expanded distribution of this program. The result of each intervention has been shown improvement in health and remained cost effective. Combining the safe water system with cotrimoxazole reduces diarrhea episodes among people with HIV by 77%

and days of work and school lost due to diarrhea by 47%. Due to its success this Basic Care Package is now being scaled up under PEPFAR (G.H.I.) .

The SWS program has been successfully implemented in over 25 countries through a social marketing approach. To enhance program impact, CDC has collaborated with partners in Kenya to implement the SWS in clinics through the installation of simple hand washing and drinking water stations in health facilities, training of health workers, and education of health facility clients. Recent evaluations have suggested that this program resulted in sustained use of the water stations in health facilities and improvement of water treatment and hand-washing behaviors in homes of health facility clients (Parker, et al., 2006).

Chapter 3: Methods and Results

3.1 Methods

This project included three components: baseline survey, distribution of the intervention to health facilities and follow up evaluation for impact assessment after four months.

3.1.1 Study design

We used a cross sectional sampling design for our intervention trial. We conducted a primary baseline survey which included a sanitary assessment of each health facility, surveys of knowledge and practices of health workers, exit interviews with clinic clients, and household surveys of clients for their knowledge and practices. The primary baseline survey was followed by distribution of hand-washing and drinking water stations to the CHAZ health facilities as well as training of health staff in safe water and hygiene education. After four months of the intervention we conducted a follow-up survey using the same strategy as at baseline in order to collect information from the facility level, clinic staff and clients who attended the clinic.

3.1.2 Evaluation sites

In a recent needs assessment, CHAZ identified deficiencies in water supply and hygiene infrastructure as the priority problems in 15 health centres in 4 provinces: Copperbelt, Northwestern, Luapula, and Southern (figure 1). Zambian Ministry of Health (MOH) noted that the Southern province was another region which needed safe water and hygiene interventions.

Figure 1: Project's evaluation sites in Zambia (arrows indicate the four provinces where health facilities were identified for intervention of the project)

Source: Maps of World (http://www.mapsofworld.com/zambia/zambia-political-map.html, 2010)

3.1.3 Baseline survey

We carried out the baseline evaluation at these 15 health facilities from February 2 –February 25, 2010. The baseline evaluation included three components. First, we conducted a sanitary assessment of each clinic to determine current staffing, and assessed the water and sanitation infrastructure. Second, we asked health workers to fill out a self-administered survey of their knowledge and practices of water treatment, as well as their hygiene and patient education practices. Finally, we conducted exit interviews with

clinic clients assessing their knowledge regarding water treatment and hygiene. This was then followed by a home visit to observe water and sanitation facilities as an indicator of confirmed water treatment practices.

3.1.4 Study population

The baseline evaluation population included the staff and clients of 15 health facilities.

3.1.5 Sample size

For the staff survey, we did attempt to interview all staff members in rural dispensaries and health centers and all outpatient staff in rural hospitals. Our target sample size for the clinic client survey was based on assumptions of Clorin utilization of 5% at baseline and an increase in use to 10% at follow-up. In this evaluation our target groups were pregnant mothers or mothers of children less than 5 years old at each health facility. Interview of the father or grandmother for example was permitted if they were the primary caretaker of the child. We consecutively invited the clients to participate in the evaluation if they were a resident of the catchment area and within 10 km of the selected facility.

3.1.6 Evaluation instrument

3.1.6.1 Health facility assessment form

We carried out a brief evaluation at each of the 15 selected health facilities to assess the health facility activities in relation to water access and availability of soap, hand-washing promotion, Clorin promotion, and Clorin utilization at the health facility.

Interviews were conducted with the in-charge nurse, the hospital director, or the environmental health technician in the health facilities. Access to water for hand-washing and drinking water stations were directly observed (Appendix 1). We used the same instrument at follow up survey, to assess the impact of intervention.

3.1.6.2 Health worker survey

We asked all available health workers at the clinic to complete a self-administered questionnaire, which included questions on demographic characteristics, previous training on safe water and hygiene practices, promotion of hand-washing and Clorin utilization and water storage, along with knowledge of hand-washing, water storage and treatment. The questionnaire was written and answered in English. A total of 33 health workers were interviewed at baseline.

At follow-up, we distributed a second self-administered questionnaire to health workers to assess the retention of water treatment and hand-washing knowledge and practices from their training and to determine if health staff members were incorporating the new information into their patient-teaching (Appendix 2).

3.1.6.3 Clinic client survey

The client surveys included a questionnaire to assess the baseline demographics and socioeconomic characteristics, knowledge of the clinic clients in relation to sources, treatment and storage of water, sanitation and hygiene practices. Due to the large diversity of languages present in Zambia, evaluation questionnaires were administered in the local language used by clinic clients present at the health facility. These languages

included Bemba, Tonga, Kaonda, English, and Lunda. A trained interviewer administered the questionnaire to consenting study participants at their households.

In each health facility, after receiving informed consent we consecutively enrolled clients who were residents within the catchment area of the respective health facility. This continued until all available mothers were interviewed or a sample size of at least 10 surveys per health facility was met. Once we administered the main sections of the questionnaire to enrolled clients at the health center, a trained interviewer accompanied each enrolled client to their household to complete the household observation section of the questionnaire, including residual chlorine testing of household drinking water. The residual chlorine was tested by using calorimetric method; N, N diethyl-p-phenylenediamine (DPD) (LaMotte Company, Baltimore, MD). A total of 80 study participants were selected and interviewed at baseline.

The questions on the follow-up survey included: what patients were taught about water treatment and hand washing during their visit to health facility; reported water treatment and hand washing practices; patients' motivations to buy and use Clorin; availability of resources to buy the Clorin and soap; and lastly, hand hygiene practices. We accompanied the patients who were interviewed at the health facility to their homes in order for the field worker to observe the water, sanitation, and hygiene facilities in their dwelling (Appendix 3). A total of 80 study participants were selected and interviewed at the follow up visit.

3.1.7 Evaluation assistant training

The investigators were accompanied by four evaluation assistants who were trained by the investigators and colleagues from the Tropical Diseases Research Centre Zambia. The evaluation assistants were fluent in the local language and assisted in conducting staff and client exit interviews at the baseline and follow up assessment.

3.1.8 Interview procedure

Our colleague from CHAZ assisted us in approaching the In-charge of the health facility at each health facility in order to discuss the surveys and request permission to conduct the health facility assessment, and staff and client surveys. After permission was granted, we and our evaluation assistants met with clinic staff, obtained their consent, and conducted the interviews. Following the provider interviews, we conducted exit interviews of clinic clients. At the follow up visit we also measured the impact of the intervention on clients' knowledge and practices.

1.9 Project implementation

At the baseline, 15 health facilities were expected to receive the intervention. However due to difficulties in timely provision of funding and human resources, implementation of the project was conducted at 8 health facilities where baseline data was obtained. Program implementation involved three components: training of clinic staff, community demonstrations and distribution of hand-washing and drinking water stations. Training of health staff was first conducted in Ndola for Copperbelt and Northwestern provinces on February 12, 2010. On-site training on safe water supply and

hand hygiene was also conducted by CHAZ at Copperbelt, Luapula and Southern provinces from April 24-May 11, 2010. It was designed for both clinic staff and volunteers already working for the water project. In addition to that, in Copperbelt province a demonstration on safe water and hygiene for the community was also conducted.

3.1.9.1 Training of clinic staff

Training of clinic staff was a 4 hour program, which covered 8 training modules, with an additional pre-test and post-test module on the safe water system and hand hygiene. The Safe Water System curriculum provided by CDC was used as a guide. The course covered several key areas which are as follows:

1. Common causes of diarrhea
2. A description of the safe water system and its importance
3. Demonstration of proper hand-washing techniques
4. A TOT (training-of-trainers) on:
    - how to teach water safety information to their patients
    - how to address patient questions and concerns
    - how safe water improves the lives of those most at risk for diarrheal disease such as people living with HIV/AIDS and their families.

We divided the onsite training into two sessions. CHAZ conducted the session in the morning at the clinics using the Safe Water System curriculum provided by CDC. In the afternoon, sessions were focused on community demonstrations and ‘Hands on

Practicum', and were conducted by the clinic staff of the health center and CHAZ. We oriented the participants and reminded them of the correct hand washing methods and the importance of the proper use of soap as well as treatment of water through chlorination. Participants demonstrated their knowledge on hand washing and were taught how to make water stations.

We distributed one hand-washing and one drinking water station (Figure 2) to each health facility and included the provision of a starter supply of Clorin and soap. We recommended that the water stations should be placed in a location where it can be easily accessed by the clinic staff and clients attending the clinic. Safe water stations were placed in patient waiting areas, wards where hand-washing between patients was a necessity, or where patients were receiving medications and needed safe drinking water.

Figure 2: Project's Safe Water Station.

3.1.10 Follow-up Visit

In July 2010 we conducted a follow up visit to assess the impact of the intervention. We collected the follow-up data on only those 8 health facilities that received the intervention. Therefore results will only be reported on those 8 facilities. This was carried out by using the same survey instrument utilized at the baseline visit. We interviewed a total of 37 clinic staff members at the health facilities. We evaluated a new convenient sample of 80 patients who were exiting these clinics to assess whether teaching by clinic staff on water treatment and hand-washing practices had been improved and if more clients were observed implementing these practices in the household. Information collected at follow-up was similar to information collected at baseline.

3.1.11 Informed Consent

We obtained a verbal informed consent from all evaluation participants. The personal identifiers were removed at the time of data entry. The risks encountered to the participants were no greater than those ordinarily encountered in daily life. The CDC Institutional Review Board Advisor declared that the project was non-research since it involved the implementation and evaluation of a proven health practice. I was not required to submit to IRB at Emory University as I did not conduct human subject research.

3.1.12 Data management and analysis

The data were entered into Microsoft Access. Although the clinic clients selected at baseline were different from those selected at follow-up, it was assumed that they would be from the same population who received knowledge from the clinic staff. Variables of interest were analyzed descriptively to assess knowledge and behaviors regarding water storage and treatment, and hand hygiene. These variables were then assessed by reported water treatment with Clorin and hygiene practices, as well as whether or not the four recommended steps of hand washing were demonstrated correctly. To determine predictors of water treatment practice, we compared educational levels of users and non-users of Clorin and proper hand washing techniques. Predictors of knowledge of effective hand-washing were determined by comparing the percentages of four hand-washing steps correctly indicated as demonstrated by population subgroups. Because personal identifiers were not included on questionnaire forms, it was not possible to confirm the percentage of health workers and patients interviewed both at baseline and follow-up. For this reason, the independence of baseline and follow-up responses could not be determined and we believed it was preferable to present the data descriptively and not conduct statistical tests. SAS software 9.2 English was used to perform the analysis.

3.2 Results

At baseline 15 health facilities were enrolled in the evaluation. However due to constraints of funding and lack of availability of trainers who could provide timely training and implementation of the intervention, the intervention had been implemented in only eight facilities at the time of the follow up visit. The following sections will describe the analysis of the survey of eight health facilities, their staff and clients in a stepwise manner. For each survey, first the results of analysis of baseline data from the eight health facilities will be discussed followed by comparative analysis of the facilities after implementation where water interventions were implemented and follow-up evaluations were conducted.

3.2.1 Health facilities assessment

3.2.1.1 Basic description of eight health facilities

At base line the median number of health staff working at the eight health facilities was 7.5 (range 5-16) and of the total 68 staff of all facilities 4 had received training on safe water and hand hygiene (Table 1). The median number of patients attending the clinics per day was 82.5 (range 35-200). Overall 26 wards reported in all eight health facilities. The median number of wards in those 8 facilities was 3 (range 0-8) and median number of beds was 39 (range 0-75).

Table 1: Number of staff, patients, wards and beds at 8 health facilities at baseline, by province, CHAZ, CDC, and Emory University collaborative water project, Zambia 2010

Province	Health facility	[a]Total Staff	[b]Female staff	[c]Received training	[d]Daily attendance of patients	Number of wards	Total Beds
Copperbelt	Fiwale	6	4	4	140	4	48
	Kavu	16	11	0	65	8	75
	Mishikishi	11	6	0	200	3	34
	Mupapa	8	5	0	60	1	16
Luapula	Chipili	11	0	Dk [e]	100	3	39
	Mambilima	6	3	Dk	100	6	72
	Mbereshi	5	4	Dk	60	0	0
Southern	Njase	5	5	0	35	1	4
Total	8	68	38	4	760	26	288
Median (Range)	----	7.5 (5-16)	4.5 (0-11)	---	82.5 (35-200)	3 (0-8)	36.5 (0-75)

[a] Total number of staff working in each facility may not equal total number of staff interviewed as staff may not be available at the time of interview or declined interview
[b] Qualified female that works with patients
[c] Total number of staff trained on safe water and hand hygiene
[d] Total population of patient seeing by facility staff everyday
[e] DK=Do not know

At follow-up visit the median number of health staff working at the eight health facilities was 6.5 (range 3-19) and of the total 70 staff of all facilities 20 had received training on safe water and hand hygiene (table 2). The median number of patients attending the clinics per day in eight health facilities was 55 (range 30-120. Overall 28 wards reported in all eight facilities. This increase in number of wards was due to renovation at Kavu rural health center. The median number of wards in those 8 facilities was 3.5 (range 0-10) and median number of beds was 20 (range 0-90).

Table 2: Number of staff, patients, wards and beds at 8 health facilities at follow-up visit, by province, CHAZ, CDC, and Emory University collaborative water project, Zambia 2010

Province	Health facility	[a]Total Staff	[c]Female staff	[c]Received training	[d] Daily attendance of patients	Number of wards	Total Beds
Copperbelt	Fiwale	7	4	2	75	4	48
	Kavu	17	11	3	50	10	85
	Mishikishi	11	6	2	60	4	33
	Mupapa	3	1	1	60	1	4
Luapula	Chipili	3	3	2	30	3	7
	Mambilima	19	7	0	120	5	90
	Mbereshi	4	3	4	50	0	0
Southern	Njase	6	5	6	50	1	4
Total	8	70	40	20	495	28	271
Median (Range)	----	6.5 (3-19)	4.5 (1-11)	---	55 (30-120)	3.5 (0-10)	20 (0-90)

[a] Total number of staff working in each facility may not equal total number of staff interviewed as staff may not be available at the time of interview or declined interview
[b] Qualified female staff that works with patients
[c] Total number of staff trained on safe water and hand hygiene
[d] Total population of patient seeing by facility staff everyday

3.2.1.2 Sources of water, water storage and treatment, and hygiene practices at the facilities

At baseline all health facilities had access to borehole. Of the 8, one (12.5%) facility had an access to piped water in addition to borehole (table 3). 7 (87.5%) health facilities had water source on premises of the facility. However access to tap water which was connected to a borehole or water tank was dependent on function of the taps and duration of availability of electricity. Of the 8 facilities two (25.0) facilities (Chipili and Mbereshi RHC) in Luapula province had no tap water access and five (62.5%) health facilities in Luapula and Copperbelt provinces had intermittent access to access to tap water. Therefore when there is no electricity or no water available from the borehole, staff from the two health facilities who had no access to tap water had to travel 1-2

kilometer to the lake or river to obtain water for their facility. Of the 8 health facilities 7 (87.5%) health facilities had no or intermittent access to tap water and storing the water in plastic buckets to be used by health staff. One (12.5%) health facility (Njase) in Southern province had full access to tap water all the time. However at follow-up visit improvement reported in the sources of water at the health facilities. Of the five facilities at baseline which had only borehole as a source of water, at follow-up visit four facilities had additional piped water and one facility had piped water and also practicing brining water from river, lake and pond in time of need (table 3). Therefore borehole and piped water reported as the main source of drinking water at four (50.0%) facilities. One (12.5%) health facility (Njase) in Southern province had full access to piped water present in the premises of the facility. Of the eight health facilities, six (75.0%) facilities had intermittent access to tap water. All (100%) facilities had the source of water in their premises.

A) Drinking water source and storage

The main source(s) of water at the eight facilities were in use both for drinking, hand-washing and storage of water for drinking and hand-washing (table 4). At baseline five (62.5%) facilities reported using only piped water (tap) for drinking. However due to intermittent access to water because of power shortage these facilities were storing water either in plastic buckets or tubs to be used later both for drinking and hand-washing purposes. Of the 8, one (12.5%) facility was using both piped water and plastic bucket with lid, and 2 (25.0%) facilities were using only buckets for drinking water purpose. At baseline survey three (37.5%) facilities had total 4 plastic buckets and of those two (50.0%) buckets had lids. Plastic buckets with tap were not observed in any facility.

At follow-up same five (62.5%) facilities were using only piped water, one (12.5%) facility was using both piped water and storage container and two (25.0%) facilities were using only storage containers (table 4). Those facilities which were using only piped were also storing their water in plastic buckets or tubs at the time of water shortage to be used later for both hand-washing and drinking purposes. Modest improvement noted in the use of project water stations. There were total of 6 containers in three facilities and among those three (50.0%) were plastic buckets with lids and three (50.0%) were project water containers.

Table 3: Comparison of water sources and access to water at baseline and follow up, at 8 health facilities, CHAZ, CDC, and Emory University collaborative water project, Zambia 2010

Characteristics	Baseline n=8 (%)	Follow-up n=8 (%)
Main Water sources		
Only Borehole	5 (62.5)	1 (12.5)
Only Piped water	0 (0.0)	1 (12.5)
Borehole and Piped water	1 (12.5)	4 (50.0)
Lake, Pond, River or Dam and Bore hole	2 (25.0)	1 (12.5)
Lake, Pond, River or Dam,Bore hole and piped water	0 (0.0)	1 (12.5)
Water source on premises	7 (87.5)	8 (100.0)
Access to Tap Water [a]		
None	2 (25.0)	1 (12.5)
Intermittent	5 (62.5)	6 (75.0)
Full access	1 (12.5)	1 (12.5)

[a] None=no access to tap water included those facilities where taps were not present or no longer functional, Intermittent tap water access refer to facilities where taps were intermittently functional due to power shortage or damaged water types, full access to tap water means taps at health facility are fully operational and provide a 24 hour water supply.

Table 4: Comparison of observed use of drinking water source and storage practices at baseline and follow up, at 8 health facilities, CHAZ, CDC, and Emory University collaborative water project, Zambia 2010

Characteristics	Baseline n=8 (%)	Follow-up n=8 (%)
Drinking water access in facility		
Piped water only [a]	5 (62.5)	5 (62.5)
Piped water and storage container	1 (12.5)	1 (12.5)
Type of container		
Jerry can	0	0
Bucket	0	0
Improved container [b]	1	2
Project water container [c]	0	1
Storage container only	2 (25.0)	2 (25.0)
Bucket	2	0
Improved container	1	1
Project water container	0	2

[a] Five facilities were using tap water for drinking, however at time of power shortage these facilities were storing their water in plastic buckets which was used both for drinking and hand-washing.
[b] Improved containers=jerry cans or plastic or metal buckets with lid
[c] Project water container=Plastic buckets with lid and tap

B) Drinking water treatment practices

At baseline, of 8 facilities, one (12.5%) facility reported that they usually treating their drinking water with Clorin (table 5). However on testing water from their improved container no residuals of chlorine were found. At follow-up visit modest improvement noted in the treatment practices of the facilities. Of the 8 facilities, three (37.5%) reported treatment of their drinking water with Clorin. Of the three health facilities where Clorin use was reported, free chlorine residual were found in water storage containers of 2 (66.7%) facilities. Of the total five storage containers in which water treatment with Clorin was reported, free residuals of chlorine were found in two (40.0%) improved containers and one project (20.0%) container. The possible reason of not detecting free

residuals of chlorine in the other two containers might be duration of water treatment over 24 hours.

Table 5: Comparison of observed drinking water treatment practices at baseline and follow up, at 8 health facilities, CHAZ, CDC, and Emory University collaborative water project, Zambia 2010

Characteristics	Baseline n=8	Follow-up n=8
Observed water treatment		
Buckets		
Reported	0	0
Contained	0	0
Improved containers [a]		
Reported	1	3
Contained	0	2
Project water containers [b]		
Reported	0	2
Contained	0	1
Number of containers with treated water		
Improved water containers	0	2
Project water containers	0	1

[a] Improved containers= Buckets or jerry cans with lid
[b] Project water containers=Plastic buckets with lid and tap

C) Hand-washing water source and storage

At baseline of 8 facilities, six (75.0%) facilities were using water from the taps or storage containers for hand-washing and two (25.0%) were using water only from storage containers to wash their hands (table 6). Of the total 11 containers four were plastic buckets and seven were improved containers (plastic buckets with lids).

At follow-up visit distribution of access to sources of water for hand-washing were similar as of baseline (table 6). However modest improvement was noted in usage

of project containers as 8 (100.0%) facilities had a total of 19 project containers and of those 18 (94.7%) containers were filled with water.

Table 6: Comparison of observed Hand-washing water access and storage practices at baseline and follow up, at 8 health facilities, CHAZ, CDC, and Emory University collaborative water project, Zambia 2010

Characteristics	Baseline n=8 (%)	Follow-up n=8 (%)
Hand-washing water access in facility		
Piped water only	0 (0.0)	0 (0.0)
Piped water and storage container	6 (75.0)	6 (75.0)
Type of container		
Jerry can	0	0
Bucket	4	0
Improved container [a]	3	0
Project water container [b]	0	11
Storage container only	2 (25.0)	2 (25.0)
Improved container [a]	4	0
Project water container [b]	0	8

[a] Improved containers=jerry cans or plastic or metal buckets with lid
[b] Project water container=Plastic buckets with lid and tap

D) Hand-washing water treatment practices

At baseline of 8 facilities, none (0.0%) had reported use of Clorin for treatment of their water (table 7). However at follow-up visit water treatment was reported by four (50.0%) facilities in their four project water containers. Of those four project water containers detectable residuals of chlorine were found in 2 (50.0%) of the containers.

E) Hygiene practices of the facilities

At baseline of eight facilities, soap was observed in seven (87.5%) facilities (table 7). Of the 26 wards in all facilities (table 1) soap was observed in 11(42.3%) wards at the site of hand-washing.

At follow-up visit, soap was observed in seven (87.5%) facilities (table 7). Modest increase was noted in the presence of soap at the site of hand-washing. Of the 28 wards in all facilities (table 2) soap was observed in 18 (64.3%) wards at the site of hand-washing.

Table 7: Comparison of observed Hand-washing water treatment practices and access to soap at baseline and follow up, at 8 health facilities, CHAZ, CDC, and Emory University collaborative water project, Zambia 2010

Characteristics	Baseline n=8 (%)	Follow-up n=8 (%)
Water treatment practices		
Reported water treatment		
Buckets	0	0
Improved water containers	0	0
Project water stations	0	4 (50.0)
Confirmed water treatment		
Detectable Clorin	0	2
Access to soap in facilities		
Soap present in facility (Observed)	7 (87.5)	7 (87.5)
Number of wards with soap [a]	11 (42.3)	18 (64.3)

[a] Soap was present either beside the hand-washing container or at the site of hand-washing (piped water)

F) Overall water treatment practices of the health facilities

At baseline five (62.5%) facilities reported that they had never treated their store water and 3 (37.5%) of facilities reported that they had ever treating their stored water

with Clorin but none (0%) was treating at the time of baseline evaluation (table 8). At follow-up five (62.5%) facilities reported that they had ever treated their stored water with Clorin. Four (80.0%) of those five facilities reported that they had treated the water at the time of follow evaluation. Of the four health facilities, 2 (50%) health facilities where Clorin use was reported, free residuals of chlorine were found in water storage containers of 2 (50%) facilities.

Table 8: Comparison of overall observed water treatment practices at baseline and follow up, at 8 health facilities, CHAZ, CDC, and Emory University collaborative water project, Zambia 2010

Characteristics	Baseline n=8 (%)	Follow-up n=8 (%)
Ever treated stored water	3 (37.5)	5 (62.5)
Reported water treatment [a]		
• Chlorination	2 (25.0)	4 (50.0)
• Boiling and chlorination	1 (12.5)	1 (12.5)
• None	5 (62.5)	3 (37.5)
Use of Clorin for making water safe, n (%)		
• Reported current treatment	0 (0.0)	4 (50.0)
- Treated current water <24 hours	0 (0.0)	2 (50.0)
• Residual chlorine present	0 (0.0)	2 (25.0)

[a] At baseline and follow-up survey some facilities were using more than one method for treating their water

3.2.2. Health staff survey

3.2.2.1 Demographics of the clinic staff members at 8 health facilities

At baseline 33 health workers were interviewed; 13 (39.4%) were female (table 9), and the median age of the staff was 37 years (range 21-60). The median number of years they had worked in their occupation was 7 (range 2 weeks to 30 years).

A total of 37 health workers were interviewed at follow-up, among those 20 (54.1%) were female. The median number of year they worked in their occupation was 4

(range 1-31 years) (table 9). As compared to baseline at the follow-up there were more environmental health technicians (2 vs. 5) and community health workers (4 vs. 8) who filled the questionnaire.

Table 9: Demographics of clinic staff at 8 health facilities, CHAZ, CDC, and Emory University collaborative water project, Zambia 2010

Characteristics	Baseline n=33	Follow-up n=37
Female, n (%)	13 (39.4)	20 (54.1)
Age, median (range)	37 (21-60)	38 (21-58)
Years worked at facility, median (range)	7 (0-30)	4 (1-31)

3.2.2.2 Knowledge about hand washing and water treatment

At baseline health staff members reported adequate knowledge and practices about hand-washing and water treatment. At follow-up visit of the 37 staff members, 14 (37.8%) health staff members reported of receiving safe water, hygiene and sanitation training from CHAZ. A modest improvement in the knowledge of staff was noted for the correct dose of Clorin to use, activities that require hand washing and type of container for water storage (table 10). However larger improvement was reported in the correct length of time to wash hands (58.1% to 89.2%).

Table 10: Comparison of knowledge and practices of clinic staff about safe water and hand-washing at baseline and follow-up evaluation in 8 health facilities, CHAZ, CDC, and Emory University collaborative water project, Zambia 2010

Characteristics	Baseline [a]n=33 (%)	Follow-up [a]n=37(%)
Number of health staff members who received training from CHAZ	0 (0.0)	14 (37.8)
Knowledge of clinic staff about safe water and hand-washing		
• Purpose of clorin use to prevent of diarrhea	33(100.0)	37(100.0)
• Correct time to wait after chlorination to drink	30 (90.0)	33 (89.2)
• Correct dose of clorin	20 (60.6)	[b]24 (66.7)
• Recommended time for rubbing fingers during hand-washing	[c]18 (58.1)	33 (89.2)
Knowledge about when to do hand-washing		
• After visiting the toilet	32 (97.0)	37(100.0)
• Before/after eating	31 (93.9)	36 (97.3)
• Before/after food preparation	27 (81.8)	32 (86.5)
• After cleaning a child who has defecated	27 (81.8)	36 (97.3)
• After coughing, sneezing or blowing your nose	26 (78.8)	36 (97.3)
• When they are dirty	25 (75.8)	35 (94.6)
Knowledge about best type of water container to use to prevent recontamination		
• Containers with a narrow mouth, lid and spigot	30 (90.9)	34 (91.9)
• Modified clay pots / jerry cans	3 (9.0)	13 (35.1)

[a] n=Total number of clinic staff who filled the questionnaire
[b] n=36 due to 1 missing value
[c] n=31 due to missing data or loss to follow-up

3.2.2.3 Teaching to clients

From baseline to follow-up the overall teaching practices reported by clinic staff members to clinic clients about use of chlorine, hand-washing and safe water storage were similar (81.8 to 83.8% [table 11]). Similarly minimal improvement was also noted in the regular teaching by the clinic staff to clients on water, sanitation and hygiene

practices (46% to 51%). Modest improvement reported by the clinic staff regarding teaching their clients about specific uses and storage of Clorin (table 11).

Table 11: Comparison of teaching practices of clinic staff to clients on hand-washing and water treatment at baseline and follow-up evaluation in 8 health facilities, CHAZ, CDC, and Emory University collaborative water project, Zambia 2010

Characteristics	Baseline [a]n=33 (%)	Follow-up [a]n=37 (%)
Overall teaching by clinic staff to clients about use of chlorine, hand-washing and safe water storage	27 (81.8)	31 (83.8)
Frequency of teaching clients		
• Regularly	15 (45.5)	19 (51.4)
• Sometime	12 (36.4)	12 (32.4)
• Never	6 (18.2)	6 (16.2)
Teaching about specific uses of chlorine for making water safe		
• What purposes (drinking, hand-washing, washing vegetables)	21 (63.6)	22 (59.5)
• Chlorination of water prevents diarrhea	20 (60.6)	27 (73.0)
• How much to use	18 (54.6)	25 (67.6)
• How long to wait before drinking treated water	15 (45.5)	26 (70.3)
• How to store	15 (45.5)	21 (56.8)
• Where to buy	11 (33.3)	20 (54.1)
Teaching about hand-washing		
• Why important	24 (72.7)	30 (81.1)
• When to wash	18 (54.6)	26 (70.3)
• How to wash	15 (45.5)	27 (73.0)
• How to dry	13 (39.4)	19 (51.4)
• Teaching and demonstration of proper technique	12 (36.4)	18 (48.7)
Teaching about water storage		
• Why storage of treated water is safe	21 (63.6)	28 (75.7)
• How to store safe	20 (60.6)	29 (78.4)
• Kind of container to use	18 (54.6)	25 (67.6)

[a] n=Total number of clinic staff who filled the questionnaire at baseline and follow–up visit in health facilities

3.2.3 Clinic client survey

3.2.3.1 Demographics and household characteristics of clinic clients

At baseline 80 clinic clients were interviewed in eight health facilities, among those 75 (93.8%) were females (table 12). The median age of the clients was 28 years (range 15-52 years) (five clients had not reported their ages) and 37 (46.3%) of the clients had received greater then primary school education. 44 (55.7%) of the households had more than five members living in it. The median number of total children of clients was 3.5 (range 0-10) and median for children under-five years of age was 1 (range 0-4) respectively.

At the follow-up evaluation 80 clinic clients were interviewed in the same eight health facilities, all of them were females (table 12). The median age of the clients was 30.5 years (range 17-54) and 46 (57.5%) of the clients had received greater then primary school education. 51 (64.6%) of the households had more than five members living in it (Table 12). On an average the median number of total children of clients was 4 (range 0-10) and median for children under-five years of age was 1 (range 0-4) respectively.

Table 12: Comparison of demographics of clinic clients in 8 health facilities at baseline and follow up evaluation, CHAZ, CDC, and Emory University collaborative water project, Zambia 2010

Characteristics	Baseline n=80	Follow-up n=80
Female, n (%)	75 (93.8)	80 (100.0)
Age, median, n(range)	[a] n=75 28 (15-52)	30.5 (17-54)
Education, n (%)		
Completed primary school or less	43 (53.8)	34 (42.5)
Greater than primary school	37 (46.3)	46 (57.5)
Household size, n (%)	[a] n=79	n=79
1-5	35 (44.3)	28 (35.4)
>5	44 (55.7)	51 (64.6)
Number of children of each client	n=80	
Total number of children, median (range)	3.5 (0-10)	4 (0-10)
Under the age of 5, median (range)	1 (0-4)	1 (0-4)

[a] Missing values were 5 for reported data for age and 1 for household size

3.2.3.2 Knowledge and practices of clinic clients for water storage and treatment

A) Water storage

At baseline, 55.7% of clinic clients reported receiving education for drinking water storage from the clinic staff from their present or a previous clinic visit (table 13). When clinic clients asked about drinking water storage practices learnt from the clinic staff, 29.5% clients reported improper storage practices can contaminate clean water, and 18.2% of clients reported to use a container with narrow mouth for improved water storage. At follow-up visit, 81.3% of clinic clients reported receiving education for

drinking water storage from the clinic staff from their present or a previous clinic visit (table 13). Modest improvement reported by clinic clients when asked about drinking water storage practices learnt from the clinic staff, 60.0% clients reported improper storage practices can contaminate clean water, and 30.8% of clients reported using a container with narrow mouth for improved water storage (table 13). Greater improvement noted in their knowledge learnt from the clinic about using containers with tap (0% to 21.5%). On house-hold observation same improvement noted in the presence of containers with tap (0% to 12.7%).

Table 13: Comparison of drinking water storage's knowledge and practices of clinic clients at baseline and follow-up evaluation in 8 health facilities, CHAZ, CDC, and Emory University collaborative water project, Zambia 2010

Characteristics	Baseline n(%)	Follow-up n(%)
Reported		
Taught about drinking water storage	**n=79** [a]	**n=80**
• During present clinic visit	1(1.3)	3 (3.8)
• During previous clinic visit	43(54.4)	62 (77.5)
Practices learnt from the clinic [b]	n=44	n=65
• Improper water storage practices can contaminate clean water	13 (29.5)	39 (60.0)
• Use container with lid	36 (81.8)	53 (81.5)
• Use container with narrow mouth	8 (18.2)	20 (30.8)
• Use container with tap	0 (0.0)	14 (21.5)
Observed		
Drinking water storage container	**n=80**	[a] **n=79**
• Ordinary claypot	1 (1.3)	4 (5.1)
• Plastic jerry can	15 (18.8)	38 (48.1)
• Plastic or metal bucket	44 (55.0)	26 (33.0)
• Container with tap	0 (0.0)	10 (12.7)
• Superdrum/tank	1 (1.3)	0 (0.0)
• Improved containers [c]	45 (76.3)	64 (81.0)

[a] (n=79)1 missing value
[b] Includes only those who were taught about water storage from clinic staff
[c] Plastic jerry can, plastic or metal bucket with lid (n=59 for baseline and n=79 for follow-up)

B) Water treatment

At baseline of 50 (62.5%) clinic clients reported water treatment practices in their households. Forty four (55.0%) percent of the clients reported that they were using Clorin (table 14). At follow-up visit 58 (72.5%) clients reported water treatment practices in their households. Forty nine (61.3%) percent of the clients reported that they were using Clorin. Modest improvement noted in their knowledge regarding proper dosage of Clorin (59.7% to 78.5%). Some improvement noted in the current practices of clients for use of Clorin, which increased from 12.5% at baseline to 18.8% at the follow-up visit. During observation at the households modest improvement noted in the percentages of the presence of free residuals of chlorine in the treated water of the clients (3.4% to 15.0%).

3.2.3.3 Knowledge and practices for Hand-washing

At baseline 62 (77.5%) of the clinic clients reported of receiving teaching about hand-washing from the clinics (table 15). At the follow-up assessment modest improvement noted in the teaching received by 71(88.8%) clients from the clinics. The major improvements were in the knowledge of clients for correct time of hand-washing (3.8% to 22.5%). On house-hold observation modest improvement noted in the presence of soap (79.4% to 90.0%) and correct hand washing procedure (41.7% to 65.0%). The observation regarding the number of households with presence of latrine was similar.

Table 14: Comparison of water treatment knowledge practices between clinic clients at baseline and follow-up evaluation in 8 health facilities, CHAZ, CDC, and Emory University collaborative water project, Zambia 2010

Characteristics	Baseline n=80 (%)	Follow-up n=80 (%)
Reported		
Water treatment [a] Yes	50 (62.5)	58 (72.5)
Method used		
• Clorin	44 (55.0)	49 (61.3)
• Boiling	24 (30.0)	23 (28.8)
• Sedimentation	1 (1.3)	0 (0.0)
• Filtration	0 (0.0)	1 (1.3)
Clorin information source [b]		n=79
• During present clinic visit	11 (13.8)	5 (6.3)
• During previous clinic visit	58 (72.5)	55 (69.6)
• Community health worker	10 (12.5)	14 (17.7)
Proper use of Clorin [b]	n=77	n=79
• Knew proper dosage	46 (59.7)	62 (78.5)
• Knew how long to wait to drink after treatment	37 (52.1)	44 (57.9)
Observed		
Practices		
• Reported current treatment with Clorin	10 (12.5)	15 (18.8)
• Clorin bottle observed in the house	6 (10.0) [c]	18 (22.5)
• Positive chlorine residuals in water	2 (3.4) [c]	12 (15.0)

[a] using any method to make their drinking water safe
[b] Include only those who reported they heard of Clorin
[c] Numbers do not sum to total due to lost to follow up; observation carried out at the available 60 and 59 households

Table 15: Comparison of hand-washing knowledge and practices of clinic clients at baseline and follow-up evaluation in 8 health facilities, CHAZ, CDC, and Emory University collaborative water project, Zambia 2010

Characteristics	Baseline n(%)	Follow-up n (%)
Reported		
Taught about Hand-washing	**(n=79)**[a]	**(n=80)**
• During present clinic visit	2 (2.5)	3 (3.8)
• During previous clinic visit	60 (75.0)	68 (85.0)
Practices learnt from the clinic	(n=62) [b]	(n=71) [b]
• When to wash hands	47 (75.8)	66 (93.0)
• Use Soap	38 (61.3)	56 (78.9)
• It prevents diarrhea	18 (29.0)	25 (35.2)
• Use of clean towel/air dry	7/60 (11.7)	17 (24.0)
• How long to wash hands	2/60 (3.3)	12 (17.0)
• Where to wash (between fingers)	2/60 (3.3)	19 (26.8)
Knowledge about how to do hand-washing	(n=80)	(n=80)
• Use soap	64 (80.0)	71 (88.8)
• Rubbing of hands for 10-15 seconds	7 (8.8)	18 (22.5)
• Rubbing between fingers	17 (21.3)	43 (53.8)
• Rubbing under finger nails	1 (1.3)	19 (23.8)
• Rinse the soap off	34 (42.5)	42 (52.5)
• Use of clean towel or air dry	17 (21.3)	25 (31.3)
• Use running water	24 (30.0)	35 (43.8)
Knowledge about when to do hand-washing	(n=80)	(n=80)
• After visiting the toilet	75 (93.8)	79 (98.8)
• Before eating	43 (53.8)	58 (72.5)
• After cleaning a child who has defecated	18 (22.5)	33 (41.3)
• Before food preparation	16 (20.0)	37 (46.3)
Knowledge about correct time for hand-washing	3 (3.8)	18 (22.5)
Observed		
Hygiene Practices		**n=80**
• Soap in House	50/63 (79.4)	72 (90.0)
• Correct hand-washing procedure [c]	25/60 (41.7)	52 (65.0)
• Latrine [d]	55/59 (93.2)	72 (90.0)

[a] (n=79)=1 missing value

[b] Includes only those who were taught about hand-washing from the clinic staff

[c] Correct hand-washing procedure on observation is defined as respondent: 1) wet hands 2)uses soap, 3)lathers all surfaces thoroughly including front and back of hands and between fingers, 4)rinses hands

[d] at baseline latrines were observed in only those 59 houses where we were able to visit (others lost to follow up)

Chapter 4

4.1 Discussion

The installation of safe water stations for drinking and hand-washing combined with training of the clinic staff in the rural health clinics of Zambia resulted in improvements in water storage and treatment practices at health facilities and households of health facility clients. The project also improved the knowledge and teaching of the clinic staff members. This improvement was also reflected in the practice of the clinic clients who were able to adapt the learnt method from the clinics. During household visits we observed proper storage of water and clients demonstrated appropriate hand-washing techniques. These findings are consistent with other safe water and hygiene programs in developing countries of Africa (Migele, Ombeki, Ayalo, Biggerstaff, & Quick, 2007; O'Reilly et al., 2008) including Zambia (Quick, et al., 2002) and successful clinic-based intervention in Kenya, where nurses were trained to teach their clients about safe water and proper hand-washing practices (Parker, et al., 2006).

These improvements were likely facilitated by the presence of the water stations, which served as a teaching learning platform for water treatment and handwashing education in health facilities. At the follow-up evaluation, seven out of eight clinics were using safe water stations and the use of Clorin at the facilities increased by 50%. This was important and appears to be reflective of the large interest among the Ministry of Health and community as more than 200 participants were present at each of the onsite trainings. In addition to that, at one onsite training in the Copperbelt province, the District Director of Health (DDH) came to observe the training. The interest of such prominent figures helps health workers understand the importance of the safe water and hygiene

programs and more actively engage in education and promotion of water, sanitation, and hygiene message to their clients. However, we also observed at the follow-up visit that use of project containers for drinking water at the facilities was less common than expected. Only two health facilities were using project containers, five facilities were using piped water, and one facility was using only improved water containers for storage of drinking water. Of the five health facilities which were using piped water, one health facility was using the project water container during their field visits for teaching clients. Similarly, the facility which was using improved water containers for storage of drinking water was also using the project water container for demonstration to the clients during their weekly visits in the field.

Almost all of the health facilities had soap present in one or more of the wards at baseline and follow-up assessment. Soap was also observed beside more than half of the hand-washing containers; however, in some instances, soap was only present in one or two rooms and not present in all wards where patients were seen. This was due to a lack of adequate funding for hand-washing soap and a dependency of the facilities on District Health to provide funding. Considering the high risk of health facility-acquired infections from lack of hand-washing with soap (Garner JS, 1986), this problem could be managed effectively if the facilities could prioritize appropriate funding for purchase of hand-washing soap and ensure there is soap in every room where a patient is seen.

The assessment of the survey of health staff did not reveal large increases in the frequency of health staff teachings on hand-washing and water treatment to patients. The staff expressed increased workload as a major constraint in regular teaching of clients. However, at the follow-up visit, we observed an improvement in consistency of health

education on water, sanitation and hygiene practices by health staff to patients at the clinics. Many health clinics incorporated safe water and hygiene teachings into their routine on a regular basis during under-five child care, maternity health and PMTCT clinics. These teachings were demonstrated to us at our follow-up visit and included placement of drinking and water stations in patient waiting areas for demonstrations on how to wash hands and chlorinate water properly.

In addition, the knowledge level of correct length of time to wash hands increased by 30% among clinic staff at follow-up. Similarly, knowledge of the health staff about when to do hand-washing was also moderately increased. This was also noted in clinic clients as a marked improvement in their knowledge of hand-washing and demonstration of correct hand-washing procedure. This is encouraging because health worker competency in water sanitation and hygiene practices and hand-washing instruction is important to ensure appropriate teaching and enable improvements among clients in hand-washing (O'Reilly, et al., 2008; Parker, et al., 2006).

Teaching of the health staff to clinic clients for proper storage of water was also moderately improved (approximately 15%). Furthermore, a high number of respondents reported receiving education on drinking water storage from clinic staff. Large improvements in clients' knowledge of water storage practices were also seen. That was observed in the household survey when more respondents used improved water storage containers at follow-up. These findings are consistent with a similar clinic-based intervention study in Kenya, where they attributed a high client-reported frequency of received instruction to the success of the intervention (Parker, et al., 2006). This also

further demonstrates that health workers and community health workers are successfully implementing water, sanitation and hygiene practices.

There were several differences in basic characteristics of clinic clients that may have affected the uptake of safe water, sanitation and hygiene practices among clinic clients. The follow-up population had a higher percentage of more educated individuals than at baseline and a larger percentage of individuals that lived in government owned homes. These clinic clients may have had a higher level of health education, increased access to health care and more income. As a result of this they may have been more likely to purchase Clorin or better understand safe water, sanitation and hygiene practices. These findings have also been reported by earlier studies where increase in use of Clorin was reported if the primary water care taker had higher education and in household better construction (Olembo L, 2004; Parker, et al., 2006). In addition of having more education, clients at follow-up were slightly older than baseline population, and thus might be better able to grasp the knowledge effectively and demonstrate it in their practices appropriately. These findings are consistent with earlier studies which have suggested that younger age and less schooling can be barriers to the adoption of a safe water system (Parker, et al., 2006; Rheingans R, 2007).

At follow up visit when clinic clients were asked regarding the source of information for Clorin, their reported responses did not show any improvement from baseline survey, in receiving information from the clinic visits. This is in contrast to earlier evaluation of the Zambia Clorin program (Olembo L, 2004), which reported that promotion through health centers had a positive effect on Clorin use in the households. Modest improvements were noted in client's knowledge on how to use Clorin and the

number of clients chlorinating their water. However it was difficult to assign any single factor responsible for that outcome. Since teachings of the health staff members to clinic clients about use of Clorin did not improve much at the follow-up visit, nor did clients report increases in Clorin instruction from clinic staff, we cannot attribute these factors to higher levels of Clorin use among clients. In addition to that, these reported findings on client knowledge and clinic staff teachings were already at high levels at baseline (approx. 80%), which would make it difficult to obtain notable increases at follow-up. The other possible mechanisms are social marketing or a communication model for behavioral change (Dunston et al., 2001; Figueroa ME, 2010; Thevos, Kaona, Siajunza, & Quick, 2000). However it is evident from previous community-based studies that social marketing alone could not lead to high utilization rates of Clorin (Dunston, et al., 2001; Parker, et al., 2006; Thevos, et al., 2000). It could also be inferred that increases in water treatment among clients may have been due to the large efforts made in community outreach after training of trainer (TOT) implementation of this project. There was a large interest among the community about this Safe Water System (SWS) program. The health staff and community health workers conducted several community demonstrations within the targeted health facilities' catchment areas.

The overall success of the safe water system (SWS) program also have largely been due to a combination of factors such as the onsite provision of training and demonstrations to the clinic staff and community, delivery of the safe water containers, the skills and enthusiasm of the primary trainer (CHAZ) and interest of collaborating organizations in implementing the intervention. CHAZ is most trusted and well-respected non-governmental organization in Zambia and is well-known both among urban and rural

Zambians for public health work. Therefore, clients may have been more motivated to practice the safe water, sanitation and hygiene messaging they learned from CHAZ community demonstrations and nurse teachings at CHAZ health facilities.

4.2 Conclusion

After four months of safe water system intervention in eight rural health facilities of Zambia, an effective impact of the intervention on hand-washing, water storage and Clorin use was evident in the follow-up assessment. More health facilities were treating their drinking water with Clorin after the SWS intervention was implemented. Modest improvement was noticed in the clinic staff knowledge on hand-washing practices, and patients demonstrated improvement in Clorin use, water storage and hand-washing practices. The simplicity of the SWS, enthusiasm of the collaborating organizations and involvement of the highly skilled trainer in implementing the intervention, as well as conducting trainings at CHAZ health facilities, likely contributed to the success of this project over such a short period of time. Due to the notable achievement of this project, this intervention has now expanded to 150 additional health facilities in Zambia, and we hope to see future safe water, sanitation and hygiene interventions implemented in other neighboring countries in Africa. It can be expected that in future, provided the presence of funding and staff, another evaluation in Zambia will measure the impact of the project at a variable period of time from the intervention.

4.3 Limitations

This study has several limitations that have decreased the overall impact of the project. First of all as mentioned earlier, we were unable to follow up with 7 of the 15 health facilities we visited at baseline. Therefore, the follow-up population may not have been completely representative of the baseline population. However, descriptive analyses were performed comparing the 8 remaining follow-up health facilities and were closely found to be representative of the original 15 in basic characteristics such as size of health facilities, age and sex of the health staff and clinic clients, number of patients served by the health facilities, and sources of water. As a result of the loss of 7 facilities, our sample size was decreased and this may have lessened the overall observed impact of the safe water system intervention.

Secondly, during the follow up visit it was observed that in some health facilities very little progress was made in promoting safe water, sanitation and hygiene education to clients and treatment of water at the facility. One of the possible reasons observed for this lack of promotion of water, sanitation and hygiene training at these rural health facilities was involvement in several concurrent health projects like prevention and treatment of malaria, HIV/AIDS, tuberculosis, hepatitis B and measles. Therefore they were giving less priority to educating clinic clients about safe water, sanitation and hygiene practices. We would not expect to see much improvement in overall water, sanitation and hygiene practices of patients who attended these clinics, and therefore these clinics could have lowered the overall observed impact of our intervention.

Third, the other potential limitation which has reduced the impact of clinic based intervention is the understaffing of nurses at health facilities globally, especially in Africa

(J., 2004; Parker, et al., 2006; WHO, 2000). In our surveys of health facilities and clinic staff members we have found similar shortage of nurses in health facilities of Zambia. The health staff members which were directly in contact with the clinic clients were comprised of nurses, clinical officers, environmental health technicians, community health workers and classified daily employees. Many nurses reported that they were extremely busy and were attending 100-200 patients a day and had felt difficult to find time to incorporate water, sanitation and hygiene trainings into daily practice. Therefore, the health staff reported they found it was easiest to conduct demonstrations at lunchtime or in the afternoon at the end of PMTCT clinics or "under 5" clinics.

Fourth, those clients who were easily accessible in the catchment area of the respective health facilities were interviewed. We have found that their sanitation and hygiene practices, including the presence of latrines at the households were improved at the follow-up visit. There might be an element of bias that those randomly selected clinic clients were living in the catchment area of the facilities, and that in certain communities they have known beforehand that they were going to be asked about their water and sanitation practices. Therefore they could not represent the overall prevalence of sanitation practices in the population of Zambia.

Fifth, cost of product and the access to and availability of product could also be a limiting factor in this study. Even at follow-up, the majority of client respondents were not currently using Clorin to treat their drinking water, as no Clorin was left for week(s) or month(s). Many clinic clients had reported that they wanted to use Clorin on a regular basis but could not afford it. The cost of the product as a barrier also reported in earlier studies (Freeman M, 2005; O'Reilly, et al., 2008). In Zambia the cost of Clorin is

dependent on location of purchase and distance to a major road in Zambia. For example, the cost of Clorin in Northwestern province was double the cost in Luapula province. The cost of shipping Clorin to areas in Northwestern is likely quite high because it is a remote region. Clients also expressed the need that Clorin should be made easily available to the clinic clients within the health facility. For example a shop within Kavu health facility was selling Clorin at a cheaper price to the clinic clients. But this shop within the facility was opening infrequently and for shorter duration. Therefore the clients were purchasing Clorin at a higher price from the local market. On observation it was also found that that those shops were not following the appropriate storage practices for storing Clorin.

In addition to that, access was also a problem in some parts, especially at one health facility we visited in Southern Province. We interviewed respondents at a farm block served by that health facility, which was approximately 12 km from town. There were no other places nearby to purchase Clorin. Those clients depend on health workers from the clinic to offer Clorin for purchase when they come to the farm to offer their health services. This situation is causing a dual problem for the clients and reducing their interest in using Clorin for water treatment. However at few households it was understood that buying Clorin was not a priority of clinic clients as compared to other livelihood of life.

Finally due to constraints of funding and time it was not possible to measure the impact of this intervention in incidence of diarrheal disease within the communities in the catchment area of the health facilities.

4.4 Recommendations

Follow-up evaluation after four months of the implementation of intervention of safe water project in 8 rural health facilities of Zambia presented positive behavioural change in the practices of health facilities, health staff members and clinic clients. Now this intervention has been expanded to over 150 health facilities in Zambia. A second follow-up evaluation after 6 months to one year of this expanded intervention may bring more encouraging results for the improved impact of change in the practices of health facilities, health staff and clinic clients. In addition to that to overcome the constraints of funding and human resources the future projects should be carried out with effective collaboration between organizations and training should be provided to train more than one master trainer.

The problem of high burden of patients at the health facilities along with understaffing of nurses which had been a limiting factor in the effective promotion of safe water, sanitation and hygiene education to the clinic clients could be overcome by supervised training and capacity building of other categories of health workers like community health workers.

It is important to encourage community members to include Clorin in their budget but in certain areas this may not be an option due to cost. In such circumstances, it would be beneficial for Non-Governmental Organizations to target these areas and offer Clorin to community members at a reduced cost. This problem can also be overcome if Ministry of health provides sufficient supply of Clorin at the health facilities to be used both at the facilities and made available to the clients during their clinic visits.

Health facilities, clinic staff members and clinic clients should be encouraged about regular use of safe water stations for storage and treatment of drinking water. The project collaborative partners should emphasize on delivery of periodic communication messages for enhancing the use of safe water stations to those 150 health facilities who had received the water stations.

References

Anna B, H. M., Jiaming O, Ward B, Timothy L, Eric M, Robert M. and Stephen L. (2007). A Cluster Randomized Controlled Trial Evaluating the effect of Hand washing Promotion Program in Chinese Primary Schools. *The Am J of Trop. Med. Hyg. , 76.* ((6),), 1166-1173.

Aung Myo, H., & Thein, H. (1989). Prevention of diarrhoea and dysentery by hand washing. *Trans R Soc Trop Med Hyg, 83*(1), 128-131.

Banerjee, A., McFarland, D. A., Singh, R., & Quick, R. (2007). Cost and financial sustainability of a household-based water treatment and storage intervention in Zambia. *J Water Health, 5*(3), 385-394. doi: 10.2166/wh.2007.034 [doi]

C, B. (2004). Girls, education and development.: The state of the world's children unicef.

CDC. *Safe Water Systems for the developing World: A Handbook for Implementing Household-Based Water Treament and Safe Storage Projects*

CDC. (2005). Preventing Diarrheal Diseases in Developing Countries: The CDC/PSI Rotary Safe Water System Project in Western Kenya, from http://www.cdc.gov/safewater/publications_pages/fact_sheets/Kenya.pdf

Clasen, T., Roberts, I., Rabie, T., Schmidt, W., & Cairncross, S. (2006). Interventions to improve water quality for preventing diarrhoea. *Cochrane Database Syst Rev, 3*, CD004794. doi: 10.1002/14651858.CD004794.pub2 [doi]

Clasen, T., Schmidt, W. P., Rabie, T., Roberts, I., & Cairncross, S. (2007). Interventions to improve water quality for preventing diarrhoea: systematic review and meta-analysis. *BMJ, 334*(7597), 782. doi: bmj.39118.489931.BE [pii]

10.1136/bmj.39118.489931.BE [doi]

Clasen, T. F. (2009). Scaling Up Household Water Treatment Among Low-Income populations: World Health Organization, Geneva.

D.H.S. (2001-2002). Demographic and Health Survey Zambia Central Statistical Office, Lusaka, Zambia.

Dunston, C., McAfee, D., Kaiser, R., Rakotoarison, D., Rambeloson, L., Hoang, A. T., & Quick, R. E. (2001). Collaboration, cholera, and cyclones: a project to improve point-of-use water quality in Madagascar. *Am J Public Health, 91*(10), 1574-1576.

Ejemot, R. I., Ehiri, J. E., Meremikwu, M. M., & Critchley, J. A. (2008). Hand washing for preventing diarrhoea. *Cochrane Database Syst Rev*(1), CD004265. doi: 10.1002/14651858.CD004265.pub2 [doi]

Fewtrell, L., Kaufmann, R. B., Kay, D., Enanoria, W., Haller, L., & Colford, J. M., Jr. (2005). Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis. *Lancet Infect Dis, 5*(1), 42-52. doi: S1473309904012538 [pii]

10.1016/S1473-3099(04)01253-8 [doi]

Figueroa ME, K. D. (2010). Social, cultural and behavioral correlates of household water treatment and storage. , from (http://www.jhuccp.org/sites/all/files/Household%20Water%20Treatment%20and%20Storage%202010.pdf).

Freeman M, e. a. (2005). Removing barriers to point-of-use water treatment products through social marketing and entrepreneurship: a case study in Western Kenya. : In: World Health Organization, Household Water, Treatment and Storage Conference. Bangkok, Thailand, .

G.H.I. U.S. Global Health Initiative. Uganda and beyond: Expanding interventions offered at primary health care centers. Retrieved April 17, 2011, from http://www.ghi.gov/what/works/149164.htm

Garner JS, F. M. (1986). CDC guidelines for the prevention and control of nosocomial infections. Guideline for handwashing and hospital environmental control. . *AJIC. , 14*((3):), 110-115.

http://www.mapsofworld.com/zambia/zambia-political-map.html. (2010). Zambia Political Map Retrieved September 12, 2010

J., H. K. Y. (2004). The global tug-of war for health care workers.: Migration Policy Institute.

Luby, S. (2001). The role of handwashing in improving hygiene and health in low-income countries. *Am J Infect Control, 29*(4), 239-240. doi: S0196-6553(01)67584-9 [pii]

10.1067/mic.2001.115678 [doi]

Luby, S. P., Agboatwalla, M., Bowen, A., Kenah, E., Sharker, Y., & Hoekstra, R. M. (2009). Difficulties in maintaining improved handwashing behavior, Karachi, Pakistan. *Am J Trop Med Hyg, 81*(1), 140-145. doi: 81/1/140 [pii]

Luby SP, A. M., Feikin DR, Painter J, Billhimer W. . (2005). Effect of Hand washing on a child health: a randomized controlled trial. . *Lancet 366:*, 225-233.

Migele, J., Ombeki, S., Ayalo, M., Biggerstaff, M., & Quick, R. (2007). Diarrhea prevention in a Kenyan school through the use of a simple safe water and hygiene intervention. *Am J Trop Med Hyg, 76*(2), 351-353. doi: 76/2/351 [pii]

Mintz E, B. J., Lochery P, Wegelin M. . (2001). Not just a drop in the bucket: expanding access to point-of-use water treatment systems. . *American Journal of Public Health. , 91* ((10):1), 565-1570.

O'Reilly, C. E., Freeman, M. C., Ravani, M., Migele, J., Mwaki, A., Ayalo, M., . . . Quick, R. (2008). The impact of a school-based safe water and hygiene programme on knowledge and practices of students and their parents: Nyanza Province, western Kenya, 2006. *Epidemiol Infect, 136*(1), 80-91. doi: S0950268807008060 [pii]

10.1017/S0950268807008060 [doi]

Olembo L, K. F., Tuba M, Burnham G. . (2004). Safe water systems: An evaluation of the Zambia CLORIN Program (Final Report). : US Agency for International Development, through the Environmental Health Project.

Parker, A. A., Stephenson, R., Riley, P. L., Ombeki, S., Komolleh, C., Sibley, L., & Quick, R. (2006). Sustained high levels of stored drinking water treatment and retention of hand-washing knowledge in rural Kenyan households following a clinic-based intervention. *Epidemiol Infect, 134*(5), 1029-1036. doi: S0950268806005954 [pii]

10.1017/S0950268806005954 [doi]

Pinfold, J. V., & Horan, N. J. (1996). Measuring the effect of a hygiene behaviour intervention by indicators of behaviour and diarrhoeal disease. *Trans R Soc Trop Med Hyg, 90*(4), 366-371.

Pruss-Ustun A, B. R., Gore F, Bartram J. Safer water, better health: costs, benefits and sustainability of interventions to protect and promote health. (2008). Safer water, better health: costs, benefits and sustainability of interventions to protect and promote health: World Health Organization.

Quick, R. E., Kimura, A., Thevos, A., Tembo, M., Shamputa, I., Hutwagner, L., & Mintz, E. (2002). Diarrhea prevention through household-level water disinfection and safe storage in Zambia. *Am J Trop Med Hyg, 66*(5), 584-589.

Rabie, T., & Curtis, V. (2006). Handwashing and risk of respiratory infections: a quantitative systematic review. *Trop Med Int Health, 11*(3), 258-267. doi: TMI1568 [pii]

10.1111/j.1365-3156.2006.01568.x [doi]

Report. (2008). Zambia Millenium Development Goals Progress Report

Rheingans R, D. R. (2007). Disparities in Sur'eau Use and Awareness: Results from the 2006 PSI TRAC Survey Atlanta, GA, USA: Rollins School of Public Health, Emory University.

Shahid, N. S., Greenough, W. B., 3rd, Samadi, A. R., Huq, M. I., & Rahman, N. (1996). Hand washing with soap reduces diarrhoea and spread of bacterial pathogens in a Bangladesh village. *J Diarrhoeal Dis Res, 14*(2), 85-89.

Sreenivasan Nandini, S. A. G., Sam Ombeki, Gordon Otieno Oluoch , Peter Skinhøj, Thea K. Fischer, Rob Quick. (November 9, 2009). Sustained utilization of safe drinking water and handwashing stations in Kenyan health facilities. Abstract presented at: American Public Health Association; Retrieved April 2011, from http://apha.confex.com/apha/137am/webprogram/Paper207202.html

Stanton, B. F., & Clemens, J. D. (1987). An educational intervention for altering water-sanitation behaviors to reduce childhood diarrhea in urban Bangladesh. II. A randomized trial to assess the impact of the intervention on hygienic behaviors and rates of diarrhea. *Am J Epidemiol, 125*(2), 292-301.

Thevos, A. K., Kaona, F. A., Siajunza, M. T., & Quick, R. E. (2000). Adoption of safe water behaviors in Zambia: comparing educational and motivational approaches. *Educ Health (Abingdon), 13*(3), 366-376. doi: 10.1080/135762800750059480 [doi]

WQDQVDV9TDK11MHG [pii]

unicef. (2008). Zambia, Statistics, Basic indicators from http://www.unicef.org/infobycountry/zambia_statistics.html

WHO. Water Sanitation and Health Retrieved April 16, 2011, from http://www.who.int/water_sanitation_health/mdg1/en/index.html

WHO. (2000). World Health Organization Regional and global Trends in Nursing and Midwifery. Global Advisory Group on Nursing and Midwifery: Report of the Sixth Meeting. Geneva.

Wright, J., Gundry, S., & Conroy, R. (2004). Household drinking water in developing countries: a systematic review of microbiological contamination between source and point-of-use. *Trop Med Int Health, 9*(1), 106-117. doi: 1160 [pii]

Appendix 1

CHAZ and CDC's Clinic-Based Water Treatment and Hand washing Evaluation

FACILITY ASSESSMENT FORM

Province: _____ Date: _____

Q1. Name of Health Facility_____

Q2. Total Patient population seen per day: _____

Q3. Number of Qualified Health staff _____ Male_____ Female_____
(These are only workers that work with patients.)
Total number of Health staff: _____

Q4. Total number of staff trained on Safe water and Hand hygiene_____
Who trains the staff on safe water and hygiene? _____

Q5. Total Number of wards: _____

Q6. Total bed capacity: _____

Q7. How many of the following community structures are supporting community health services within your catchment area?

1. Community Health Workers (CHWs) _____
2. Traditional Birth Attendants (TBAs) _____
3. Support Group _____

Q8. What is the main source of drinking water at the health facility? *(Choose one)*

1) Lake, Pond, River or Dam
2) Protected well
3) Unprotected well
4) Protected Spring
5) Unprotected spring
6) Borehole
7) Rain water catchment
8) Piped water

Q9. Is the source of water on the health facility premises?

1) Yes ► **skip to Q12**
2) No

Q10. How far from the facility is the water source? _____ Meters

Q11. How long does it take to walk from the facility to the source? _____ Minutes

Q12. Do you ever treat the stored water?

1 Yes
2 No ► **skip to Q25**

Q13. How is the water treated? *(Circle all that apply)*

1) Clorin
2) Boil
3) Filter
4) Allow it to settle for some time
5) Other specify_____

skip to Q25

Q14. How many liters of water do you treat per day? _____ Liters

Q15. Who is assigned the duty of replenishing and treating water every day

1. EHT
2. Health Workers
3. Support Staff
4. Community structures (CHWs, TBA & SGs)
5. No one

Q16. For how many months have you been treating the drinking water at the facility with Clorin? _____ Months

Q17. How long does one bottle of Clorin last? _____

Q18. Do you receive any Clorin bottles from a sponsor? (ie District Health, CHAZ)?

1 Yes (specify _____)
2 No ► **Skip to Q21**

Q19. How many bottles of Clorin did the sponsor give you? _____ Bottles

Q20. Do you still have Clorin left that the sponsor gave you?

1. Yes
2. No

Q21. Do you ever purchase Clorin bottles for the clinic?

1) Yes
2) No ► **Skip to Q25**

Q22. From where do you purchase Clorin?

1 CHAZ
2 Retail shop / Supermarket
3 Chemist
4 Hospital canteen
5 Other specify_____

Q23. Does this facility have a budget for Clorin?

1) Yes
2) No ► **Skip to Q25**

Q24. How much does this facility spend on Clorin?

____ ZMK per day/week/month/year (*circle*)

Q25. Do you receive any soap from a sponsor? (ie District Health, CHAZ)?

1 Yes (specify _____)
2 No

Q26. Do you still have soap left that from this sponsor?

1) Yes
2) No (**Skip to observations)**

Q27. Did you purchase soap for the clinic after the soap the sponsor gave you ran out?

1 Yes
2 No **(Skip to Q28)**

Q28. From where did you purchase soap?

1 CHAZ
2 Retail shop / Supermarket
3 Chemist shop
4 Hospital canteen
5 Other specify_____

Q29. Does this facility have a budget for **handwashing** soap?

1 Yes
2 No **(This ends the interview)**

Q30. How much does this facility spend on **handwashing** soap?

____ ZMK per day/week/month/year (circle)
9 Don't know

OBSERVATIONS

Drinking water container type 0=none 1=plastic jerry can 2=plastic or metal bucket 3=Skip 4=Tap 5=Plastic with tap 6=Other, specify	Storage capacity (Liters) 3=skip	Contains water? 3=skip	Treated? 1=yes 2=no 3=skip	Lid present? 1=yes 2=no 3=skip	Chlorine present? 1=yes 2=no 3=skip	Tap functions? 1=yes 2=no 3=skip	Number of times filled per day 3=skip

Hand-washing container type 0=none 1=plastic jerry can 2=plastic/metal bucket 3=Skip 4=Tap 5=Plastic with tap	Storage capacity (Liters) 3=skip	Contains water 1=yes 2=no 3=skip	Treated? 1=yes 2=no	Soap present? 1=yes 2=no	Chlorine present? 3=skip	Tap functions? 1=yes 2=no 3=skip	Number of times filled per day 3=skip

Appendix 2

CHAZ and CDC's Water Treatment and Hand washing Evaluation
CLINIC STAFF KNOWLEDGE ASSESSMENT SURVEY

Province: _____ Date: _____

A. General Information

Q1. Name of health facility: _____

Q2. Health Staff's title

1 Nurse
2 Clinical Officer
3 Environmental health Technician
4 Community Health worker
5 Traditional Birth Attendant (TBA)
6 Other, specify _____

Q3. Gender

1 Male
2 Female

Q4. Age: _____

Q5. When did you start working here? _____

Q6. Have you received any training about Clorin, safe water storage and hand-washing?

1 Yes **(from whom, specify _____)**
2 No

Q7. Do you teach your clients at the health facility about Clorin, safe water storage and hand washing?

1 Yes
2 No ► **skip to Q9**

Q8. How frequently do you teach your clients at the health facility about Clorin, safe water storage and hand washing?

1 Every day
2 Almost every day
3 Occasionally
4 Almost never
5 Other specify_____

► **Skip to Q10**

Q9. Why not? *(Multiple responses possible.)*

1 There are too many patients waiting
2 I don't see the relevance of the information
3 I already have too much to do with each patient
4 I forgot
5 Other specify_____ _____

► **Skip to Q13**

Q10. What do you teach your patients about Clorin? (*Multiple responses possible.)*

1 Where to purchase Clorin
2 How much Clorin to use
3 What to use Clorin for (e.g. drinking water, hand-washing, washing vegetables etc.)
4 How long to wait before drinking water treated with Clorin
5 How to store Clorin
6 That Clorin is a prevention against diarrhea
7 I don't teach them
8 Other (specify) _____

Q11. What do you teach your patients about hand washing? (*Multiple responses possible*.)

1 When to wash your hands
2 How to wash your hands (i.e. technique, use soap, treated water etc.)
3 How to dry hands after hand-washing
4 The importance of hand-washing (i.e. reduces risk of infections, diarrhea etc.)
5 I demonstrate proper hand washing techniques
6 I don't teach them
7 Other (specify) _____

Q12. What do you teach your patients about drinking water storage? (*Multiple responses possible*.)

1. Why safe drinking water storage is important (i.e. prevents recontamination etc.)
2. How to store water safely (i.e. use lid, spigot etc.)
3. What kind of containers to use
4. I don't teach them
5. Other (specify) _____

B. Health Staff knowledge on safe water and hand wash

Q13. What is the purpose of Clorin, safe water storage and hand-washing? *(Choose one)*

1 Prevention of diarrheal disease
2 Treatment of diarrheal disease

Q14. What is the correct dose of Clorin in a 20-litre container of CLEAR water? *(choose one)*

1 ½ capful
2 1 capful
3 I don't know
4 Other (specify) _____

Q15. What is the recommended time to wait after dosing CLEAR water with Clorin for water to be safe? *(choose one)*

1 Less than 30 minutes
2 30 minutes or more
3 Don't know
4 Other (specify) _____

Q16. What is the recommended time for "*Rubbing fingers & palms"* during hand washing? *(Choose one)*

1 Less than 10 seconds
2 10-15 seconds
3 Don't know
4 Other (specify) _____

C. Health Staff practice on safe water and hand hygiene

Q17. Which water sources should be treated? *(Multiple responses possible.)*

1. Rain water
2. Well water
3. Spring water
4. Lake water
5. River
6. Tap water
7. All water sources

Q18. Which period of the year should water be treated? *(Choose one)*

1. Dry season
2. Rainy season
3. All seasons

Q19. For which purpose should we use treated water? *(Circle all that reply)*

1. Drinking
2. Washing fruits and vegetables
3. Washing utensils
4. Washing hands
5. Cooking
6. Other (specify) _____

Q20. When should one wash his/her hands? *(Circle all that apply)*

1. Before/after eating
2. Before/after food preparation
3. After visiting the toilet
4. After cleaning a child who has defecated
5. When they are dirty
6. After coughing, sneezing or blowing your nose
7. Don't know
8. Other (specify) _____

Q21. What are the best types of vessels (water containers) to use to prevent recontamination? *(Multiple responses possible)*

1 Modified clay pots / jerry cans
2 Containers with a narrow mouth, lid and spigot
3 Don't know
4 Other (specify) _____

THANK YOU

Appendix 3

CHAZ and CDC's Water Treatment and Hand washing Evaluation

PATIENT EXIT INTERVIEW

Province: _____ **Date: _____**

Q1. Name of health facility: _____
Q2. Interviewer's name: _____
Q3. Respondent Gender: M___F____
Q4. Respondent's age at last birthday _____
If they don't know, can ask about agemate, ID card, historical event around time of birth.

Q5. Respondent's village: _____
Q6. Respondent's district: _____
Q7. Which department did you visit in the facility today? _____
Q8. What was the reason for you (or your child's) visit today? (*Do not read. Multiple responses possible.)*

1 Diarrhea
2 Don't Know
3 Other (specify) _____

Q9. Have you or a household member had diarrhea within the last 7 days?

1 Yes
2 No

Socioeconomic information

Q10. What is your marital status?

1 Married
2 Single
3 Widow
4 Separated/divorced

Q11. Total number of children of respondent: _____
(Anyone they care for in their home.)

Q12. Total number of children under the age of 5: _____

Q13. Number of people living in your household: _____

Q14. What is your highest level of education? *(circle one)*

1 None
2 Some primary school
3 Completed primary
4 Some secondary school
5 Completed secondary school
6 Trade school or university
7 Other (specify) _____
8. Refuse/Don't know

Q15. Do you have tenants in your house, or is it owned by you/your family?

1 Owned
2 Rented
3 Don't know
4 Other (specify) _____

Q16. Does your house have electricity?

1 Yes
2 No
3 Other_____

Q17. Which (and how many) of the following does your household own? *(Write the <u>number</u> owned next to each asset. Read EVERY option)*

1 Grinding mills: _____
2 Sewing machine: _____
3 Ox-ploughs: _____
4 Gas/Electric cooker: _____
5 Telephone (*landline/mobile)*: _____
6 Bicycle: _____
7 Boats: _____
8 TV: _____
9 Radio: _____
10 Motorcycle: _____
11 Vehicle: _____
12 Refrigerator

Knowledge and practice of water treatment

Q18. Do you do something to make your drinking water safe?

1 Yes
2 No → **skip to Q20**
3 I don't know → **skip to Q20**

Q19. What do you do? (*Do not read. Multiple responses possible.)*

1 Boiling
2 Filtration
3 Sedimentation
4 Clorin
5 Others (specify)_____

Q20. Have you heard of Clorin liquid?

1 Yes
2 No → **skip to Q36**

Q21. How did you hear about it? *(Do not read. Multiple responses possible. Probe.)*

1 This health facility (today)
2 This health facility (on previous occasions)
3 Other health facility
4 Community health worker (incl. TBA, support groups)
5 Brochure / poster
6 Community gathering
7 Neighbor / family / friends
8 Radio
9 School
10 Other (specify)_____

Q21a. Were you taught about Clorin during your clinic visit today or during a previous clinic visit?

1 Yes, today
2 Yes, previous visit
3 No → **skip to 23**

Q22. Describe what you learned in your own words about Clorin during your clinic visit (today or previously). (*Do not read. Multiple responses possible. Probe for responses and ask "anything else" after each response.)*

1 Where to purchase Clorin
2 How much Clorin to use
3 What to use Clorin for (e.g. drinking water, hand-washing, washing vegetables etc.)
4 How long to wait before drinking water treated with Clorin
5 How to store Clorin
6 That Clorin is a prevention against diarrhea
7 Don't remember
8 Don't know
9 Was not taught anything
10 Other (specify) _____

Q23. Have you ever used Clorin?

1 Yes → **skip to Q25**
2 No

Q24. Why not? (*Do not read. Multiple responses possible)*

1 Expensive
2 Bad taste/smell
3 Don't need/ my water source is safe
4 Don't know where to buy it
5 No Clorin in the house
6 Too busy
7 I treat my water using another method
8 Other (Specify) _____

After all responses skip to Q30

Q25. Have you ever bought a bottle of Clorin?

1 Yes
2 No
3 Don't know

Q26. Has someone given you a bottle of Clorin?

1 Yes
2 No
3 Don't know

Q27. Do you have a bottle of Clorin in your home now?

1 Yes
2 No
3 Don't know

Q28. Did you use Clorin to treat your water today?

1 Yes → **skip to Q30**
2 No
3 Don't know

Q29. When did you last treat your water with Clorin?

1 Less than 24 hours
2 24 hours or more
3 Can't remember / don't know
4 Other (specify) _____

Q30. After treating your water with Clorin, when is it safe to drink? *(Choose one. Do not read.)*

1 Less than 30 minutes
2 Thirty minutes or more
3 Don't know
4 Other (specify) _____

Q31. Where should you keep your bottle of Clorin? *(Do not read. Multiple responses possible. Probe for responses and ask 'anything else' after each response.)*

1 Out of sunlight (cupboard)
2 In a cool dry place (cupboard, away from fireplace)
3 Out of reach of children (in a high place, cupboard)
4 Don't know
5 Other (specify) _____

Q32. Where can you purchase Clorin? (*Do not read responses. Multiple answers possible.)*

1 Community Health Worker
2 Retail shops / Supermarket
3 Hospital canteen
4 Chemist
5 Market
6 Don't know
7 Other (specify) _____

Q33. How much Clorin should you add for CLEAR water in a 20liter container? *(Do not read responses.)*

1 ½ capful
2 1 capful
3 Don't know
4 Other (specify) _____

Q34. Apart from drinking, should you use your treated water for any other purpose?

1 Yes
2 No → **skip to Q36**
3 Don't know → **skip to Q36**

Q35. What other purposes (apart from drinking) should you use the treated water for? (*Do not read. Multiple responses possible. Probe for responses and ask "anything else" after each response.)*

1 For washing utensils
2 For washing fruits and vegetables
3 Cooking
4 For washing hands
5 Other (specify)_____

Q36. Were you taught anything about drinking water storage during your clinic visit today or during a previous clinic visit?

1 Yes, today
2 Yes, during a previous visit
3 No → **skip to Q38**

37. Describe what you learned in your own words about drinking water storage from your clinic visits (*Do not read. Multiple responses possible. Probe for responses and ask "anything else" after each response.)*

1 Water storage practices can contaminate clean water (e.g. dirty hands, open container, dirty container)
2 Use a lid
3 Use a container with a narrow mouth
4 Use a container with a spigot
5 Don't remember
6 Other (specify) _____

Q38. What are the best types of vessels for storing drinking water? *(Do not read responses. Multiple responses possible)*

1 Containers with a narrow mouth and lid
2 Bucket with lid and tap
3 Bucket with lid
4 Bucket
5 Traditional clay pots
6 Don't know
7 Other (specify) _____

Q39. Were you taught about hand washing during your clinic visit today or during a previous clinic visit?

1 Yes, today
2 Yes, previous visit
3 No → **skip to Q41**

Q40. Describe what you learned in your own words about hand washing during your clinic visit(s) (today or previous visits). (*Do not read. May have more than one response. Probe for responses and ask "anything else" after each response.)*

1 When to wash my hands
2 Use soap
3 Use of clean towel/air dry
4 How long to wash hands for
5 Where to wash (between fingers and under fingernails)
6 It prevents diarrhea
7 Don't remember
8 Other (specify) _____

Q41. How do you wash your hands? (*Do not read. Multiple responses possible. Prompt for responses.*

1 I use soap
2 I rub my hands together for 10-15 seconds
3 I rub between my fingers
4 I rub under my finger nails
5 I rinse the soap off
6 I wipe my hands with a clean towel/air dry my hands
7 I use running water
8 Other (specify) _____

Q42. When should you wash your hands with soap? *(Multiple responses possible. Prompt until respondent can't answer.)*

1 Before eating
2 Before food preparation
3 After visiting the toilet
4 After cleaning up a child who has defecated
5 Don't know
6 Other (specify) _____

Q43. What is the recommended time for "*Rubbing fingers and palms*" during hand washing?

1 Less than 10 seconds
2 10-15 seconds
3 Don't know
4 Other (specify) _____

Q44. What other comments do you have regarding the teaching you received about Clorin, drinking water storage and hand washing from your clinic visit(s)? (*Probe for answers).*

_____
_____
_____

THANK YOU!

Interviewer's comments

_____
_____
_____

Questionnaire checked by _____ Date_____
(Day/month/year)

HOUSEHOLD OBSERVATIONS

READ: Now I would like to observe you washing your hands as you would normally do. This will help us to understand what is normally being done in the community.

1. Do you have soap in the house? 1) Yes
2) No ⇒SKIP TO 3

2. Can you show me?
Soap observed 1) Yes 2) No

3. Where do you wash your hands?
Are soap, water, basin present in one place? 1) Yes 2) No

Observe the hand washing practices and circle appropriately:

4. Respondent wets hands 1) Yes 2) No
5. Respondent uses soap 1) Yes 2) No
6. Respondent lathers all surfaces thoroughly
(*lathers front of hands, back of hands and between fingers*) 1) Yes 2) No
7. Respondent rinses hands 1) Yes 2) No
8. Respondent air dries hands 1) Yes 2) No
9. Uses towel to dry 1) Yes 2) No

10. Can I see your drinking water storage container? *(Confirm presence and circle one)*

1. Ordinary clay pot
2. Plastic jerry can
3. Plastic or metal bucket

4. Container with tap
5. Superdrum/ tank
6. Other, specify _____

11. Container has a lid or cap? (*Confirm by observation*)
1) Yes
2) No

Observations Part II. Main roofing wall and floor material for the household's dwelling:

12. Roof	13. Wall	14. Floor
1) Grass thatch	1) Mud	1) Dung/Earthen
2) Iron sheets	2) Cement	2) Cement/Plaster
3) Tiles	3) Bricks/Blocks	3) Tile
4) Cement	4) Timber	4) Wood

15. Do you have a latrine? 1) Yes
2) No ⇒SKIP TO 17

16. Can you show me your latrine?

Latrine observed around compound 1)Yes 2) No

17. Do you have a bottle of clorin in your home now? 1) Yes
2) No ⇒ END INTERVIEW

18. Can you show me?

Clorin observed 1) Yes ⇒ Test for chlorine Q19.
2) No ⇒ END INTERVIEW

19. TEST FREE CHLORINE Positive (immediate pink color change) Negative

Surveyor's comments: _____

THANK YOU VERY MUCH.