Safe Water and Hygiene Integration with Human Immunodeficiency Virus and Antenatal Services: Leveraging Opportunities for Public Health Interventions and Improved Service Uptake

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Abstract. Integrating public health interventions with antenatal clinic (ANC) visits may motivate women to attend ANC, thereby improving maternal and neonatal health, particularly for human immunodeficiency virus (HIV)-infected persons. In 2009, in an integrated ANC/Preventing Mother-to-Child Transmission program, we provided free hygiene kits (safe storage containers, *WaterGuard* water treatment solution, soap, and oral rehydration salts) to women at their first ANC visit and refills at subsequent visits. To increase fathers' participation, we required partners' presence for women to receive hygiene kits. We surveyed pregnant women at baseline and at 12-month follow-up to assess ANC service utilization, HIV counseling and testing (HCT), test drinking water for residual chlorine, and observe handwashing. We conducted in-depth interviews with pregnant women, partners, and health workers. We enrolled 106 participants; 97 (92%) were found at follow-up. During the program, 99% of pregnant women and their partners received HCT, and 99% mutually disclosed. Fifty-six percent of respondents had ≥ 4 ANC visits and 90% delivered at health facilities. From baseline to follow-up, the percentage of women who knew how to use *WaterGuard* (23% versus 80%, $P < 0.0001$), had residual chlorine in stored water (0% versus 73%, $P < 0.0001$), had confirmed *WaterGuard* use (0% versus 70%, $P < 0.0003$), and demonstrated proper handwashing technique (21% versus 64% $P < 0.0001$) increased. Program participants showed significant improvements in water treatment and hygiene, and high use of ANC services and HCT. This evaluation suggests that integration of hygiene kits, refills, and HIV testing during ANC is feasible and may help improve household hygiene and increase use of health services.

INTRODUCTION

In developing countries, serious public health problems such as human immunodeficiency virus (HIV) infection, maternal, neonatal, and child mortality, and diarrheal diseases tend to cluster together. Programs designed to treat or prevent these problems are often organized vertically, missing opportunities to improve outcomes by providing more efficient, coordinated services.¹ The achievement of Millennium Development Goals 4 and 5 (reduction in child and maternal mortality) could be accelerated by integrating essential services for maternal, newborn, and child health with large-scale vertical programs such as the President's Emergency Plan For AIDS Relief (PEPFAR) that address HIV and Prevention of Mother to Child Transmission (PMTCT).²

In Malawi, where maternal and infant mortality are high (510/100,000 and 46/1,000 live births respectively),^{3,4} 93% of pregnant women attend one antenatal visit, but only 21% complete the recommended four antenatal visits, 72% deliver at a health facility, and 33% have postnatal checks.⁵ As recently as 2010, only 66% of pregnant women attending antenatal clinics (ANCs) were tested for HIV.⁶ Prevention of Mother to Child Transmission coverage was 53% in 2010, which was below the goal for 2013 of 80% set by the Malawi Ministry of Health.⁷ Cholera outbreaks are common⁸ and 20%

of mothers report an episode of diarrhea in their child in the previous 2 weeks.⁵

In 2007, the Malawi Ministry of Health, United Nations Children's Fund, and the Centers for Disease Control and Prevention (CDC) conducted a pilot program to improve safe water and hygiene behaviors among pregnant women in ANCs through the integration of free water and hygiene kits (hereafter referred to as WHKs) consisting of a water storage container with a lid and tap, a bottle of *WaterGuard* water chlorination solution, a bar of soap, and two sachets of oral rehydration salts (Figure 1). Participants were also given refills of *WaterGuard* and soap. In addition to sustained increases in confirmed household water treatment and proper hand washing practices, the program achieved increased rates of institutional delivery and postnatal checks.⁹ Three years later, 33% of the same women who participated in the initial evaluation had sustained these improved household water treatment practices compared with baseline.¹⁰ In 2009, the Clinton Health Access Initiative (CHAI) designed and integrated a similar program of free hygiene kits and refills into a PMTCT program as incentives to increase health service use and improve household water quality and hygiene.

The CHAI pilot program took place in 15 health facilities in Machinga district, Malawi. In this program, over 25,000 pregnant women received free "WHKs" after their first ANC visit. Because long-term success of Option B+ PMTCT (providing lifelong antiretroviral therapy to pregnant women) depends heavily on participation of women's partners,¹¹ CHAI required partners' presence for women to receive the initial hygiene kit. At the time of the first ANC visit, HIV counseling and testing (HCT) was offered to the couple. Expert Clients—community members living with HIV/AIDS—were present to

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FIGURE 1. Safe water and hygiene kits consisting of a covered water storage container with a tap, a bottle of *WaterGuard*, a bar of soap, and two sachets of oral rehydration salts. Photo credit: Anagha Loharikar, Centers for Disease Control and Prevention. This figure appears in color at www.ajtmh.org.

counsel women and their partners found to be infected with HIV and escort them to locations where they were placed in the appropriate HIV risk category and received PMTCT services and antiretroviral therapy, if indicated. All women were eligible to receive up to three free refills of *WaterGuard* and soap during subsequent ANC visits, at delivery, or during postnatal checkups. In March 2011, CDC evaluated program impact on HCT, ANC service uptake and home water and hygiene practices.

MATERIALS AND METHODS

Evaluation design. We conducted cross-sectional surveys of a sample of pregnant women at their first ANC visit and 1 year later at eight rural health facilities in Machinga district in which the program was first initiated (Figure 2). The CHAI data analyst abstracted maternal health and HCT service use data from antenatal and HCT registries at all 15 health facilities in Machinga district for 2008 quarter 2 (the year preceding program implementation) and all 12 subsequent quarters from 2009 to 2011.

Sample selection. Machinga is a rural district in the Southern region of Malawi with an economically impoverished population of approximately 370,000 and an overall HIV prevalence of 15.1%, well above the national average of 10.1%.⁵ Evaluation participants were limited to those attending ANC for the first time during their current pregnancy. We aimed to enroll all eligible pregnant women at the eight health facilities initially participating in the program during the week of March 15–22, 2010. We selected a sample of pregnant women from each of these facilities proportional to at least 10% of their average monthly ANC attendance. Participants were enrolled in a continuous fashion until the correct number for each clinic was obtained. Prior to enrollment, enumerators read a consent form explaining the purpose of the evaluation, and women gave verbal consent to participate. Women were eligible to participate if this was the first ANC visit for this pregnancy, and they were accompanied by their husband or partner. If a woman's partner was not present because of divorce, death, or travel, she could participate if she could present a note from the village headman verifying her partner's status. Our resulting total sample size of 106 pregnant women provided 80% power to detect a 12% difference from baseline to follow-up, assuming a 20% proportion of discordant pairs.

Baseline data collection. The baseline survey took place in March 2010. We used standardized questionnaires to interview participants at their first ANC visit on demographic and socioeconomic characteristics, water sources, and water storage, treatment, and hygiene practices. We then visited participants' homes to observe water storage and treatment practices, presence of soap, and demonstration of handwashing procedure. We tested stored drinking water for free chlorine residual (FCR) using the N,N-diethyl-phenylenediamine colorimetric method using Hach Free and

FIGURE 2. Timeline for implementation and evaluation of water hygiene kit (WHK) intervention into prevention of mother to child transmission program, Machinga District, Malawi, 2008–2012. This figure appears in color at www.ajtmh.org.

Total Chlorine kits (Hach Co., Loveland, CO) as an objective measure of *WaterGuard* use. Enrollees received their hygiene kits after completing the baseline survey.

Program implementation. Distribution of hygiene kits began in Machinga in September 2009 and continued through December 2011, at which time CHAI handed the program over to the Ministry of Health. Participants were offered HCT together with their partner, and told that they would receive a WHK at that visit, and up to five refills of *WaterGuard* and soap: at three return ANC visits, delivery and 6-week post-natal check. In preparation for program implementation, Population Services International, the non-governmental organization that marketed *WaterGuard*, trained health facility staff, consisting of ANC nurses and Health Surveillance Assistants (Ministry of Health employees who provide community health services, hereafter referred to as HSAs) on patient communication, handwashing techniques, and appropriate water storage, handling, and treatment with *WaterGuard*. Antenatal clinic nurses were asked to incorporate these topics into ANC educational activities. Health Surveillance Assistants were encouraged to reinforce hygiene kit use by demonstrating correct *WaterGuard* use and handwashing technique during periodic home visits.

Follow-up data collection. In March 2011 we visited program participants enrolled at baseline to conduct follow-up interviews and make observations. The questionnaire was identical to the baseline questionnaire except for additional questions on the hygiene kit program and use of ANC and HIV testing services.

Registry data collection. Before initiation of the program, CHAI collected data from quarter 2, 2008 for specific ANC and HIV indicators from Machinga district in all 15 health facilities providing ANC and HIV care. Clinton Health Access Initiative then abstracted data on ANC, maternity, and HIV services received by pregnant women during all 12 subsequent quarters, including the study period March 2010–March 2011, from registries at the same 15 health facilities, which included the eight facilities participating in the evaluation. The registry data from 2008 and from the 12 subsequent quarters that included the study period were compared with the Malawi Demographic and Health Survey (DHS) data, collected in 2010.⁵

Qualitative data collection. In May 2011, we conducted in-depth interviews and focus group discussions (FGDs) with a convenience sample of program participants to determine factors influencing use of PMTCT and ANC services, and water treatment and handwashing practices. To provide context, interviews were also conducted with partners of program participants and health providers (mostly nurses). Focus group discussions and in-depth interview topic guides were developed and modified to adapt to local linguistic and cultural nuances. Topic guides included use of ANC and delivery services, and water treatment and hygiene practices. Local research assistants conducted the in-depth interviews and FGDs, which each took about 45 minutes, in Chichewa, the local language. Verbatim field notes were taken during the in-depth interviews and FGDs, and were then transcribed and translated into English for analysis.

Data analysis. Data from both baseline and follow-up surveys were entered into a Microsoft Access 2007 database (Microsoft, Redmond, WA) and analyzed using SAS 9.3 (SAS Institute, Cary, NC). Antenatal clinic and delivery service use were examined descriptively and compared with Malawi

DHS data for 2010.⁵ Human immunodeficiency virus service use data were also analyzed descriptively. Baseline and follow-up data were summarized and compared using McNemar's test for paired proportions. When McNemar's test was not feasible, an exact test of a binomial proportion was used. While we were unable to statistically adjust for any correlation within health facility subjects, we performed stratified analysis for the eight health facilities and determined that these results supported the overall results. Therefore we present the overall estimates, for all clinics for primary outcomes of interest. Outcomes of interest included knowledge of water treatment procedures with *WaterGuard*, detectable FCR in stored drinking water, confirmed use of *WaterGuard* (defined as presence of a bottle of *WaterGuard* and detectable FCR in stored water), reported purchase and confirmed use of *WaterGuard*, and use of proper handwashing technique (lathering hands completely with soap during a handwashing demonstration). Data from district maternal health and CHAI PMTCT registries were examined descriptively. For this paper, major themes were identified from in-depth interviews and FGDs and are presented using illustrative quotes.

Ethical review. The CDC Human Subjects Contact determined that, because this activity consisted of an evaluation of a proven public health practice, it was exempt from human subjects research review (protocol 6082). The Malawi Ministry of Health authorized the evaluation and provided CHAI with a letter of approval for the comprehensive and integrated PMTCT pilot program in Machinga. Verbal informed consent was obtained from all survey participants and personal identifiers were permanently removed from the database.

RESULTS

Enrollment. At baseline, we enrolled 106 pregnant women attending eight health facilities in Machinga district. One year later, we successfully completed follow-up visits with 97 (91.5%) of 106 women originally enrolled. Of the nine (8.5%) participants lost to follow-up, seven had moved away and two died; all were excluded from analysis. We limited our analysis to paired data from 97 women present at both baseline and follow-up. Because some women lacked stored water for testing during one or both home visits, analysis of water testing data was restricted to paired baseline-follow-up samples from 74 households.

Demographic and socioeconomic characteristics. The median age of participants at baseline was 24 years (range 15–45 years); 97% of participants were married. Twenty (21%) participants reported having no education, and 10 (10%) had completed primary school. The median household size was four persons (range 2–11 persons), with a median of one child < 5 years old (range 0–3). Ninety-one (94%) households had thatched roofs and 94 (97%) had mud floors. At baseline and follow-up, one house (1%) had electricity, 51 (53%) had a radio, and 71 (73%) had a bicycle. Pit latrines were observed in 78 (80%) homes at baseline and 87 (90%) homes at follow-up. There were no differences in demographic characteristics between participants and those lost to follow-up.

Antenatal clinic and HCT service use. Participants were all in their third to ninth month of pregnancy (median 5 months) at enrollment. At follow-up, 54 (56%) participants reported ≥ 4

visits to ANC compared with 46% of women reported in the DHS. Eighty-seven (90%) participants reported delivering at a health facility compared with 72% reported in the DHS. Of 94 live births, 87 children (93%) were alive at the 1-year follow-up; 95% of those alive had been seen at least once by a health care provider. All 97 program participants were tested for HIV; 96 (99%) were accompanied by their partners to the first ANC visit (one partner died before the visit took place); all 96 partners were tested, and 95 (99%) participant-partner pairs voluntarily disclosed their test results. Antenatal clinic register data from all 15 health facilities in Machinga District documented that, from the pre-implementation period in 2008 to the evaluation in 2011, there was an increase in the percentage of women delivering in health facilities (21% versus 89%), and tested for HIV (50% versus 91%) (T. Kisimbi, CHAI, personal communication).

Water source, storage and treatment. At baseline, 67% of program participants described using an improved† drinking water source and 99% reported storing their drinking water (Table 1); these proportions were similar at follow-up. At follow-up, 95 (98%) of 97 participants were observed to be using the hygiene kit storage container; the other two participants stated that the tap had broken. A higher percentage of program participants at follow-up reported boiling, filtering, or, chlorinating their water (95% versus 37%, $P < 0.0001$), said they treated their water in the past 2 days (88% versus 18%, $P < 0.0001$), and demonstrated knowledge of correct *WaterGuard* treatment procedure (80% versus 23%, $P < 0.0001$) than at baseline. There were increases from baseline to follow-up in detectable FCR in stored water (73% versus 0%, $P < 0.0001$), confirmed *WaterGuard* use (70% versus 0%, $P < 0.0003$), and confirmed use with reported purchase (45% versus 0%, $P = 0.005$). Increases in these objective water treatment variables were observed among study participants enrolled at each of the eight health facilities.

Hand hygiene. From baseline to follow-up, we observed a statistically significant increase in soap in the home (59% versus 75%, $P = 0.014$) and in the ability of program participants to demonstrate proper handwashing technique (21% versus 64%, $P < 0.0001$).

Program participation. Of 97 participants, 66 (68%) reported receiving refills of *WaterGuard* and soap, of whom eight (12%) received three or more refills, 41 (62%) got two, and 17 (26%) received one.

HSA made one or more home visits to 83 (86%) participants, and three or more to 37 (38%). The median number of HSA visits was two (range 1–15). Eighty-one percent of women who received three or more HSA visits had confirmed *WaterGuard* use after 1 year, compared with 29% of women who received no visits (Spearman Correlation Coefficient 0.31, $P = 0.002$) (Figure 3).

Qualitative data. We conducted in-depth interviews with 36 program participants and 16 HCWs; eight FGDs with program participants; and three FGDs with health providers.

Focus group discussions with program participants indicated that the incentives appeared to encourage women to attend ANC: “The part of the program that is most valuable is

receiving the hygiene kit because it has encouraged a lot of people in the village who didn’t want to go and get an HIV test. They now get an HIV test because they know that they will receive the hygiene kit. They hear their results and know their status because of the kit.” Some program participants said that incentives also seemed to help their partners overcome reluctance to accompany their wives to ANC: “Some men are difficult or they think they will look foolish going to ANC. But I told him that we will get a free bucket which has a tap. Most men eventually complied because of the free buckets. It was if they were being offered something freely just for accompanying their wives.”

Findings from program participants also suggested that partner HCT strengthened relationships within the family: “I think the idea of the men accompanying their wives is good because it is strengthening the marriages in our community. If both of you are HIV negative, you take care of yourselves and avoid doing other things. You trust each other. You are assured that he will not sleep with any other woman. So we move about proudly, knowing that he will not propose to any other woman.” According to some respondents, men gained greater appreciation for the process of pregnancy: “So they (husbands) would stay with us even up to the time we were around ten months pregnant. They didn’t go fishing even if they wanted to. My husband actually accompanied me to deliver the baby and he really wanted to be there on the maternity ward.”

On the other hand, some program participants reported that their partners were reluctant to participate because of fear of getting HIV tested (fear of knowing their status). Some respondents indicated that men were reluctant/unwilling to attend for other reasons, such as believing it’s not proper for husbands to attend the ANC clinic; not wanting to leave work; working away from home; not wanting to be seen walking/fishing to the clinic with their wife; shame about not having funds to purchase wife nicer clothes, etc.

Some health workers said that they themselves or women attending the clinic were frustrated, found it discriminatory, or counter-productive to not allow all pregnant women, particularly those whose husbands were not available, to obtain the WHK if the goal of the program was to reduce diarrheal disease.

Health workers expressed approval for the program, even though they were initially wary about the potential for increased workload: “We saw long lines at the ANC to receive the bucket and we worried. But because these women started making their water safe for drinking, this decreased our work in urgent care, taking care of women and children with diarrhea.”

Program participants also said that the attention paid to the program at ANC helped to overcome the barrier of taste or smell of chlorine: “I tell my family that the smell of *WaterGuard* is the smell of safety.” Two program strategies strongly influenced women’s decisions to use *WaterGuard*. First, the free trial of *WaterGuard* allowed program participants to experience the health benefits of *WaterGuard* and appreciate its value and relevance to their lives: “I started hearing about *WaterGuard* a long time ago but I wasn’t interested. But, when I heard about it at the ANC, I saw its benefits. I thought taking care of my water (e.g. covering it) was treating it, but after I went to the ANC then I noticed *WaterGuard* was important.” Second, positive, ongoing contacts with health providers and HSAs, especially during home visits, raised program

† Improved water sources include: piped water, public tap, borehole, protected well, protected spring, rainwater.

TABLE 1

Comparison of knowledge and practices regarding water sources, storage and treatment, and hand hygiene, at baseline and 1-year follow-up among program participants in the integrated safe water, hygiene and ANC program, Machinga District, Malawi, 2010–2011

WHK usage variables*	Baseline* N = 97	Follow-up* N = 97	P value (95% CI)
Water source			
Improved primary water source	65 (67%)	59 (61%)	–
Protected borehole or well	64 (66%)	55 (57%)	–
Household or yard tap	1 (1%)	0 (0%)	–
Public tap	0 (0%)	4 (4%)	–
Water storage			
Water storage in the home	96 (99%)	97 (100%)	–
Primary water storage container			
Bucket	62 (64%)	1 (1%)	–
Bucket from WHK	n/a	95 (98%)	–
Clay pot	15 (16%)	0 (0%)	–
Other (jerry can, bottle)	14 (14%)	1 (1%)	–
No storage container	5 (5%)	0 (0%)	–
Water storage and handling			
Water storage container has cover	57 (59%)	93 (96%)	< 0.0001
WHK used for water storage	n/a	95 (98%)	n/a
Pours or uses tap to remove water	5 (5%)	70 (72%)	< 0.0001
Reported water treatment			
Appropriate drinking water treatment†	36 (37%)	92 (95%)	< 0.0001
WG	19	90	–
Boiling	13	15	–
Filter	5	5	–
PuR	7	1	–
Chlorine	5	2	–
Reported use of any method in past 2 days	17 (18%)	84 (88%)	< 0.0001
WG knowledge and use			
Heard of WG	92 (94%)	97 (100%)	0.03 (0.54–1)
Knows correct WG treatment procedure	21 (23%)	73 (80%)	< 0.0001
Ever used WG	38 (39%)	97 (100%)	< 0.0001
Reported use of WG in past 2 days	4 (5%)	65 (81%)	< 0.0001
WG bottle observed in home	3 (3%)	73 (76%)	< 0.0001
Detectable FRC in stored water‡	0 (0%)	54 (73%)	< 0.0001 (0.6–0.8)
Confirmed WG use (positive FRC and presence of WG bottle in the home)‡	0 (0%)	52 (70%)	0.0003 (0.6–0.8)
Confirmed WG use and purchase‡	0 (0%)	34 (46%)	0.005 (0.3–0.5)
Hygiene practices			
Soap observed in home	57 (59%)	72 (75%)	0.014
Handwashing demonstration			
Uses soap	23 (25%)	62 (65%)	< 0.0001
Lathers hands completely	20 (21%)	61 (64%)	< 0.0001

ANC = antenatal clinic; CI = confidence interval; FRC = free residual chlorine; WG = *WaterGuard*; WHK = water hygiene kit.

* For some items *n* may vary by small numbers.

† Some respondents reported more than one water treatment method.

‡ At baseline, only 74 households had water available for testing; analysis performed on 74 baseline-follow-up pairs, using binomial proportions.

participants' awareness of the need to treat water and supported continuing use: "My neighbors may say bad things about me treating my water, but HSAs come and compliment me on my treated water. They (HSAs) tell me that it is important to treat water that my children will not get sick." The program helped reduce initial cost barriers to continuing to use *WaterGuard*: "At my age, I started hearing about *WaterGuard* a long time ago, but you know how it is here in the village. People say stuff about *WaterGuard*, others say if you drink water treated with *WaterGuard* you vomit. So, we ended up not having interest in it. So when we received educational messages from the health workers, I decided to try it out. Then we found out that *WaterGuard* is important. So when we joined the program I started using it, when it finished I would go get more, until I started buying it." The ability to try free *WaterGuard* also may have motivated husbands of program participants to purchase the product: "He (my husband)

isn't even stingy when he finds money. He even sacrifices his cigarettes for *WaterGuard*."

DISCUSSION

Results of this evaluation showed that a high percentage of pregnant women participating in a program to integrate free water treatment and hygiene products into antenatal care received HCT, had ≥ 4 ANC visits, and delivered in a health facility. These findings were corroborated by antenatal registry data for all 15 district health facilities, which documented large increases in health facility deliveries and HCT from program baseline in 2008 to the follow-up in 2011. Of note, HCT for mothers and partners was near universal, exceeding results obtained in other evaluations of partner testing.^{12–15} There are several possible explanations for these findings. First, clients may have valued the incentives, which may have motivated

FIGURE 3. Confirmed *WaterGuard* (WG) use by number of Health Surveillance Assistant (HSA) visits.

them to return for further services. Similar results have been obtained from studies using a variety of incentives.^{9,10,16,17} Second, the requirement that women attend the initial visit accompanied by their partner to be eligible to receive the incentive may have contributed to increased utilization of services, as has been observed in other studies.^{12,13,18} Third, during this study, the Minister of Health began promoting ANC visits and health facility deliveries, which could have influenced outcomes.¹⁹ Finally, the Expert Client program may have contributed to improved service retention by giving women with HIV an opportunity to interact with peers who experienced similar diagnoses and motivating them to improve their health by keeping appointments at ANC and antiretroviral treatment clinics. Peer advocacy has been shown to boost initiation and uptake of HIV services.²⁰

Results of this study also demonstrated that confirmed water treatment and the ability to demonstrate proper handwashing technique increased significantly among study participants. These results were consistent with results of two previous antenatal integration studies among pregnant women^{9,10} and their friends and relatives.²¹ The relatively high uptake of water treatment behavior by mothers in this study has several possible explanations. First, by integrating a household water treatment product and hygiene promotion with ANC services, the program targeted mothers during a “teachable moment” motivated by the impending birth of a newborn and the urge to protect the infant from harm.^{9,22–25}

Second, quantitative and qualitative data from other studies suggest that trust in health personnel can motivate clinic clients to adopt interventions promoted by health workers.^{24,25} In fact, a study of a similar intervention in other districts in Malawi suggested that, despite negative peer pressure from some neighbors and friends regarding the use of *WaterGuard*, mothers were motivated by health personnel to maintain their use of the product and encourage friends and relatives to also improve their household water treatment and handwashing behaviors.²¹ Men in particular appeared more willing to believe professional staff.

Third, ownership of the program by health workers in the implementing clinics helped enhance the quality of implementation. Fourth, visits by the HSAs to clients’ homes appear

to have helped encourage clients maintain their water treatment practice, thereby providing time for families to experience the benefits of improved water quality and hygiene behaviors. Finally, program participants likely valued the water and hygiene incentives. A qualitative study from Malawi showed that mothers found value in the cost of a bottle of *WaterGuard* compared with the cost of a hospital visit for a sick family member.²⁵

This evaluation had several limitations. Because of financial constraints, we were not able to measure the health impact of increased use of antenatal care, HIV services, and household water treatment, nor were we able to enroll pregnant women from comparison health facilities engaged in usual ANC practices. Our results were not generalizable because this PMTCT program was conducted in one district of Malawi that benefitted from funding from the PEPFAR¹¹; however, comparable programs implemented in the context of standard antenatal care (i.e., not a PMTCT program) in two other districts in Malawi yielded similar results.^{9,10} Results of this study may have been influenced by the Hawthorne effect, as women enrolled in the evaluation may have been more motivated to use services and improve household hygiene practices as a result of expected home visits by the study team and HSAs than other program participants.²⁶ Although trends in these eight health facilities were greatest, district-wide data for HCT, ANC visits, and health facility deliveries, which included results from seven health facilities that did not participate in the surveys, exhibited similar trends. This evaluation depended on data from antenatal and delivery registries, which can be subject to error. This possibility was mitigated by intensive efforts by both CHAI and the Machinga DHO to maintain data quality; the positive impact of such efforts on data quality has been documented in at least one study.²⁷ While it is possible that other interventions in Machinga District contributed to improved clinic attendance and improved household water and handwashing behaviors, repeated inquiries throughout the evaluation period yielded no evidence of such interventions. Finally, this evaluation was limited to a year. Several studies have suggested that the practice of point-of-use water treatment attenuates over time.²⁸ A prior evaluation 3 years after the launch of a similar integrated intervention in Malawi

found a decrease in *WaterGuard* use over time, but that it was still significantly greater than at baseline.¹⁰

CONCLUSION

In conclusion, the integration of water treatment and hygiene incentives into a PMTCT program with required partner participation, peer support by HIV-infected Expert Clients, and community follow-up by local health workers motivated high proportions of pregnant women to attend ≥ 4 ANC visits, deliver in health facilities, receive HCT with their partners, treat household water, and improve hand washing technique. After this pilot program in Machinga District, the Malawi Ministry of Health developed a National Operational Plan on Household Water Treatment. Although financial constraints did not permit the assessment of health impact in this study, results of other studies demonstrating negative associations between water treatment interventions and diarrheal diseases,^{29–31} HIV progression,²⁸ and health facility visits for any illness³² raise the possibility that the population in this study likely benefited from improved health. Because it is not known whether this intervention could have had an effect on retention in HIV care and quality of life for people living with HIV/AIDS, an evaluation of these potential impacts is warranted. Finally, because the sustainability of interventions requiring financial support has been questioned,³³ a cost-benefit analysis should be incorporated into future studies of interventions integrated into ANC.

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