A community-based approach to promote household water treatment in Rwanda

Slavea Chankova, Laurel Hatt and Sabine Musange

ABSTRACT

Treatment of drinking water at the household level is one of the most effective preventive interventions against diarrhea, a leading cause of illness and death among children in developing countries. A pilot project in two districts in Rwanda aimed to increase use of Sûr'Eau, a chlorine solution for drinking water treatment, through a partnership between community-based health insurance schemes and community health workers who promoted and distributed the product. Evaluation of the pilot, drawing on a difference-in-differences design and data from pre- and post-pilot household surveys of 4,780 households, showed that after 18 months of pilot implementation, knowledge and use of the product increased significantly in two pilot districts, but remained unchanged in a control district. The pilot was associated with a 40–42 percentage point increase in ever use, and 8–9 percentage points increase in use of Sûr'Eau at time of the survey (self-reported measures). Our data suggest that exposure to inter-personal communication on Sûr'Eau and hearing about the product at community meetings and health centers were associated with an increase in use.

Key words | community-based, point-of-use, Rwanda, water treatment

Slavea Chankova (corresponding author)
Laurel Hatt
International Health Division,
Abt Associates, Inc.,
4550 Montgomery Ave,
Bethesda, MD 20814,
USA
E-mail: *slavea_chankova@abtassoc.com*

Sabine Musange
Economics and Management Department,
National University of Rwanda,
School of Public Health,
Health Policy,
PO Box 5229,
Kigali,
Rwanda

INTRODUCTION

Diarrhea is one of the leading causes of morbidity and mortality among children under five globally, accounting for more than 1.3 million child deaths each year (Black *et al.* 2010). In Rwanda, more than one in five child deaths is attributed to diarrhea (Black *et al.* 2010). Unsafe drinking water, along with inadequate sanitation and hygiene, is a key cause of diarrheal disease (World Health Organization 2007). Treatment of drinking water at the household, point-of-use (POU) level, has been identified as one of the most effective interventions to reduce the incidence of diarrhea (Fewtrell *et al.* 2005; Arnold & Colford 2007; Clasen *et al.* 2007).

Interventions focusing on POU water treatment aim to increase the consistent and correct use of an effective product or method (such as boiling, chlorination, filtration, or solar disinfection) along with safe water storage. The most widely used approach to improve household water treatment practices is social marketing of safe water products, which combines mass media promotion with improving product supply, often at subsidized prices. However, this approach has had limited success in achieving widespread household water treatment (Stockman *et al.* 2007; Clasen 2009; Kremer *et al.* 2009). The addition of motivational interviewing and other interpersonal communication (IPC) strategies has been found to result in higher rates of POU treatment compared to social marketing alone (Quick 2003; Thevos *et al.* 2003; Dunston *et al.* 2001). Also, promising community-based approaches to promote POU water treatment have been tested, often in combination with social marketing, such as promotion and distribution by village health promoters (Makutsa *et al.* 2001), community-based sales agents (Ram *et al.* 2007), and women's self-help groups (Freeman *et al.* 2009).

Innovative approaches combining a community-based focus with IPC, defined as direct person-to-person communication to promote a concept, behavior, or product, are of

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increasing interest among donors, researchers, and implementers of safe water programs in developing countries. However, published evidence of the effect of such programs is scarce, particularly evidence from evaluations with strong research design that allows for reliable measurement and attribution of results to the specific intervention. This paper contributes to the evidence base on the effectiveness of community-based approaches to promote POU treatment by presenting results from an innovative pilot project implemented in Rwanda. The project enrolled community-based health insurance (CBHI) schemes and community health workers (CHWs) to promote and distribute Sûr'Eau ('Safe Water'), a low-cost liquid chlorine-based water disinfectant, to households that were members of the insurance schemes, particularly targeting those with children under five. We conducted a pre-post evaluation with control and intervention sites to measure the impact of the pilot on knowledge and use of Sûr'Eau among target households. The remainder of this paper presents a description of the pilot project, the evaluation methodology, results and their limitations, and resulting conclusions.

THE RWANDA SÛR'EAU PILOT PROJECT

Sûr'Eau, a low-cost liquid chlorine-based water disinfectant, was first made available in Rwanda in 2002 through a social marketing program implemented by Population Services International (PSI), an international non-governmental organization, in collaboration with the Rwanda Ministry of Health and UNICEF. The product was available predominantly through the public sector, sold at health centers, and distributed free during cholera outbreaks. The program was put on hold in 2005 due to a lack of funding. In 2007, nationwide social marketing and supply of Sûr'Eau resumed with funding from the United States Agency for International Development, this time targeting households with children under five and placing a greater emphasis on the private sector for production and sale of the product. Since 2007, Sûr'Eau has been sold throughout the country through two main channels, health centers and commercial outlets at a price of Rwandan Francs 300 ($0.55). However, sales have been very low: about 450,000 bottles were distributed by PSI to these two channels over three and a half years (2007–2010) which translates, on average, to a bottle per year for about 6% of households. A bottle of Sûr'Eau can treat the drinking water of a family of four to five members for about 6 weeks.

Nationwide promotion of Sûr'Eau, conducted by PSI, has relied on a social marketing approach: advertizing and promotion of the product through billboards, radio, point-of-sale materials (flip charts, stickers, brochures, T-shirts), mobile cinema, and drama performances. Health education talks on the importance of household water treatment and use of Sûr'Eau were conducted at health centers as part of routine patient education, but there is no data on what proportion of health centers conducted Sûr'Eau promotion on a regular basis or at all. At the end of 2007, use of Sûr'Eau remained low, particularly in rural communities where 11% of households with children under five reported ever using the product, and only 4% reported use in the previous month (PSI 2008).

In Rwanda, CBHI schemes covered 85% of the population in 2008, paying for both outpatient and inpatient care for a wide range of diseases, including treatment for diarrheal diseases. The CBHI schemes in the country have established structures at the district, sub-district, and community level that include elected volunteer CBHI committees. Thus, they have presence at the community level and are involved in promoting disease prevention among the population.

The pilot project was designed in 2007 to explore an approach that could increase the low uptake of Sûr'Eau. The project was implemented for 18 months in two districts in Rwanda, with support from two projects funded by the United States Agency for International Development – Social Marketing Plus for Diarrheal Disease Control: Point-of-Use Water Disinfection and Zinc Treatment (POUZN) and Health Systems 20/20. Key implementing partners were PSI, the department for CBHI technical assistance at the Rwandan Ministry of Health 2008 (*Cellule Technique d'Appui aux Mutuelles de Santé*) and CBHI schemes in the two pilot districts. The pilot project enrolled CBHI schemes and CHWs in two districts to promote and distribute Sûr'Eau. The target group for the project was households that were members of the insurance schemes, particularly those with children under five.

The pilot aimed to increase use of Sûr'Eau among CBHI member households. Increased use of the product was expected to lead to decreased prevalence of diarrhea, and lower expenditures on members' diarrhea treatment for the CBHI schemes. The potential cost-savings to the schemes would, in turn, provide further incentive for them to institutionalize the intervention and consider distributing other similar health promotion products for their members.

In Rwanda, CHWs (known as *animateurs de santé*) are volunteers elected by the community and supervised by health centers. In 2007, there were two CHWs per village (100 to 150 households), trained under the government's program to educate community members about preventive health practices (including hygiene and sanitation), monitor child growth, and refer sick patients to health facilities.

The pilot was implemented from February 2008 until August 2009 in Nyagatare and Rubavu, two rural districts known for recurrent cholera outbreaks. CBHI managers and committees at the district and sub-district levels were trained to promote and manage the sales of Sûr'Eau through the pilot. CHWs were trained to promote and sell Sûr'Eau to CBHI member households at the community level, and received a margin on each bottle sold.

In December 2007 and January 2008, project partners trained about 3,200 CHWs and CBHI managers and committee members in Nyagatare and Rubavu to promote and distribute Sûr'Eau, covering more than 1,100 villages and a population of about 600,000. The training covered the technical aspects of household water treatment, management of Sûr'Eau stocks, and distribution and sales at the community level. PSI distributed Sûr'Eau to CBHI sub-district offices in the pilot districts, and provided post-training technical assistance in management of supplies and promotion activities to CBHI scheme managers.

Through the pilot, CHWs sold Sûr'Eau to CBHI members in Rubavu at the market retail price of Rwandan Francs 300 ($0.55), while in Nyagatare sales were at a discounted price of Rwandan Francs 200 ($0.35). CHWs in Nyagatare retained a profit margin of Rwandan Francs 30 per bottle sold, while CHWs in Rubavu retained a margin of Rwandan Francs 50.

The project's implementing partners and district CBHI scheme managers organized a pilot launch event in each district, which included product promotion and demonstrations. A free bottle of Sûr'Eau was offered to each CBHI member household in the initial stage of the pilot. Central components of the pilot were small group outreach sessions conducted regularly by the CHWs and CBHI staff. These sessions provided education on safe water and sanitation, and were used to promote and sell Sûr'Eau at the community level. Messages included in the outreach sessions supported by the pilot were consistent with the information heard through radio, mobile cinema, and at health centers as part of PSI's nationwide social marketing campaign. CHWs were trained to coordinate their outreach and promotional activities in order to reach each community in their area at least once a month, to ensure consistent supply of Sûr'Eau and to monitor correct use in households.

EVALUATION METHODOLOGY

An impact evaluation of the pilot was designed at inception of the project, to measure the effect of the pilot on use of Sûr'Eau among target households. The evaluation used a pre-post design with intervention and control sites. The intervention sites were the two pilot districts, and a comparable district, Karongi, was selected as a control site (Table 1). The three study districts were chosen by the project partners, Health Systems 20/20 and PSI, in collaboration with the Ministry of Health and the central CBHI advisory board to be comparable based on the criteria of high diarrhea prevalence and frequent cholera outbreaks, as well as high coverage of the population by the CBHI schemes. In addition, the two pilot districts were selected because of strong support for the pilot from the district CBHI management and local government.

All three districts are predominantly rural, and similar in population size (about 300,000 people). CBHI coverage of the population at baseline varied from 51 to 82%, increasing substantially in Rubavu and Karongi but not in Nyagatare by the time of the endline survey. Rubavu is smaller in territory and more densely populated than the other two districts, and thus has fewer health centers, the units around which the CBHI sub-district schemes are usually established.

The main outcome indicators for the evaluation were knowledge and use of Sûr'Eau in the target population.

Table 1 | Study districts

	Pilot districts		Control district
	Nyagatare	Rubavu	Karongi
Population	280,000	300,000	280,000
Location	Northeast	Northwest	West
Area (square km)	1,741	600	993
Number of CBHI sub-district schemes (health centers)	18	8	17
CBHI coverage			
2007	82%	51%	68%
2009	84%	78%	97%
Sales of Sûr'Eau through commercial retail and health centers, supported by social marketing	Yes	Yes	Yes
Promotion and sales of Sûr'Eau by CHWs and CBHI schemes	Yes	Yes	No

CBHI = community-based health insurance.

Data for the study were collected through cross-sectional baseline and endline household surveys in the three study districts. The surveys covered insured households with children under five (the primary target group of the pilot). An insured household was defined as a household where the head and/or spouse of the head of household were enrolled in a CBHI. Baseline data were collected from 2,378 households in December 2007, shortly before launch of the pilot; endline data were collected from a separate cross-section of 2,402 households in August 2009. In each surveyed household, the person in charge of the household's drinking water was interviewed.

The sample of households in each time period was selected to be representative of the target population at the district level, and independent samples were selected at baseline and endline. We did not use a panel survey (i.e., surveying the same households in both baseline and endline) because membership in CBHI schemes varies from year to year and the additional focus of the intervention was on households with children under five years. In other words, some households who are eligible for the study at baseline would have become ineligible by the time of the endline due to change in their CBHI membership status or because of children growing to be older than five years.

Households were selected using a two-stage systematic random sampling design. First, a sample of communities (primary sampling units) were selected in each district with probability proportional to size, where size was determined by the number of households. Second, households in sampled communities were selected using a systematic random sampling process and those that were eligible for the study (CBHI members with children under five) were interviewed. The same communities were included in the baseline and endline sample. It is possible that there was some overlap between the baseline and endline samples, although this was not a panel survey. This potential overlap would be due to the fact that many households who were CBHI members at baseline were likely to also be members at endline; and also that many households that had children under five at baseline likely also had under fives at endline.

Free and informed consent of the participants in the study was obtained and the study protocol was approved by the Rwanda National Research Ethics Committee.

Sampling weights reflecting the probability of selection into the sample, were assigned to each household, and were used in all analyses. Data on household assets and housing quality were used to construct a wealth index, employing principal components analysis (Filmer & Pritchett 2001). The index was constructed by using the pooled sample of households across the three districts and both survey rounds. The index scores were then ranked and households were divided into five asset wealth quintiles.

The key analytic method employed in the study is adjusted difference-in-differences measures using multivariate linear regression analyses to control for potentially

confounding socio-demographic variables including sex of the head of household, household asset wealth quintile, type of water source, education and age of the person in charge of the household's water supply, and time and district effects. All standard error estimates were adjusted for stratification at the district level and clustering at the community level.

In addition, some indicators that were only measured at endline are reported descriptively and compared across the three study districts. Statistical significance of difference in means between districts or between baseline and endline is measured by *t*-tests for continuous outcomes and by chi-squared tests for binary or categorical variables. All analyses were conducted using Stata v.10.

RESULTS

Sample description

Table 2 summarizes key household sample characteristics at baseline. Detailed endline sample description data is provided elsewhere (Chankova *et al*. 2010). In each district, household heads are predominantly farmers, and about half have no education. Few households have electricity, nearly all use some form of pit latrine, and very few have piped water in their residence.

Comparison in household assets across districts shows notable differences for ownership of radio, bicycle, and mobile phone. Although nearly all households use some form of pit latrine, better-quality ventilated improved pit latrines are more prevalent in Nyagatare (71% of households) and Rubavu (58%), compared to Karongi (49%). There is significant variation in the type of drinking water source used in each district. In Rubavu, 70% of households in the baseline sample get their drinking water piped from a public tap. In Nyagatare, the two most common sources at endline are a public well (36%) and surface water (30%), while in Karongi 67% of households use a public well as their primary source of drinking water.

Households in Rubavu and Karongi are classified by the relative asset wealth index as poorer, compared to those in Nyagatare: 62% in Karongi and 38% in Rubavu belong to the poorest two quintiles, compared to 24% for Nyagatare.

In each district, there were few substantial differences overall between the baseline and endline samples in the key household socio-economic characteristics. One notable difference is seen in the type of water sources used in Rubavu where 27% at endline were using a public well, compared to 3% at baseline, and the proportion of those using a public tap had decreased from 70 to 52%. In our regression analyses (presented below) we control for differences in socio-economic variables among districts and between the baseline and endline sample to ensure that such differences do not introduce bias in our estimates of the key dependent variables in household water treatment.

Exposure to pilot activities

A key element of the pilot project was IPC. In the two pilot districts, CHWs and CBHI managers and committees were trained to promote safe water practices in general and Sûr'Eau in particular directly to households, including through IPC conducted during home visits and at community gatherings. CBHI managers at the sub-district level, whose offices are typically based in health center compounds, gave 'health talks' on safe water, hygiene, and sanitation, and promoted Sûr'Eau to patients waiting to be seen at health centers (aiming to reach mothers with young children). In the endline survey, we measured the extent to which these elements of the pilot had reached the target population.

At endline, about 90% of respondents in the pilot districts and 70% in the control district had heard messages on safe water, hand-washing, hygiene, and sanitation in the 6 months preceding the survey (Table 3, $p < 0.01$ for differences between the control and each of the pilot districts). (Unfortunately, the questions about exposure to water, hygiene, and sanitation messages were not asked at baseline). It is likely that this difference is largely a result of the communication activities implemented through the pilot, but it could also be a result of other district-specific initiatives related to water, hygiene, and sanitation that were more active in the pilot districts. For example, a government campaign on hygiene and sanitation was taking place nationwide at the time of the pilot, and it is possible that this campaign was implemented with different rigor in each of the three study districts. One element of the government campaign

Table 2 | Household sample description at baseline, 2007

	Nyagatare	Rubavu	Karongi	*p*-value[a]
Average household size	5.6	5.4	5.4	0.21
Average number of children under 5 per household	1.5	1.5	1.4	0.03
Female head of household	15%	12%	17%	0.28
Education of household head (% of households)				0.01
No education	60%	46%	60%	
Primary	30%	36%	33%	
Post-primary	6%	14%	6%	
Secondary or higher	4%	5%	2%	
Occupation of household head (% of households)				0.40
Unemployed	3%	3%	3%	
Farmer/shepherd/fisherman	82%	82%	88%	
Civil servant/government employee/military	4%	5%	4%	
Trader/artisan or other	11%	11%	5%	
Asset ownership (% of households)				
Radio	74%	56%	53%	<0.01
TV	1%	3%	1%	0.41
Bicycle	52%	11%	3%	<0.01
Mobile phone	19%	13%	5%	0.00
Have electricity (% of households)	3%	6%	2%	0.48
Main material of house floor (% of households)				0.22
Earth/mud/dung	83%	84%	94%	
Cement, wood, or other	17%	16%	6%	
Main source of drinking water (% of households)				<0.01
Piped water in residence	2%	4%	1%	
Piped water from public tap	25%	70%	10%	
Public well	36%	3%	67%	
Surface water (river/canal/lake/spring)	30%	15%	18%	
Other	7%	8%	3%	
Primary sanitation facility (% of households)				0.04
Pit latrine	27%	40%	48%	
VIP latrine	71%	58%	49%	
Other/no latrine	2%	2%	3%	
Relative household wealth (% of households)				0.01
Poorest quintile	11%	13%	39%	
Poor-middle quintile	13%	25%	24%	
Middle quintile	15%	22%	24%	
Middle-rich quintile	34%	17%	5%	
Richest quintile	27%	23%	8%	

[a]*p*-value from *F*-test or chi-squared test of difference across districts.
VIP = ventilated improved pit.

Table 3 | Exposure to messages and interpersonal communication on water, hygiene, and sanitation in past 6 months, endline sample (% of households)

Heard a message on safe water, hand-washing, hygiene, sanitation:	Safe water	Hand washing	Hygiene	Sanitation	
Nyagatare	88%	88%	90%	88%	
Rubavu	90%	90%	91%	90%	
Karongi (control)	70%	70%	71%	73%	
p-value[a]	< 0.01	< 0.01	< 0.01	< 0.01	
		Heard message on Sûr'Eau from			
Heard message on Sûr'Eau:	Heard message on Sûr'Eau	Radio	Community meeting	Health facility	Brochure/poster
Nyagatare	71%	29%	24%	26%	2%
Rubavu	88%	46%	55%	45%	8%
Karongi (control)	42%	31%	7%	11%	1%
p-value[a]	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
		Received IPC on Sûr'Eau from			
Received inter-personal communication on Sûr'Eau:	Received IPC on Sûr'Eau	Community resource person	Neighbor/family/ friend	Health facility worker	Other
Nyagatare	51%	37%	8%	8%	0.4%
Rubavu	45%	40%	8%	3%	1%
Karongi (control)	6%	3%	3%	1%	1%
p-value[a]	< 0.01	< 0.01	< 0.01	< 0.01	0.31

[a]*p*-value from chi-squared test of difference across districts.

was monthly community gatherings to discuss hygiene and sanitation issues and to clean common areas in the community.

Exposure to messages on Sûr'Eau was significantly higher in the pilot districts: 88% of respondents in Rubavu and 71% of respondents in Nyagatare had heard at least one message on Sûr'Eau in the 6 months preceding the endline survey, compared to 42% of respondents in the control district (Table 3, $p < 0.01$ for differences between the control and each of the pilot districts). About half of respondents in Rubavu, and 24% in Nygatare had heard a message on Sûr'Eau at community meetings. The proportion of respondents who mentioned health centers was similar. In the control district, the most frequently cited source of messages on Sûr'Eau was the radio, with few respondents citing community meetings or health centers as sources.

While four out of ten households in the pilot districts reported that a community resource person (typically a CHW) had spoken with them personally about Sûr'Eau in the past 6 months, this was the case for only 3% of households in the control district. Exposure to IPC from neighbors/friends and health facility workers, on the other hand, was relatively low in all three districts, but was somewhat more frequent in the pilot districts compared to the control district.

General water treatment practices

The person in charge of water for the household was asked whether he/she did anything to treat the household's drinking water, and if so what was the method used most often. At baseline, more than half of households in each district

reported that they boiled their drinking water, and very few reported use of any other water treatment method.

In the two pilot districts, there was a significant decrease in the proportion of households who said they did not treat their water at all: in Nyagatare, the proportion of households not treating their water decreased from 23 to 14%, and in Rubavu this decrease was from 44 to 25%. In the control district, the proportion of households who said they did not treat their water increased from 38 to 47%.

We did not ask at baseline how frequently those who treated water did so, but added this question to the endline survey. About 60% of those reporting some form of household water treatment at endline said they practiced the method every time they collected water. However, more than half of the respondents who reported at endline that they used Sûr'Eau every time they collected water, later in the questionnaire said that they did not use the product to treat their current drinking water. It should be noted that self-reported water treatment behavior may not reflect accurately actual practiced behavior: for example, there could be a tendency to over-report a behavior that is perceived as socially desirable. However, to the extent that such over-reporting bias is consistent over time, the trends in self-reported behavior likely reflect the trends in actual behavior.

Effect of pilot on knowledge and use of Sûr'Eau

Table 4 summarizes the results for the key outcome indicators for the pilot related to knowledge and use of Sûr'Eau. The estimated impact of the pilot is measured by crude (unadjusted) and adjusted difference-in-differences measures. These measures are estimated regression coefficients on the key independent variable of interest, *residence in pilot district at endline*, which is a dummy variable with a value of 1 for observations from Rubavu and Nyagatare from the endline sample (indicating a household exposed to the pilot intervention) and a value of 0 otherwise. The adjusted estimates are from multivariate linear regression models that control for time and district effects, as well as differences among districts and over time in socio-economic variables.

At baseline, knowledge of Sûr'Eau and its purpose was high in all three study districts, with 65% or more of respondents having heard of Sûr'Eau, and the majority of these respondents having correct knowledge of what Sûr'Eau is used for. In the pilot districts, there was a substantial increase at endline in the proportion of respondents who had heard of Sûr'Eau, with nearly universal knowledge of the product and its purpose; whereas there was no change in these indicators in the control district where knowledge of Sûr'Eau remained at 77%. The pilot was associated with a 10 to 35 percentage point increase in knowledge of Sûr'Eau among target households, and a similar increase in the knowledge of the purpose of Sûr'Eau.

At endline, knowledge of correct use of Sûr'Eau was also significantly better in the pilot districts, compared to the control district. Those who had used Sûr'Eau in the past were asked to describe how they used the product; data collectors used a checklist to record whether respondents mentioned each of the key steps for using the product correctly, which are: fill bottle cap with Sûr'Eau; pour in 20 l jerry can, close jerry can and shake well; and wait 30 min before drinking the treated water. About a third of respondents in the pilot districts mentioned each of these four key steps, which was a significantly higher proportion compared to the control district where 10% or fewer of respondents mentioned each step. Knowledge of correct use was not measured at baseline.

We measured four key indicators related to use of Sûr'Eau: (1) ever use, (2) self-reported consistent use (defined as self-reported use every time we collect water), (3) self-reported current use (defined as self-reported use to treat currently stored drinking water), and (4) current use verified by measurement of chlorine residual by the survey team among self-reported current users (endline survey only). Chlorine residual test of stored water was conducted in the households reporting use of Sûr'Eau on the day of the interview or the previous day. Respondents who reported treating their current stored drinking water with Sûr'Eau were asked to prepare a cup of water, the way they would usually do for their child to drink. Interviewers took a 5 ml sample of this water and conducted a chlorine-residual test using DPD (*N,N*-diethyl-*p*-phenylene diamine) tablets, recording the test result as positive if a pink color was observed (indicating presence of free chlorine residual of at least 0.2 mg/l, the level that ensures

Table 4 | Changes in knowledge and use of Sûr'Eau

	Pre-post comparison (% of households)			Difference-in-differences pilot v. control district[a]	
	Baseline 2007 n = 2378[c]	Endline 2009 n = 2402[c]	*Signif.*[a]	Crude n = 4780[c]	Adjusted[b] n = 4752[c]
Heard of Sûr'Eau					
Nyagatare	86%	97%	***	0.11*	0.10***
				[0.040]	[0.038]
Rubavu	65%	96%	***	0.31***	0.35***
				[0.043]	[0.041]
Karongi (control)	77%	77%		Ref.	Ref.
Heard of Sûr'Eau and have correct knowledge of what it is used for[d]					
Nyagatare	76%	94%	***	0.18***	0.17***
				[0.039]	[0.039]
Rubavu	56%	90%	***	0.34***	0.38***
				[0.045]	[0.048]
Karongi (control)	70%	70%		Ref.	Ref.
Ever used Sûr'Eau (self-report)					
Nyagatare	19%	61%	***	0.41***	0.40***
				[0.064]	[0.062]
Rubavu	18%	59%	***	0.41***	0.42***
				[0.047]	[0.044]
Karongi (control)	11%	12%		Ref.	Ref.
Currently using Sûr'Eau (self-report)					
Nyagatare	2%	11%	***	0.09***	0.09***
				[0.024]	[0.024]
Rubavu	4%	12%	***	0.08***	0.09***
				[0.018]	[0.016]
Karongi (control)	1%	1%		Ref.	Ref.
Consistently using Sûr'Eau (self-report)					
Nyagatare	2%	26%	***	0.23***	0.23***
				[0.046]	[0.046]
Rubavu	4%	25%	***	0.20***	0.21***
				[0.028]	[0.029]
Karongi (control)	1%	2%		Ref.	Ref.

[a]Statistical significance: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.
[b]Adjusted regression coefficient and SE from multivariate linear regression model including sex of the head of household, household wealth, type of water source, education and age of the person in charge of the household's water supply, and time and district-specific effects.
[c]Total sample across all three districts. Sample is smaller for some variables.
[d]Among respondents who had heard of Sûr'Eau. Correct knowledge means respondent said Sur Eau was used to 'kill germs' or 'to make drinking water safe'.

microbiologically clean water according to guidelines by the CDC Safe Water System project).

Use of Sûr'Eau, as measured by these indicators, increased substantially in the two pilot districts between baseline and endline, and remained unchanged in the control district. The key results, summarized in Table 4, are:

- *Ever use*: the pilot was associated with a 40–42 percentage point increase in ever use. At endline, the

proportion of households reporting ever use of Sûr'Eau reached 59–61% in the pilot districts, but remained at 11–12% in the control district.

- *Consistent use (self-reported):* the pilot was associated with a 20–23 percentage point increase in consistent self-reported use, which reached 21–22% in the pilot districts and remained at 1–2% in the control district.
- *Current use (self-reported)*: the pilot was associated with 8–9 percentage point increase in current self-reported use; it reached 8–9% in the pilot districts and remained at 1% in the control district.
- *Current use verified by chlorine residual*: At endline, 3–6% of households in the pilot districts reported current use of Sûr'Eau and had a chlorine residual in their stored drinking water, compared to 1% in the control district.

Results are largely similar in the two pilot districts: differences between the districts in the effect on knowledge and use of Sûr'Eau are very small across nearly all indicators (results from comparisons between the two pilot districts are available in a separate report, Chankova *et al.* 2010). This indicates that the discounted price (available only in Nyagatare) may not have played a substantial role in use of Sûr'Eau. One confounding factor limits our ability to make a definitive conclusion on the effect of price discount, however. CHWs in Nyagatare retained a margin that was 40% lower than the margin for CHWs in Rubavu. This might have decreased Nyagatare CHWs' motivation for selling Sûr'Eau and countered any effect that the price discount might have had.

The reliability of self-report on consistent use is limited, as further analysis of our data indicates there is over-reporting of consistent use: in the endline survey, 59% of the respondents who said they used Sûr'Eau every time they collected water, later in the questionnaire reported not using it to treat their current drinking water. This result highlights the importance of longitudinal follow-up study design, including water testing for chlorine residual, to objectively verify consistent as well as long-term use of Sûr'Eau.

Similarly, the results on self-reported current use should be treated with caution. About 75% of self-reported current users said they treated their water on the day of the survey or the previous day. A Sûr'Eau bottle was observed in nearly all households with chlorine residual (91%) but chlorine residual was detected in the water of 57% of these households. These results indicate that there may be over-reporting of current use or incorrect dosage of Sûr'Eau in case of turbid water. Turbid water requires doubling the dose of Sûr'Eau, and using less may not achieve the appropriate, and measurable, levels of chlorine residual. This result is similar to findings in other studies (Olembo *et al.* 2004; Ram *et al.* 2007; Kremer *et al.* 2009).

Effect of messages and IPC on use of Sûr'Eau

We used multivariate regression analysis of the endline data from all three districts to investigate the effect of different messages and messaging channels on the various indicators of use of Sûr'Eau. We employed a linear regression model controlling for household socio-economic variables, age and education of the person in charge of water, district, and type of water source. Since we could not measure directly actual exposure to specific messages and IPC, we rely instead on self-reported recalled exposure. These results should therefore be considered indicative rather than conclusive, given that there may have selection bias in who was exposed to and who recalled exposure to messages. To measure recalled exposure to safe water messages in the 6 months preceding the survey, respondents were asked about: (1) hearing or seeing a message on making water safe to drink; (2) hearing or seeing a message Sûr'Eau; and (3) whether someone had spoken with her in person about Sûr'Eau (which we define as exposure to IPC).

Respondents who recalled hearing a message about Sûr'Eau or safe water, or receiving IPC about Sûr'Eau were significantly more likely to report using Sûr'Eau and to have a chlorine residual (Table 5). The regression results indicate a strong effect of IPC about Sûr'Eau on use, but do not show consistent or large effect of messages specific to Sûr'Eau or safe water received from any general channel (Table 5; detailed regression results shown in Appendix A, available online at http://www.iwaponline.com/jwh/010/071.pdf). Exposure to IPC about Sûr'Eau is associated with a 17 percentage-point increase in ever use, 6 percentage point increase in current self-reported use, and a 4 percentage point increase in verified current use.

Table 5 | Use of Sûr'Eau among households with and without recalled exposure to messages and interpersonal communication on Sûr'Eau and safe water

	Ever used Sûr'Eau					
	No	Yes	Crude difference	Signif[a]	Adjusted difference[b]	Signif[a]
Heard message on Sûr'Eau in past 6 months	21%	54%	0.33	***	0.07	**
Received IPC on Sûr'Eau in past 6 months	30%	70%	0.40	***	0.17	***
Heard message on safe water in past 6 months	25%	47%	0.22	***	–0.01	
	Currently using Sûr'Eau (self-report)					
	No	**Yes**	**Crude difference**	**Signif.[a]**	**Adjusted difference[b]**	**Signif.[a]**
	row %					
Heard message on Sûr'Eau in past 6 months	2%	11%	0.09	***	0.01	
Received IPC on Sûr'Eau in past 6 months	4%	15%	0.11	***	0.06	***
Heard message on safe water in past 6 months	2%	9%	0.08	***	0.02	**
	Currently using Sûr'Eau (self-report & chlorine residual)					
	No	**Yes**	**Crude difference**	**Signif.[a]**	**Adjusted difference[b]**	**Signif.[a]**
	row %					
Heard message on Sûr'Eau in past 6 months	0%	5%	0.04	***	0.01	
Received IPC on Sûr'Eau in past 6 months	1%	6%	0.05	***	0.04	***
Heard message on safe water in past 6 months	1%	4%	0.03	***	0.002	

[a]Statistical significance of difference: *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.
[b]Estimated from multivariate regression model, adjusting for: household's socio-economic and district-specific effects and exposure to IPC and messages on Sûr'Eau and safe water in past 6 months.

Additionally, we investigated the effect on use of Sûr'Eau of the most-frequently cited sources of messages related to Sûr'Eau: radio, health facility, community meeting, and brochure/poster. Among these four sources, community meetings appear to be the channel that was associated with the greatest increase in use of Sûr'Eau, followed by health facilities (Table 6; detailed regression results shown in Appendix B, available online at http://www.iwaponline.com/jwh/010/071.pdf). Exposure to messages on Sûr'Eau at a community meeting is associated with a 14 percentage point increase in the probability of ever using Sûr'Eau, 8 percentage point increase in self-reported current use, and 4 percentage point increase in current use verified by chlorine residual. Similarly, exposure to message(s) on Sûr'Eau at a health facility is associated with a 14 percentage point increase in the probability of ever use, and a 5 percentage point increase in current self-reported use. Hearing message(s) on Sûr'Eau on the radio was not found to have a significant effect on ever use or current use. Seeing message(s) on a brochure/poster in the past 6 months is associated with a 20 percentage point increase in probability of ever use of Sûr'Eau, but was not found to have a significant effect on current use.

Limitations

Our study has a number of limitations. The design that is best suited for measuring impact of an intervention on individual behavior/outcomes is the randomized controlled design, whereby households or villages in the same area are randomly allocated to an intervention and a control group. However, randomization of households or villages was not possible in this pilot because the intervention had to be implemented at the district level in order to assess its implementation feasibility by district-wide CBHI schemes. The key indicators measured by this pre-post study are likely influenced by a multitude of household-level factors that cannot be easily observed and measured and may, on average, be different in the intervention and control groups.

Changes over time in population characteristics that were unobservable or not measured could also confound

Table 6 | Use of Sûr'Eau among households exposed and not exposed to messages on Sûr'Eau from different sources

	Ever used Sûr'Eau					
	No	**Yes**	**Crude difference**	**Signif.[a]**	**Adjusted difference[b]**	**Signif.[a]**
Heard/saw message on Sûr'Eau from:	*row %*					
Radio	40%	47%	0.07	**	<0.01	
At community meeting	34%	66%	0.31	***	0.14	***
At health facility	35%	65%	0.30	***	0.14	***
Poster/brochure	42%	72%	0.30	***	0.20	***
	Currently using Sûr'Eau (self-report)					
	No	**Yes**	**Crude difference**	**Signif.[a]**	**Adjusted difference[b]**	**Signif.[a]**
Heard/saw message on Sûr'Eau from:	*row %*					
Radio	7%	10%	0.03	**	0.01	
At community meeting	5%	17%	0.12	***	0.08	***
At health facility	5%	15%	0.09	***	0.05	***
Poster/brochure	8%	7%	0.00		–0.02	
	Currently using Sûr'Eau (self-report & chlorine residual)					
	No	**Yes**	**Crude difference**	**Signif.[a]**	**Adjusted difference[b]**	**Signif.[a]**
Heard/saw message on Sûr'Eau from:	*row %*					
Radio	2%	5%	0.03	***	0.02	*
At community meeting	1%	8%	0.06	***	0.04	**
At health facility	2%	6%	0.04	***	0.02	
Poster/brochure	3%	4%	0.01		−0.01	

[a]Statistical significiance of difference: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

[b]Estimated from multivariate regression model, adjusting for: household's socio-economic and district-specific effects, and exposure to IPC and other sources of messages on Sûr'Eau and safe water in past 6 months.

our results. By selecting households from the same villages (primary sampling units), we aimed to minimize differences between the baseline and endline samples. However, district-wide average household characteristics of CBHI members may have changed due to the substantial increase in membership, particularly in Rubavu and Karongi. For example, it is likely that the households who joined a CBHI later, between baseline and endline, are different on average from those who were members at baseline, both in observable and unobservable characteristics related to household water treatment. To account for potentially confounding effects on our key indicators by observable socio-economic characteristics, we used multiple regression analysis to compute adjusted difference-in-differences estimates. However, the differential increase in insurance coverage between pilot and control districts might have introduced endogeneity bias, given that we only surveyed insured households. Specifically, the endline sample of households in the control district (where coverage increased to nearly universal by endline) likely includes more households that were 'late adopters' of insurance, while in the pilot districts insurance coverage increased less or stayed at baseline level. Since households joining insurance later might also be less likely to adopt preventive health practices such as water treatment, our results on the effect of the pilot on use of Sûr'Eau could be overestimated.

Respondent bias to over-report use of Sûr'Eau could be more prevalent in the intervention districts, where use of the product could have been more likely to be perceived as a socially desirable behavior. Such bias would lead to overestimation of the effect of the pilot on key indicators. As noted earlier, self-reported exposure to messages is subject to recall bias, whereby those who were more likely to report

using Sûr'Eau may also be more likely to recall hearing or seeing messages on this product. Recalled exposure to messages and use of Sûr'Eau also might be positively associated with some unobservable (endogenous) characteristic, such as personal motivation to practice healthy behavior. This endogeneity could lead to overestimation of the magnitude of association between actual exposure to messages/IPC and use of Sûr'Eau.

CONCLUSION

Experience with social marketing programs on safe water treatment at the household level has shown limited success in scale up of water treatment by households, even after years of program implementation. Activities implemented at scale by social-marketing programs rely primarily on a mass-media approach to promoting safe water treatment, and on making water treatment products available from retail outlets at the community level (often at subsidized prices). In recent years, IPC by health promoters at the community level (such as non-governmental organizations, CHWs and other staff at health facilities) has gained increasing attention as a strategy to add to the typical social marketing package.

The pilot evaluated in our study demonstrated that introducing promotion and distribution of a safe water product by CHWs alongside social marketing can lead to a significant increase in safe water treatment among the target population within a relatively short time period. Our results are based on a stronger study design than is typically found in evaluations of similar interventions: we rely on pre- and post-implementation data from both the pilot and a comparable control site, while many studies rely only on post-implementation data or data only from the intervention site.

IPC between CHWs and target households was a key element of the pilot. Our data suggest that exposure to IPC on Sûr'Eau and hearing about the product at community meetings and health centers was associated with an increase in use of the promoted product, but this needs to be explored further through stronger study designs, such as randomized controlled trials. Qualitative research to document the challenges faced and best practices used by the CHWs participating in the pilot is essential to inform program design of a potential expansion of this pilot approach in Rwanda. In other countries, an assessment of existing practices in household water treatment promotion by community health agents would be a starting point in the design of a similar intervention (Behailu *et al*. 2010).

In this pilot, CBHI schemes were used as the vehicle to implement this approach, as they were well-established structures with representation at the community level and significant population coverage. In addition, each community in Rwanda had a number of CHWs in place, as a result of a nationwide government-mandated program. These pre-existing structures made implementation of the pilot model feasible and potentially replicable in other districts in Rwanda. In countries with nascent CBHI structures or uneven distribution of CHWs, replication of this pilot approach may need to consider engaging other community-level structures such as non-governmental organizations or health facilities.

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