Introducing Purified Water To Thomassique, Haiti

Report on a Pilot Study

Principal Investigators:
Rita Baumgartner
Nicholas Cuneo

Adjunct Investigators:
Christina Booth
Meryl Colton
Kathleen O'Neill
Kavita Vinekar

Senior Advisor:
Peter J. Dirr, Ph.D.

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Abstract

This study was conducted to explore if home-based water purification is feasible in Thomassique, Haiti. The study provided an opportunity to document residents' current practices regarding drinking water and sanitation. It also tested the effectiveness of two affordable water purification systems, a granulated chlorine system (Klorfasil) and a solar disinfection system (SODIS).

Sixty households in eastern Thomassique were recruited to participate in this study. They were randomly assigned to three groups: Klorfasil, SODIS, and Control.

Two Global Health Fellows who were serving for one year at St. Joseph clinic in Thomassique carried out the study. Besides recruiting participants, the Fellows conducted pre and post oral interviews and gave a short lesson on basic hygiene and how to use the water purification systems properly.

Data showed that more than four of five households depend on public water fountains for their drinking water. Women and children under 15 walk an average of 30 minutes each day to fetch drinking water for the family. About 1/3 of the participants think the water from the public fountains is potable (it's not), another 1/3 are not sure, and 1/3 know it is contaminated. One-half of the participants are prepared to pay for a filter or chemicals to treat their drinking water. Fewer than 12% of the households has a latrine (none have proper toilets), and 94% dispose of children's stool by leaving it out in the open.

Data also showed that treatment of drinking water jumped when residents had water purification systems in their homes. There was also a dramatic reduction of diarrhea in children under 5.

This study provides sufficient evidence that the people of Thomassique recognize that water purification is a helpful tool for reducing illnesses, especially among children; that home-based water purification can be affordable and effective in Thomassique; and that a graphic-based education program is a helpful tool for promoting appropriate uses of home-based water purification systems. Based on the results of this study, plans can be made to extend the use of home-based water purification systems.

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Study Background

Thomassique, Haiti, is a poor, rural community of approximately 60,000 to 80,000 people, located in Haiti's Central Plateau, not far from the border with the Dominican Republic. Thomassique's major source of water is a spring located approximately 15 miles away in the town of Cerca-la-Source. The water delivery infrastructure, an aqueduct consisting of a 5" PVC pipe, was constructed in the 1980s. Approximately 15% to 20% of Thomassique residents have water piped to their households, a single spigot near their front doors. All other residents get water from public fountains (tiyos), often having to walk miles to retrieve the water. Tests of the water from all these sources consistently reveal high levels of bacterial contamination.

Global Health Fellows, graduates of U.S. universities, who volunteer to work for a year at St. Joseph's Clinic in Thomassique, conducted this study. The Clinic, constructed in 2006 by Medical Missionaries, is the first permanent medical facility in Thomassique and the surrounding region. In total, it serves about 125,000 people throughout the region, treating an average of 25,000 to 30,000 patients each year. Many of those patients suffer from illnesses caused by contaminated water. That is also seen as a major cause of infant deaths in the region, which are ten times as high as in the United States.

This study is part of an ambitious program to address some of the underlying causes of health problems in the region. Because potable water is such an essential element of basic healthy living, we wanted to explore whether "point of use" (POU) (i.e., home-based) water purification is feasible in the culture and living conditions of most of the residents of Thomassique. We considered other types of water purification, including community purification plants in various locations, but we believe that POU systems might be most suitable for the conditions in this region.

This pilot study sought to learn more about residents' current drinking water and sanitation practices and to test two low-cost, home-based "point of use" systems. The two systems that were chosen for testing were solar disinfection (SODIS) and a granulated chlorine system (Klorfasil). SODIS was selected because it can be implemented easily and at little or no expense (just the cost of getting two-liter plastic bottles). To use this system, a family places two-liter #1 plastic bottles filled with water from any source in the sun (often on their corrugated metal roofs). Six hours of exposure to the sun's ultra-violet (UV) rays purifies the water. Klorfasil was selected because it can be implemented easily at very little expense ($10 the first year; $4 in subsequent years). A five-gallon bucket (with a spigot on the bottom) is filled with water from any source. A small, pre-measured quantity of granulated chlorine is added and the bucket is covered. The water is purified and ready to drink 30 minutes later.

The study focused on 5 issues related to potable water:

1. Residents' current drinking water and sanitation practices
2. Residents' opinions regarding the quality and accessibility of water in their community
3. Rates of diarrheal diseases among children under 5 years old
4. Residents' willingness to invest in home-based water purification
5. Relative effectiveness of two different home-based water purification systems among residents of Thomassique

The Study Sample

The participants in this study consisted of the residents in 60 households living in the northeastern zone of Thomassique. The study design called for the households to be randomly assigned to three treatment groups of 20 houses each. The three groups were (1) a control group, (2) water purification by granulated chlorine (Klorfasil Group), and, (3) water purification by solar disinfection (SODIS Group). The person in the household to which the survey and educational information were directed was the head woman of the household.

This population was chosen for the study for three reasons. First, the northeast zone of Thomassique is remote from downtown Thomassique and the households were not likely to be on the water distribution system (i.e., the participants did not have water delivered directly to their homes). Second, the Medical Missionaries Fellows, who carried out the pilot study, live at Saint Joseph Clinic, which is located in northeast Thomassique. Therefore, any participants with questions, comments, or problems, had easy access to the Fellows. Third, the head woman of each household was selected as the target for the survey and education because, as the person doing most of the childcare, food preparation, and cleaning, she would be most familiar with the precise water situation. Furthermore, because the women are the primary care providers, they were considered the best source to pass on the information they learned regarding proper water treatment and sanitation to their children.

Participants were recruited through personal contact by the Medical Missionaries' Global Health Fellows, who were acquainted with many people living in the northeast zone of Thomassique due to their work at Saint Joseph's Clinic, their other community outreach efforts, and the fact that they are easily identifiable as the only foreigners in Thomassique. The Fellows visited the homes of people living in the area, usually working in pairs so that one could take notes and record data. They visited the homes by foot, the only way most of them could be reached, the majority being situated along dirt paths. The Fellows asked the residents if they would be willing to participate in the study. They interviewed the head woman of each household using a consistent interview protocol. (Appendix A) This method of recruitment was chosen because many of the residents of this zone are not literate and thus any written questionnaires, advertisements, or flyers were not practical for much of the target population. The Fellows visited people's homes in the late afternoon, between 3:30 PM and 6 PM. This time was chosen

because the afternoon meal would have already been prepared and any family members who were working in the fields or doing other tasks would have returned.

Recruitment of the sample proceeded largely according to design. At the end of the recruitment process, 60 households had agreed to participate. One household dropped out of the study after the pre-intervention interview. (Repeated visits to the house failed to find the residents.) It had been assigned to the Control group. The households were randomly assigned to the three conditions, adhering as closely as possible to the original study design.

Table 1. Experimental Grouping

	Frequency	Percent
Klorfasil	20	33.3
Solar disinfection	19	31.7
Control	21	35.0
TOTAL	60	100.0

Even though efforts were made to be as scientific as possible in recruiting participants for this study and randomly assigning them to the three conditions, the sample cannot be said to represent all the residents of Thomassique because participation was voluntary.

The Study Protocol

After households agreed to participate in the research, the main woman of the house was led through an oral informed consent process and asked to sign an informed consent form and a photo consent form on behalf of all the residents of the house. (Appendix B) The next step was a pre-intervention oral questionnaire designed to gain information regarding participants' current drinking water and sanitation practices, participants' opinions regarding the quality and accessibility of water in their community, rates of diarrheal diseases among children under 5 years old in each household and participants' willingness to invest in public and private home-based water purification interventions. (Appendix C) This questionnaire was based on "Core questions on drinking water and sanitation for household surveys," 2006 standards from the World Health Organization (WHO) and the United Nations International Children's Education Fund (UNICEF). The same questionnaire was used with all three study groups.

For each child under 5 years of age who is reported to have had diarrhea in the past two weeks, the researchers intended to asses the severity of the child's dehydration based on the clinical classification of severity of dehydration taken from "Lecture Notes on Tropical Medicine," edited by G. Gill and N. Beeching (2007). This system (Appendix D), which classifies individuals into three groups (mild, moderate, and severe dehydration), was chosen to ensure that any children with severe dehydration received medical attention. This part of the protocol was dropped out of concern that the Fellows, in applying these criteria, might be perceived as physicians (which they were not). Any participating children who appeared to have diarrhea were referred to the clinic for diagnosis.

The next step of the study was a short education session, which took place approximately 2 weeks after the initial administration of the questionnaire. The Fellows visited each family and gave a lesson on basic causes of diarrheal disease, safe stool disposal, hand washing, approaches to improve household drinking water quality, and how a household can benefit from improved drinking water quality and sanitation. The lessons were given orally, usually at the participants' houses, and contained pictures and graphic demonstrations to aid in comprehension. (Appendix E) This lesson lasted approximately 20 minutes. All three groups in the study received the same initial 15-minute presentation. After the general presentation, each study group received a unique 5-minute additional presentation focused on the intervention specific for that group. The three focused presentations addressed:

1. General review of all other information covered in original lesson (Control Group)
2. Use of chlorine to treat drinking water (Klorfasil Group)
3. Use of solar disinfection to treat drinking water (SODIS Group)

Additionally, participants in the Klorfasil Group were given a "Klorfasil" system (a covered bucket with a spigot on the bottom and enough chlorine to treat 5 gallons of water each day for 12 to 18 months). These participants were asked to attend another education session run by the Klorfasil representative from Hinche. That lesson focused on the correct use of the system. Participants in the SODIS were given two clear plastic, two-liter bottles per household.

The final step of the study implementation was a short post-intervention oral questionnaire. (Appendix F) This questionnaire was administered approximately one to two months after the education session. The post-intervention questionnaire contained only 7 questions, requiring no more than 10 minutes of participants' time to complete. The post-treatment questionnaire was administered to determine whether the interventions were effective in changing and sustaining people's behavior.

Data Analyses

The Global Health Fellows recorded all the data in this study manually and in real time. (Note: Although this report is in English, the interviews, lessons, and educational materials used in the study were in Creole.) On returning from the field, they transferred the data to an Excel spreadsheet. The data were then exported from Excel to SPSS for final analysis.

Study Limitations

This was a small pilot study to evaluate whether either or both interventions are appropriate for use in the Thomassique region and whether they are effective for the people of the region. The small numbers involved in the study don't provide the statistical stability needed to determine effectiveness with a high degree of confidence. Furthermore, although efforts were made to implement sound procedures (e.g., randomly

assigning participating houses to the three treatment groups), conditions sometimes required small modifications to the procedures.

Another limitation was that no effort was made to track and document treatment fidelity or cross-group contamination. Although the respondents were asked if they were treating drinking water, there was no measure of how consistently they treated it, whether all members of the household drank only treated water, or how accurate they were in implementing the treatment regimen.

Finally, it was not always possible to obtain reliable information (e.g., children's ages and the incidence of diarrhea), thereby further limiting the number of cases that were usable for data analysis.

Because of these limitations, the results of this study should be seen as tentative and preliminary to a larger and more systematic study as the interventions are introduced to larger populations.

Findings

This study provided enough information to begin to formulate answers to the issues it set out to study. The small numbers of participating households in each of the three groups make it difficult to place full confidence in the findings. However, the results cited below provide enough evidence to suggest that both interventions be continued and expanded for further study.

A. Baseline Data

Once the sample was selected, each household was visited in person to establish baseline data. A consistent protocol was used for all the interviews. (See Appendix C.) The results of those interviews provided baseline data for this study. They also provided very helpful insight into some of the living conditions in one part of Thomassique, the northeast section. Understanding those conditions will help the staff or St. Joseph's clinic work with the people of Thomassique to address some of the underlying causes of health problems in the region.

Table 2. Household Demographics

	Frequency	Mean
No. of Residents in House	60	7.2
No. Children in House	60	4.4
No. Children Under 5 in House	60	1.6

We learned that although most houses in the region are about 420 square feet in size, an average of seven people live in each house. This ranged from one person in the house to fourteen. Four of the residents in the average house are children, half (2) being 5 years old or younger. (Five of the 60 houses had no children. One had ten children.) The head

woman of the house is, on average, 37 years old (ranging from 18 to 70 years old). She had delivered an average of 6 children.

Main Water Source

The residents of the northeast section of Thomassique do not have water delivered to their homes. We wanted to learn more about what sources they turn to for daily water, how long it takes them to get the water, and who fetches it. We learned that four out of five households in this region of Thomassique get their water daily from public taps (called "tiyos"). The other one-fifth of the households relies on surface water, specifically a river or canal.

Table 3. Main Water Source

	Frequency	Percent
Public tap/ standpoint	49	81.7
Surface water (river, canal)	11	18.3
Total	60	100.0

We also wanted to know whose job it is each day to fetch the water and how long it takes them to do that. We learned that a variety of household members are responsible for fetching the water each day. The adult woman of the house is most often responsible for fetching water, followed by both male and female children under age 15. Most travel a long distance to retrieve water, averaging 31 minutes. The range is from 2 minutes to 90 minutes. In 20% of the houses, it takes the responsible person 60 minutes or more to fetch the water each day.

Table 4. Who Fetches The Water

	Count	Pct of Responses	Pct of Cases
Adult Woman	36	40.0	60.0
Adult Man	6	6.7	10.0
Female Child Under 15	19	21.1	31.7
Male Child Under 15	19	21.1	31.7
Everyone in the House	10	11.1	16.7
Responses (multiple Responses allowed)	90	100.0	150.0

We knew from tests we had done at various spots in Thomassique that water from all sources is contaminated. We wanted to find out what the residents thought about the quality of their water. They were about evenly divided in their beliefs. One-third thinks

the water at the public fountains is potable, one-third thinks it is not, and one-third doesn't know.

Table 5. Believe Public Fountain Water Is Potable

	Frequency	Percent
Yes	19	31.7
No	20	33.3
Don't Know	21	35.0
Total	60	100.0

The respondents were asked how they could tell if water from the public fountains is good to drink. Only 2% thought you could tell by looking at the water. Almost half thought you can't tell whether the water is potable or not. Almost half suggested "other" ways they thought they could spot potable water.

Table 6. How To Tell If Water Is Good To Drink

	Frequency	Valid Percent
Can't tell	29	49.2
By looking at it	1	1.7
Other (specify)	27	45.8
Don't know	2	3.4
Total	59	100.0

The "other" ways suggested for spotting potable water included a wide range of opinions, but one stood out. Almost half said they rely on the source of the water, where it comes from. Some mentioned specific sites such as a river or a ravine as being especially dangerous sites. Another one-fifth of those citing "other" ways said something similar to this respondent: "when water is kept in a jar, little bugs start to grow after three days." One thought the water would be good if "it doesn't smell." Two said it must be OK if it "doesn't kill us" or "doesn't make us sick."

Only one respondent voiced an opinion, "if you are used to it, it won't cause you harm." The majority of the respondents did not share that opinion. More than two-thirds (68%) said they know that unclean water can make them sick. One-sixth denied that and another one-sixth said they do not know.

Rates Of Diarrheal Diseases Among Children Under 5 Years Old

One of the consequences of drinking contaminated water is manifest in repetitive bouts of diarrhea. This tends to especially affect the very young and the very old. We sought to document the rate of diarrhea among children under the age of five. The respondents reported having 242 children living in their houses (Mean = 4 per house), of whom 98 were under the age of five (Mean = 2 per house). We tried to learn the ages of the children under five but were successful in only about one-third of those cases (34 children). Therefore, these data might or might not be representative of the situation in

this northeast sector of Thomassique. Where we were able to collect data, the children ranged from 2 months old to five years, with the average age being about 30 months (two and a half years). The incidence of diarrhea in those children over a two month period immediately prior to the interviews ranged from two to fifteen times, with an average of five or six times. This could indicate widespread parasites, possibly from drinking contaminated water.

Residents' Experience With Treating Water

As we started this experiment to explore the effectiveness of two home-based water purification systems, we wanted to know what experience the residents might already have had with water purification. We asked if they were currently treating water before they drank it, if they did so in the past, and how they treated water, if they did.

Table 7. Current Practice Of Treating Drinking Water

	Frequency	Percent
Yes	9	15.0
No	28	46.7
Used to but don't now	23	38.3
Total	60	100.0

We learned that only 15% of the households currently treat water before drinking it. We expected to find a variety of ways that water might be treated: boiling it, adding bleach or chlorine; straining it through a cloth; using a ceramic, sand, or ceramic filter; solar disinfection, or some other means. What we found was that almost all who currently filter water do so by boiling it or adding bleach or chlorine. Only one family responded that they use solar disinfection.

We found that another 38% of the households used to treat water but no longer do. ALL of them used to use Clorox for water treatment.

What would the respondents like to do to improve the quality of their water? Thirty-one respondents provided 53 responses (multiple answers were allowed), with almost an even split between those who would like to treat the water in their homes and those who would want it treated at the public taps. A smaller percentage hopes to have a water connection at their homes (which begs the question of how or where the water is treated).

Table 8. What Can Be Done To Improve The Quality Of Water

	Count	Pct of Responses	Pct of Cases
Treat water at home	22	41.5	71.0
Treat water at the public taps	21	39.6	67.7
Have a connection at their homes	9	17.0	29.0
Nothing -- it's fine now	1	1.9	3.2
Responses (multiple Responses allowed)	53	100.0	171.0

When asked if they were willing to pay for the improvement they identified, 68% said they would, 13% were not sure, and 18% said they would not pay for the improvement.

Exploring Home-Based Water Purification Options

Next, the interviews explored the resident's opinions about the use of filters and chemicals for water purification and explored further the issue of purification within the home vs. purification at public taps.

Fewer than one-third of the respondents (32%) had heard about filters to purify water. After an explanation of what was involved in using a filter to purify water, six out of ten (60%) said they would use a filter in their home; one-third (35%) were not sure; only five percent said they would not consider using a filter. When asked if they would be willing and able to pay for a filter, just under half (48%) said yes; an almost equal percentage (45%) said they were not sure.

Table 9. Use And Support Of Water Filters And Chemical Treatment

	Would Use Filter in Home		Would Pay for Filter		Would Use Chemical		Would Pay for Chemical	
	N	%	N	%	N	%	N	%
Yes	36	60.0	29	48.3	60	100.0	50	83.3
No	3	5.0	4	6.7	0	0	8	13.3
Don't Know	21	35,0	27	45.0	0	0	2	3.3
Total	60	100.0	60	100.0	60	100.0	60	100.0

When asked if they would use a chemical that could be added to household water to make it clean, ALL of the respondents (100%) responded in the affirmative. More than four out of five (83%) said they would be willing to pay for the chemical.

The respondents were asked again whether they preferred to have their water treated at the public tap or to purify it in their homes. Whereas they had been evenly split when asked the first time, the responses to this question came down more in favor of treating

water in the home (73%), although most of the respondents indicated that they could be happy if the water were treated at the public taps (86%) and that they would be willing to work with their neighbors to maintain the systems at those taps (84%).

Table 10. Preference For Treatment Of Water

	Frequency	Percent
At Home	44	73.3
At Public Taps	8	13.3
Don't now	8	13.3
Total	60	100.0

Table 11. Attitudes Toward Public Taps

	Could be Happy with Filtration at Public Tap		Willing to Work to Maintain Public Filter	
	Frequency	Percent	Frequency	Percent
Yes	44	86.3	43	84.3
No	7	13.7	8	15.7
Total	51	100.0	51	100.0

Household Sanitation

The final portion of the pre-intervention interviews focused on sanitation facilities and practices, critical elements related to the health of a community. We wanted to learn what sanitation facilities each house had, whether they shared those facilities with other households, and how they dispose of children's feces. In other parts of Haiti, there is a variety of sanitation facilities, ranging from flush toilets to ventilated, improved pit latrines, pit latrines with slabs, pit latrines without slabs, composting toilets, buckets, and no facilities at all (where people use the field and bushes). We learned that in this part of Thomassique there are only two types of sanitation, pit latrines with slabs (12%) and none at all (88%). None of the respondents indicated that they shared their sanitation facilities with other households

Table 12. Type Of Toilet Facilities At Home

	Frequency	Percent
Pit latrine with slab	7	11.7
No facilities -- field, bush	53	88.3
Total	60	100.0

As an indication of sanitary practices, we asked households that have children how they disposed of the child's last stool. Of the many possible responses (flush it, put it in a latrine, bury it, throw it in the garbage, place it in a pit or ravine), the 47 households that responded indicated only two practices: 6% put the stool in a latrine; 94% left it in the open

Table 13. Disposition Of Child's Stool

	Frequency	Percent
Put/rinsed in toilet/latrine	3	6.4
Left it in the open	44	93.6
Total	47	100.0

That concludes the baseline data gathered prior to the intervention. They provide a helpful view of underlying health conditions in the northeast sector of Thomassique.

B. Post-Intervention Data

Following the pre-intervention interviews, the houses were given the interventions. Each house in the SODIS group received two clear plastic bottles, along with instructions on how to use them appropriately. The head woman from each house in the Klorfasil group was invited to attend a training session provided by a Klorfasil representative at St. Joseph's clinic. Following that session, the women were given a Klorfasil system (bucket with tap and cover and a year's supply of granulated chlorine). Both groups were taught the importance of implementing the intervention according to the instructions they had received. The houses in the control group received instruction about general hygiene and the importance of washing hands.

About one month after the interventions, each house was re-visited to see how the interventions were being implemented and to gather some follow-up measures of success. One household dropped out of the study, leaving a total N of 59.

The head woman of each house was asked a series of questions, most of which paralleled questions asked in the pre-intervention survey.

Currently Treating Water

Two of the groups (Klorfasil and solar disinfection – SODIS) received resources for treating water; the third group received education on the importance of hygiene but received no resources for treating water. We wanted to know if the two experimental groups were following through with the treatment and whether the Control group had started water treatment on their own. We found that all (100%) of the SODIS households reported that they were treating water; four fifths of the Klorfasil households had implemented the treatment. This was a big increase over the incidence of treatment prior to this project. Sixteen percent (16%) of the Control households were treating water without any special intervention from this study.

Table 14. Current Practice Of Treating Drinking Water

Pre-Treatment				Post-Treatment		
Klorfasil	SODIS	Control		Klorfasil	SODIS	Control
5 23.8%	2 10.5%	2 10.5%	Yes	17 81.0%	19 100.0%	3 15.8%
10 47.6%	9 47.4%	9 47.4%	No	3 14.3%		9 47.4%
6 28.6%	8 42.1%	8 42.1%	Used to but don't now	1 4.8%		7 36.8%
21 100.0%	19 100.0%	19 100.0%	TOTAL	21 100.0%	19 100.0%	19 100.0%

We probed further to see why four households in the Klorfasil group were not using the system to purify water. We found that there was a temporary problem in two of the four cases. One woman had not taken the bucket system with her following the education session. Now she wants the system and intends to use it. Another woman used the system for a few weeks then had a problem with the spout. She stopped using it until one of our researchers fixed the problem for her. Now she will be using the system again. A third woman provided confusing information. She said that she was treating the water "sometimes" and asked for more bottles (which was more consistent with a response that might have been expected from the SODIS group rather than the Klorfasil group). The fourth case was more problematic: the woman reported that the Klorfasil system "made everyone sick," so she stopped using it. Now she wants to try the SODIS system. She is the only one of the four who indicated that she preferred a different system after reporting a problem with the Klorfasil system

A fifth woman reported that she had been dissatisfied with the Klorfasil system at first because she had a stomach ache when she first used it. Nevertheless, she continued to use the system and felt fine in a short time.

Almost nine out of ten of the households in the Control group reported that they were not happy with their water. This reinforced the findings from the pre-intervention survey that showed that most households want to have some way to purify their drinking water.

Impact of Treatment on Children's Health

We wanted to see if the introduction of water purification had any measurable effect on the incidence of diarrhea in children under five. We had trouble getting reliable reports of the ages of the children in the participating households. Consequently, we limited our data analyses to the 24 children for whom we had reliable reports of the incidence of diarrhea in the two weeks immediately preceding each interview. The findings were quite dramatic and, if they are substantiated by further study, are strong testimony to the importance and effectiveness of purifying drinking water for children under five years of age.

Table 15. Diarrhea in Children Under the Age of Five

	Klorfasil	SODIS	Control
Number in sub-sample	8	5	11
Average Pre-treatment incidence	5.6	5.6.	5.7
Average Post-treatment incidence	1.0	1.0	3.2
Reduction in diarrhea	4.6	4.6	2.5

The data show that the incidence of diarrhea was greatly reduced in both experimental groups immediately following the start of water purification. Prior to treatment, the average number of bouts with diarrhea for the sub-sample was 6 incidents (5.7) per child in the two months preceding the start of this study. In the post-treatment survey, the average number of incidents reported for the same children was 2. All three groups reported improved health but the improvement in the two experimental groups was far greater than in the Control group. Whether the improvement in the Control group can be attributed to the heightened awareness of hygiene from the education session or to chance needs to be probed in further study.

Changes in Sanitation Practices

We wanted to see if heightened awareness of good hygiene practices and a focus on water purification to improve children's health would have a residual impact on sanitation practices, specifically the use of latrines and sanitary disposition of children's stool. While we found some small differences, it is not clear whether they are significant or due to differences in the number of houses reporting pre and post treatment data.

Table 16. Sanitation Facilities And Practices

Pre-Treatment				Post-Treatment		
Klorfasil	SODIS	Control		Klorfasil	SODIS	Control
			Toilet Facilities			
2 9.5%	2 10.5%	3 15.8%	Pit latrine with slab	2 9,5%	2 10.5%	3 15.8%
			Pit latrine without slab		1 5.3%	2 10.5%
19 90.5%	17 89.5%	16 84.2%	No facilities--bush, field	19 90.5%	16 84.2%	14 73.7%
21 100.0%	19 100.0%	19 100.0%	TOTAL	21 100.0%	19 100.0%	19 100.0%
			Disposition of Child's Stool			
1 6.3%		2 11.1%	Rinse/put in latrine/toilet	1 6.7%		5 27.8%
15 93.7%	12 100.0%	16 88.9%	Left in open	14 93.3%	10 100.0%	13 72.2%
16 100.0%	12 100.0%	18 100.0%	TOTAL	15 100.0%	10 100.0%	18 100.0%

Discussion

This study probed the current conditions, attitudes, and practices regarding drinking water and hygiene in Thomassique, Haiti. It also explored the appropriateness and effectiveness of two home-based water purification systems for the people who live there.

The study gave us valuable information for better understanding life in Thomassique. For example, we learned that the average number of persons living in the households studied was seven (7). Fewer than 12% of the households have a latrine. None of the households has water at the house: all have to walk to a public fountain (88%) or a surface source such as a river or canal (12%) to fetch water. In most cases, the woman of the house (40%) or children under age 15 (40%) fetch the water. The average time it takes to fetch water is just over 30 minutes, but for 20% of the households it is 60 minutes or more.

We learned that the people of Thomassique recognize the benefit of treating drinking water, especially to protect children from water-borne diseases. Most of the houses in the two experimental groups intend to continue purifying water. More than 84% of the households in the Control group reported that they wanted a purification system. The people of Thomassique are willing to adopt almost any purification system that is effective at filtering out water contaminants.

The education program that was developed to teach basic hygiene and how to use the experimental purification systems was effective and well-received by the people of Thomassique. They understood the lessons and implemented the hygiene practices and water purification procedures taught in the lessons. Heightened awareness of good hygiene practice might have had a small carryover effect on sanitation practices of the participating households.

The solar disinfection water purification system (SODIS) was well received by all (100%) of the households in that experimental group. Most of the households in that group found it easy to implement. Later follow-up found that some of the households were experiencing difficulty obtaining additional plastic bottles, something that will have to be addressed as the program expands.

The Klorfasil water purification system was well received by all but one of the households in that experimental group. All the others found it easy to use. Klorfasil's community-based staff easily remedied the problems that two households experienced with the technology.

Both the SODIS and Klorfasil systems had a dramatic impact on reducing the incidence of diarrhea in children under five years of age. This is perhaps the most important finding of this study. As the water purification program expands to include entire neighborhoods and/or villages, the staff at St. Joseph clinic should expect to see fewer patient visits for water-borne illnesses from those areas.

In summation, this study provides sufficient evidence that:

(a) the people of Thomassique recognize that water purification is a helpful tool for reducing illnesses, especially among children;
(b) home-based water purification can be affordable and effective in Thomassique; and,
(c) a graphic-based education program is a helpful tool for promoting appropriate uses of home-based water purification systems.

Based on the results of this study, plans can be made to extend the use of the two home-based water purification systems that were tested. Those plans should include further research on issues raised but not fully addressed by this study as well as further community education on sound principles of hygiene and effective practices for water purification.

Appendix A
Initial Interview Protocol

Good afternoon! How are you this afternoon? How is your family? May we please speak to the head woman in the household?

Our names are Rita and Nick and we work in Clinic Saint Joseph, in the Pierre-Louis zone. We are very interested in how people in this neighborhood obtain their water and what sanitation and hygiene practices people use. We are doing a research project to learn more about water in this zone and how people think it could be improved.

For our project, we would like to ask you some questions regarding how many people live here, if people in your home have had diarrhea, where you get your water from, and where you go to the toilet. After we ask these questions, we would like to return to your home to do an education session about how clean water and better sanitation can improve your life. After the education, we would like to return to your home three times to ask you a few additional questions. Each time we visit your home and ask you questions, we will give you three bars of soap to thank you for the time you gave to help us.

Do you think you would like to help us with this project?

Yes—Thank you very much! We are very interested in learning more about your situation here. Can we ask you some questions now? (Go to Consent Form – Appendix B)

No—Thank you very much for your time. We hope that everyone in your home is healthy and have a good day!

Appendix B
Oral informed consent forms, with fingerprint

Participation Consent Form

Script: Before we begin asking you questions, we want to make sure that you understand what our project is about. We will read you this form that explains what we are going to do in our project to make sure that you want to participate.

Our project has 5 important objectives. The first is to gain a better understanding of how people in Thomassique treat their water and what sanitation practices you use. We also want to understand how you would like to improve your situation concerning water. We want to know how often the very young and very old people in your household have diarrhea. We want to know if people in Thomassique would want to give their time and money to have things that would change the quality of their water. Finally, we want to know what ways of treating water work best for the people of Thomassique.

Our project has some benefits too. All people who decide to participate will receive education and materials that will help them improve their drinking water, sanitation, and hygiene practices. This will help make everyone in your household healthier. Each time we come to visit your house, you will also receive 3 bars of soap. The information we learn from the project will be used to help more people in Thomassique have water that is safe for drinking.

There are also a few risks in our project. We will ask some personal question about your health. We will make many efforts to keep this information private. The other risk is that if you do not closely follow the directions for treating the water, it may not be completely safe. We will take great caution to make sure you understand all the directions.

If you want to quit the study at any time, you are always able to do so. Also, if we ask any questions that you do not want to answer, you do not have to answer them.

Do you have any other questions for us? If you have other questions in the future, you can always reach us at Saint Joseph Clinic, located in Pierre-Louis.

If you still want to participate, we would like you to put your fingerprint on this sheet to show that, at this time, you would like to participate in the study.

Fingerprint of participant: _____

Signature of Investigator: _____

Photo Consent Form

Script: If you agree, we would also like to take some photos of your home and where you keep your water. You can participate in the study even if you do not want us to take pictures. The pictures will be used for presentations at the clinic and future education sessions, here and abroad.

We will keep your identity private when we are using the pictures. Please let us know what parts of your home you feel comfortable with us taking pictures; we will not take pictures anywhere you don't want us to. Also, we can bring copies of the photos for you to have, if you would like them.

I agree to have my picture taken in my home showing how we treat water in our home. I agree that my picture can be used in presentations of this project and for future education sessions.

Fingerprint of participant: _____

Signature of Investigator: _____

Participant Household Number: _____

Appendix C
Pre-Intervention Oral Questionnaire

Opening questions:

1. How many people live in this house?
2. How many children under 5 years old?
    a. How many times has each child under 5 had diarrhea, more than 3 times in a day, during the past 2 weeks?
3. How many adults over 50 years old? **(Note: This question was dropped from the interviews)**
    a. How many times has each adult over 50 had diarrhea, more than 3 times in a day, during the past 2 weeks?

Questions 4-8 taken from "Core questions on drinking water and sanitation for household surveys," (WHO and UNICEF, 2006)

4. What is the main source of drinking water for members of your household?
5. How long does it take to go there, get water, and come back?
6. Who usually goes to this source to fetch the water for your household?
7. Do you treat your water in any way to make is safer to drink?
8. What do you usually do to make it safer to drink?
9. How can you tell if the water you are drinking is clean?
10. Can unclean water cause people in your household to become sick?
    a. How?
11. What would you like to do to improve the quality of drinking water in your household?
12. Would you be willing to pay for this improvement?
    a. If yes, how much?
13. Would you use a filter to clean the water in your home?
    a. Would you be willing to buy such a filter?
    b. Would you be willing to pay for maintenance?
14. Would you buy a chemical which you could add to the water you drink to make it clean?
    a. How much would you be willing to pay for this chemical?

15. Would you be happy if a filter to clean the water was built at the public water pump?

16. Would you be willing to help your neighbors pay for maintenance of the water filter at the public water pump?

    a. If yes, how much?

Questions 17-20 taken from "Core questions on drinking water and sanitation for household surveys," (WHO and UNICEF, 2006)

17. What kind of toilet facility do members of your household use?

18. Do you share this facility with other households?

19. How many households use this toilet facility?

20. The last time (name of youngest child) passed stool, what was done to dispose of the stools?

Appendix D

Classification of Dehydration Severity
(from Lecture Notes on Tropical Diseases, eds. Gill, G.V. and N.J. Beeching. Blackwell Science, Malden, MA: 2007)

	Mild	**Moderate**	**Severe**
Subjective			
General state:	Alert, active, up and about	Weak, lethargic, able to sit and walk	Dull, inactive, unable to sit or walk
Ability to perform daily activities:	Able to perform daily activities without difficulty	Able to perform daily activities with some difficulty, e.g. stays away from work, needs support	Unable to perform daily activities, stays in bed or needs hospitalization
Thirst:	Not increased	Increased thirst	Feels very thirsty
Objective			
Pulse:	Normal	Tachycardia	Tachycardia
Blood Pressure:	Normal	Normal or decrease, 10-20mmHg systolic	Decrease greater than 20mmHg systolic
Postural hypotension:	No	Yes or no	Yes
Jugular venous pressure:	Normal	Normal or slightly flat	Flat
Dry mucosa (mouth, tongue)	No	Slight	Severe
Skin turgor	Good	Fair	Poor
Sunken eye balls	No	Minimal	Sunken
Body weight loss	<5%	5-10%	>10%

Appendix E
Protocol and Materials For An Education Session

Goal of session: increase health in families in order that families can be happy, productive and safe. We want to accomplish this goal by teaching and talking about ways we can get sick from water and how we can protect ourselves and our families.

- Common illness in Thomassique—diarrhea. Diarrhea is bad because it causes us to lose nutrients and fluids from their bodies. In very young children, this can be very dangerous.
- What causes diarrhea? (ask for ideas). Microbes cause diarrhea. Do you know what a microbe is?
    - A microbe is a living thing that is very very small, too small to be seen without a microscope.
    - Microbes can cause humans to become sick and they can cause diarrhea.
    - Many bad microbes are found in feces.
    - Feces are enemy number 1!
- How can feces get to people to make them sick? (handout F diagram, next page)
    - Feces can get onto hands when people are cleaning after going to the bathroom and then microbes can be spread onto food, eaten, and people can get diarrhea.
    - Feces on the ground can get into water sources, then the water can be drunk by a child who will get diarrhea
    - Flies can spread microbes from poop onto food
- How can we protect people from contact with feces and help them stay healthy? 3 ways:
    1. Safe stool disposal
        a. Safe stool disposal for ALL stool, including children and animal stool
        b. All feces must be buried to protect other people from contact
        c. Why should we bury feces?
            i. The yard will look clean and nice for visitors
            ii. No bad smells
            iii. People will not walk in stools
            iv. The neighbors will respect our clean yard
            v. KEEPS FAMILY HEALTHY!
    2. Washing hands
        a. Washing with only water does not get rid of sticky particles that contain microbes
        b. Must use ash or soap to wash hands after going to the bathroom or cleaning up after a child.
        c. Hand washing demonstration
            i. Wet hands
            ii. Apply soap
            iii. Scrub for 20 seconds
            iv. Don't forget between fingers, back of hands, and under fingernails

v. Rinse
vi. Use a towel to dry hands that is not used for other purposes
vii. Distribute hand washing pictures

3. Treat drinking water
    a. Very important to treat water for drinking to prevent people from drinking microbes and becoming sick
    b. Clean water=better health
    c. Cannot tell if water is clean by looking at it—demonstration with two bottles, one with treated water, one without. Ask people to guess which has clean water.
    d. Ways to keep water clean:
        i. Do not put hands in container where drinking water is kept
        ii. Keep animals away
        iii. Use bottles with narrow-necks
        iv. Cover water after it is collected
        v. No defecating near water
        vi. Pay attention to your water, look for contamination as described above

Focus education sessions:

- Solar water disinfection (with instruction sheet)
    - Find a clean bottle
    - Put water in a small, clear plastic container. Close lid.
    - Bottles like this, with one side painted black, are best
    - Put water bottle on a metal sheet or on roof.
    - Leave the bottles out **for 6 hours** in the sun
    - After 6 hours on a sunny day, the water is clean!
    - On cloudy days, you must leave the bottle outside for two days.

- Chlorination
    - Chlorine is a chemical that can be added to water to kill microbes
    - Have you ever heard of the Klorfasil system? They use it in Hinche.
    - We would like you to attend a session with Madame Joslin from Hinche. She will be at Saint Joseph Clinic (insert date). She will give you the chlorination system and tell you how to safely use it. Also, when you come for this session, we will give you three more bars of soap. Please bring this paper (hand over paper indicating inclusion in study) when you come!
    - (Show example system) This is what you will use to dispense the chlorine. The most important thing to remember is to add only one dose to your water. But you must add the whole dose. (Demonstrate how it works).
    - Please make sure your children do not have access to the chlorine dispenser.
    - Madame Joslin will give you much more information. If you still have questions after you speak to her, please come talk with us.

- (Specific instructions will be added after a source of chlorine is determined)
- Be careful! Adding too much chlorine to water can make you sick!

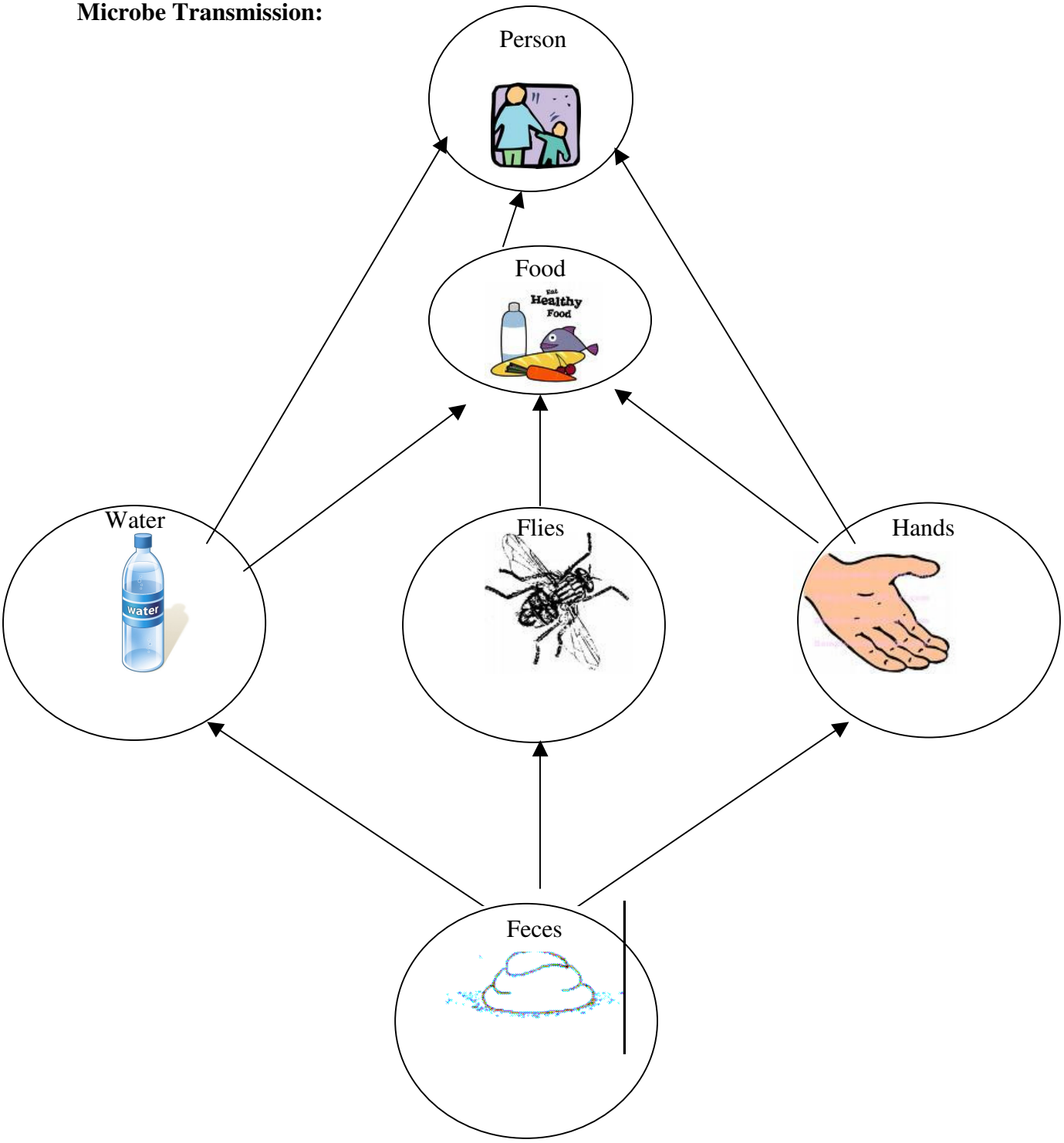
Conclusions: Thank you very much for paying attention! Do you have any questions? (Ask a few review questions)

Please come see Nick and me at any time at St. Joseph Clinic if you have questions.

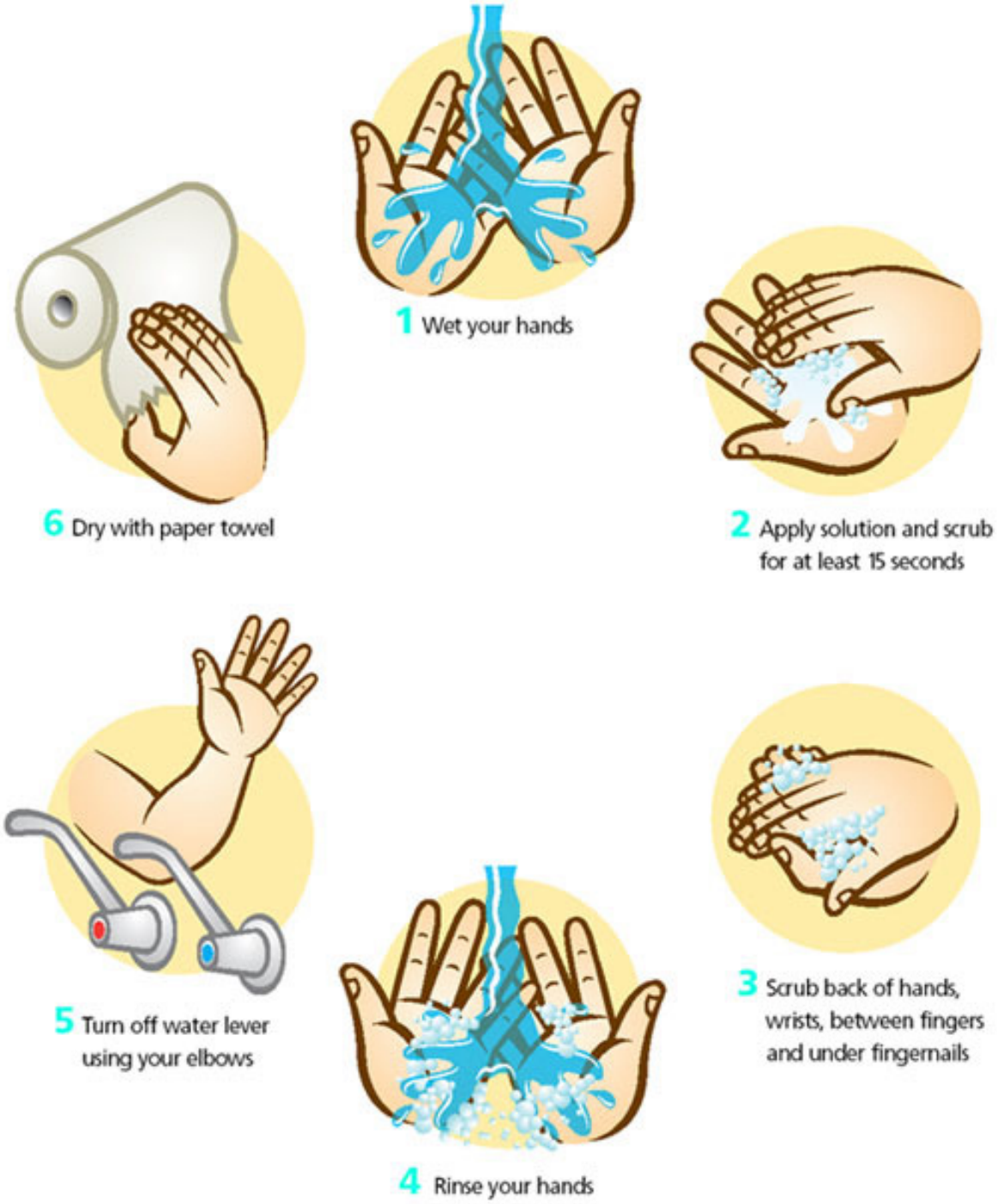
We will come back in two weeks to ask a few more questions. Have a good day!

Appendix G: Focus Presentation Content

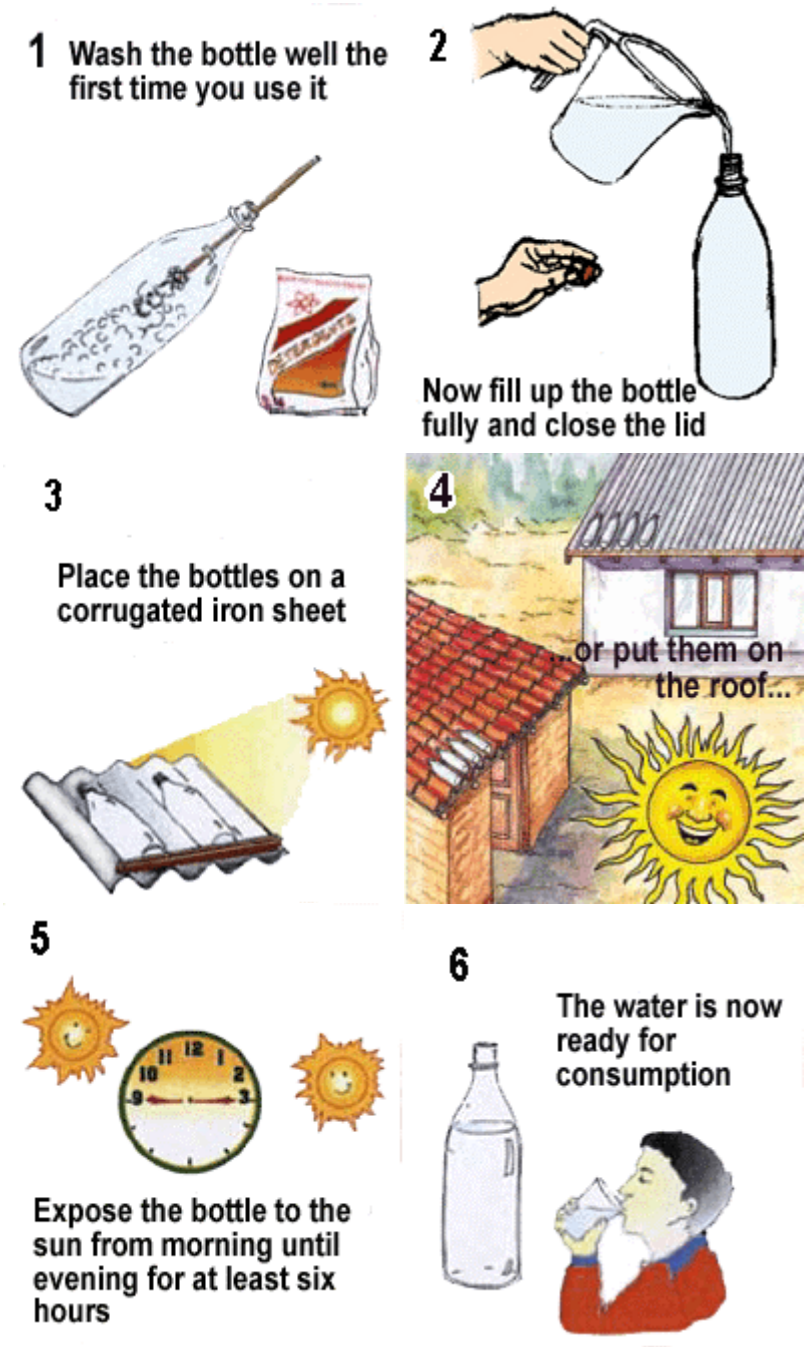
Microbe Transmission:



Hand washing pictures:



Solar Water Treatment Instructions:



Appendix F
Post-Intervention Oral Questionnaire

1. How many people live in this house?
2. How many children under 5 years old?
    a. How many times has each child under 5 had diarrhea, more than 3 times in a day, during the past 2 weeks?
3. How many adults over 50 years old?
    a. How many times has each adult over 50 had diarrhea, more than 3 times in a day, during the past 2 weeks?
4. Do you treat your water in any way to make is safer to drink?
5. What do you usually do to make it safer to drink?
6. Do you have any problems with the way you are treating your water?
    a. If yes, what are they?
7. What would you like to do to improve the quality of drinking water in your household?
8. What kind of toilet facility do members of your household use?
9. The last time (name of youngest child) passed stool, what was done to dispose of the stools?