Short Communication

Cost analysis of the implementation of portable handwashing and drinking water stations in rural Kenyan health facilities

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ABSTRACT

Many health care facilities (HCFs) in developing countries lack adequate infrastructure for handwashing and drinking water, increasing the risk of healthcare-associated infections. Attaining permanent, 24-hour/day piped water access – the long-term goal – is time-consuming and expensive. To address this problem in the short- to medium-term, low-cost portable handwashing water stations (HWSs) and drinking water stations (DWSs) were installed in rural Kenyan HCFs in 2011. Access to HWSs with soap and DWSs with safe water was ascertained at baseline and 1-year follow-up. Cost data were obtained from the program budget and beneficiary data (number of health workers, households, and individuals within HCF catchment areas) from the Ministry of Health. A cost analysis was adjusted for incremental gains from baseline to follow-up in access to improved handwashing and safe DWSs. The cost of improved access to handwashing with soap was $1,527/HCF, $217/health worker, and $0.17/individual, and to safe drinking water was $720/HCF, $103/health worker, and $0.08/individual. The favorable cost of this intervention per beneficiary justifies its use for rapid improvement of handwashing and drinking water access in HCFs during planning and construction of permanent infrastructure.

Key words | cost analysis, drinking water, handwashing, health care facilities, Kenya

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INTRODUCTION

Recent data from 54 middle and low income countries showed that 38% of health care facilities (HCFs) lacked improved water supplies and 35% lacked handwashing facilities (Cronk & Bartram 2015). The lack of a consistently-available water supply for handwashing and drinking in exam rooms and patient wards in HCFs prevents health workers from washing their hands between patients or providing safe drinking water for administration of oral medications, and increases the risk of healthcare associated infections (HAI) (Nejad *et al.* 2011; Matanock *et al.* 2014). The burden of HAI in developing countries is unknown, but believed to be substantially higher than in developed countries (Allegranzi & Pittet 2007; Nejad *et al.* 2011). In recognition of this silent global health crisis, WHO and UNICEF launched a global initiative in conjunction with the Sustainable Development Goals to achieve 100% coverage of improved water, sanitation, and hygiene (WASH) infrastructure for HCFs by 2030 (www.wssinfo.org/fileadmin/user_upload/resources/JMP-Update-report-2015_English.pdf). Even if this ambitious goal is achieved, millions of patients will be at risk in the intervening years.

doi: 10.2166/washdev.2017.010

To address this problem in the short- to medium-term, the Safe Water and AIDS Project (www.swapkenya.org), Ministry of Health of Kenya, Churches Health Association of Kenya, UNICEF, and US Centers for Disease Control and Prevention collaborated to pilot a health facility-based hygiene and drinking water program in rural western Kenya in 2011 (Bennett *et al.* 2015). The intervention in 117 HCFs included health worker trainings in proper handwashing, water treatment, and water station maintenance, followed by installation of an average of four portable handwashing stations (HWSs) and two drinking water stations (DWSs) per health facility (quantity determined by patient load), which were accompanied by laminated WASH guides designed to be hung near the water stations; the total cost was $44,651. Each handwashing water station consisted of a 60-liter plastic bucket with a tight-fitting lid and tap, metal stand, and plastic washbasin (Figure 1), and DWSs included either a 60-liter bucket with a lid and tap on a simple metal stand (Figure 2) or a ceramic pot filter (brand name Chujio) nested in a 20-liter bucket (Figure 3). Each HCF also received a three-month starter supply of soap and sodium hypochlorite solution (dilute bleach at 1.25% concentration) for disinfection of drinking water. In 2012, a program evaluation in a random sample of 40 HCFs showed that 97% of DWSs and 78% of HWSs were in use (Bennett *et al.* 2015). Management of human excreta through improved sanitation infrastructure is also a gap in quality of care at HCFs (Cronk & Bartram 2015), but because of a lack of short-term, low-cost options, sanitation was not included as an intervention in the original pilot study. In this paper, we present results of a cost analysis of the hygiene and drinking water intervention.

Figure 1 | Improved HWS comprised of water container with tap, basin, and soap.

Figure 2 | DWS comprised of a 60-liter bucket with a lid and tap on a simple metal stand.

Figure 3 | DWS consisting of a ceramic pot filter (brand name Chujio) nested inside a 60-liter bucket (lid missing from photo).

METHODS

For this analysis, program beneficiaries were defined as health workers, households, and individuals in HCF catchment areas. We obtained the number of health worker beneficiaries from the initial study sample of 40 HCFs, and extrapolated to all 117 HCFs. To estimate the total number of beneficiary households, we obtained the approximate number of households in the catchment area of each HCF from the Kenya Master Health Facility List database (http://kmhfl.health.go.ke). To calculate individual beneficiaries, we multiplied the number of households by the median number of persons per household obtained from the evaluation database (Bennett *et al.* 2015). For HCFs in the database without information on the number of households in their catchment areas, we used the evaluation database to estimate the number of households as a function of the average number of patients seen daily in each catchment area and then multiplied that number by the median number of individuals per household.

The evaluation database included baseline and follow-up measures (obtained during surprise visits 12–15 months later) on the status of HWSs and DWSs in HCFs. These were used to calculate incremental changes in access. Changes in HWS access were calculated by subtracting baseline from follow-up percentages of HCFs with HWSs observed to have soap. Similarly, we subtracted baseline from follow-up percentages of HCFs with access to improved DWSs (defined as a bucket with tight-fitting lid and spigot or a ceramic filter), and safe DWSs (defined as detectable chlorine residual in stored water or use of a ceramic filter), to determine incremental changes in improved and safe drinking water access. We assumed that incremental changes obtained for the 40 randomly selected HCFs would be similar across all 117 facilities.

Program costs were derived from the funds received from UNICEF and costs documented in program implementation by SWAP. Costs included training of trainers; training of health workers; procurement of HWSs, DWSs, soap, and sodium hypochlorite solution; and supervisory visits. Additional support costs included evaluation staff salaries and office costs, and indirect costs (10% of total costs).

We calculated costs per beneficiary by dividing total costs by the total number of beneficiaries, including HCFs, health workers, households, and individuals, adjusted by incremental changes in access to HWSs or DWSs.

RESULTS AND DISCUSSION

The total cost of implementation was $40,592, including $15,509 for training, $25,083 for equipment, supplies, and distribution, and an additional $4,059 was required for indirect costs (Table 1). The 117 HCFs employed an estimated 822 health workers and encompassed a catchment area of approximately 214,180 households inhabited by approximately 1,070,900 individuals. Each HCF had 1–2 representatives who attended one of the five 2-day training sessions. The average cost per attendee and trainer was approximately $47, including transport, accommodation, and meals. Following each training, project equipment and supplies were delivered to each health facility.

The average overall program cost was $382/HCF, $54/health worker, $0.21/household, and $0.04/individual in the HCF catchment areas. The estimated cost for the incremental gain in access to HWSs with soap in HCFs was $1,527/HCF, $217/health worker, $0.83/household, and $0.17/individual (Table 2). The estimated cost for the incremental gain in access to improved DWSs in HCFs was $477/HCF, $68/health worker, $0.26/household, and $0.05/individual. The estimated cost for gains in safe DWSs was $720/HCF, $103/health worker, $0.39/household, and $0.08/individual.

Recurring costs for sodium hypochlorite products, soap, and replacement of water station components were not considered in this analysis, but are estimated to be $155/HCF per year, $22/health worker per year, $0.08/household per year, and $0.02/individual per year. This estimate assumes an average of two bars of soap per day and one bottle of sodium hypochlorite solution every 4 days per HCF, as well as an annual repair cost of 10% for replacing broken buckets, taps, and basins. If ceramic pot filters are used instead of chlorination solution, recurring costs drop to $143/HCF per year with proportional changes in cost for health workers, households, and individuals. Because this program did not have ongoing funding and previous similar projects in western Kenya have shown continued use of these water stations 4 years or more after implementation

Table 1 | Costs of health worker training and procurement and transport of supplies

Training costs

Line item	Details	Unit price (KS)	No. days	No. pax	No. trainings	Total (KS)	Total (USD)
Accommodation	Bed and breakfast	1,500	2	161		483,000	5,682
Meals and teas	Lunch, two teas, two water	750	2	161		241,500	2,841
Transport reimbursement	To training venue + return home	1,000	2	161		322,000	3,788
Hall hire for trainings	Training hall	2,000	2		5	20,000	235
Photocopies training materials	Copies + binding	100		161		16,100	189
Stationery	Notebooks, pens etc	100		161		16,100	189
Overnight and per diem trainers	Overnight + incidentals	3,000	4	2	5	120,000	1,411
Fuel vehicle	To and from training venue	3,000	4		5	60,000	705
Communication	Airtime for logistics	1,000	2		5	10,000	117
Fuel vehicle	Organizing trainings	3,000	2		5	30,000	352
Total						1,318,700	15,509

Procurement and distribution of supplies

Line Item	Detail	Unit Price (KS)	Quantity	No. of clinics	Total (KS)	Total (USD)
60 liter buckets	With lid and taps	550	6	117	386,100	4,542
Stand for handwashing	Heavy metal with soap dish	2,750	4	117	1,287,000	15,141
Stands for DWS	Without soap dish, etc.	750	2	117	175,500	2,064
Basins	For handwashing	200	4	117	93,600	1,101
Waterguard	150 mL	20	12	117	28,080	330
Hand washing soaps	Ushindi	15	24	117	42,120	495
Fuel	Distribution + M and E	3,000	20		60,000	705
Per diem driver	Distribution	500	20		10,000	117
Monitoring visits	Fuel and per diem	5,000	10		50,000	588
Total					2,132,400	25,083

(Sreenivasan *et al.* 2008; Davis *et al.* 2017), we made the assumption that the Ministry of Health would replace commodities and broken parts, which were all originally purchased locally and could be readily replaced. HCFs also assigned the task of filling the water stations to existing paid staff as part of their duties, so we did not include this cost in our estimates (see supplemental table for detailed cost breakdown, available with the online version of this paper).

This cost analysis showed that handwashing and improved DWSs could be implemented in HCFs at a fraction of a dollar per individual and approximately one dollar per household in HCF catchment areas. If the water stations were designed to include both handwashing and drinking water functions, the implementation costs could be lower than the values used in this analysis. This approach would be most practical in small HCFs with relatively low patient volume. Although recurring costs for commodities and repairs would make the program more expensive, these costs are primarily for soap and sodium hypochlorite, essential and inexpensive HCF supplies that should be included in Ministry of Health budgets. At a very small incremental cost, continuing education and reinforcement of the training could be included in the pre-service and in-service health provider curricula, and monitoring of the HWS and DWS could be included in the supervisory checklists during site visits.

Table 2 | The estimated cost for incremental gains in access to HWSs with soap, improved DWSs, and safe DWSs

	HWS with soap	Improved DWS	Safe DWS
Utilization rate			
Pre-intervention	53%	18%	5%
Post-intervention	78%	98%	58%
Incremental gain	25%	80%	53%
Cost per beneficiary			
Cost per HCF ($n = 117$)	$1,527	$477	$720
Cost per health worker ($n = 822^a$)	$217	$68	$103
Cost per household ($n = 214{,}180^a$)	$0.83	$0.26	$0.39
Cost per person ($n = 1{,}070{,}900^a$)	$0.17	$0.05	$0.08

[a]Estimated.

The cost estimates used for this interim intervention are substantially lower than the programmatic costs of construction of permanent water supply and hygiene infrastructure in HCFs, which include community mobilization, training, hardware procurement, construction (i.e. drilling, laying pipe, and/or building large water storage containers) and establishment of a system of maintenance and repair. Although it is difficult to obtain cost data, water source development and hygiene infrastructure can range from at least $15,000 to $40,000 or more per HCF. The cost per beneficiary for these investments, according to assumptions used in this analysis, would range from $2,135 to $5,693 per health worker, $8 to $22 per household, and $1.64 to $4.37 per individual in HCF catchment areas. The benefits of reliable and safe HCF water infrastructure are multi-faceted and justify this expense in the long term. Also, the metric by which achievement of SDGs will be measured is universal and equitable access to a safe water supply for all, which includes health workers, patients and their families in institutional settings like HCF. However, the construction of water infrastructure is time-consuming and expensive, and the immediate risk of HAI for patients and health workers in underserved HCF demands rapid action (Allegranzi & Pittet 2007; Nejad *et al.* 2011; Matanock *et al.* 2014). An extreme example of this risk was observed during the Ebola epidemic in West Africa (Matanock *et al.* 2014), and in response hundreds of portable HWSs were installed in health centers as a practical measure to mitigate the risk (www.unicef.org/appeals/files/2015_HAC_Ebola_MYR_final.pdf). The cost of implementing inexpensive water stations is a justifiable expense to mitigate HAI risk in the short- to medium-term. In water-scarce regions where uninterrupted access to water supply may not be feasible, water stations can help bridge gaps in supply to provide access to safe water in HCFs through safe water storage and point-of-use water treatment.

This analysis had several important limitations. First, the evaluation of HWS and DWS use occurred only 12–15 months after implementation, limiting the assessment of duration of use to a relatively short period. At least two other evaluations in two other counties of Kenya have demonstrated use of similar HWS and DWS for periods of 4–12 years after implementation (Sreenivasan *et al.* 2008; Davis *et al.* 2017). Second, because this analysis addressed a program in only five Kenyan counties, findings are not generalizable to other locations. Finally, direct and indirect costs may have increased since program implementation in 2010, which may have increased the cost per beneficiary.

CONCLUSIONS

The simple health facility intervention described in this paper can be rapidly implemented and provide ready access to a basic and essential service in the short- to medium-term at a low cost per beneficiary. It is expected that this intervention will help reduce health risks through improved hygiene and drinking water access until longer-term, more expensive water infrastructure interventions are planned and executed. In water-scarce areas with intermittent supplies that require water storage, these interventions may help bridge gaps in supply and remain in use in HCFs for the long term. Engagement with ministries of health to ensure ongoing training of health workers and resupply of commodities or broken water stations are critical to maintenance and sustained use of the water stations.

ACKNOWLEDGEMENTS

We are grateful to Alie Eleveld of the Safe Water and AIDS Project for her assistance with program implementation details.

DISCLAIMER

The opinions expressed by authors contributing to this paper do not necessarily reflect the opinions of the Centers for Disease Control and Prevention or the institutions with which the authors are affiliated.

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First received 23 January 2017; accepted in revised form 6 September 2017. Available online 31 October 2017