Promotion of Cholera Awareness among Households of Cholera Patients: A Randomized Controlled Trial of the Cholera-Hospital-Based-Intervention-for-7 Days (CHoBI7) Intervention

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Abstract. Previous studies have demonstrated that household contacts of cholera patients are highly susceptible to cholera infections for a 7-day period after the presentation of the index patient in the hospital. However, there is no standard of care to prevent cholera transmission in this high-risk population. Furthermore, there is limited information available on awareness of cholera transmission and prevention among cholera patients and their household contacts. To initiate a standard of care for this high-risk population, we developed the Cholera-Hospital-Based-Intervention-for-7-Days (CHoBI7), which delivers a handwashing with soap and water treatment intervention to household contacts during the time they spend with the admitted cholera patient in the hospital and reinforces these messages through home visits. To test CHoBI7, we conducted a randomized controlled trial among 302 intervention cholera patient household members and 302 control cholera patient household members in Dhaka, Bangladesh. In this study, we evaluated the effectiveness of the CHoBI7 intervention in increasing awareness of cholera transmission and prevention, and the key times for handwashing with soap. We observed a significant increase in cholera knowledge score in the intervention arm compared with the control arm at both the 1-week follow-up (score coefficient = 2.34 (95% confidence interval [CI] = 1.96, 2.71)} and 6 to 12-month follow-up period (score coefficient = 1.59 [95% CI = 1.05, 2.13]). This 1-week hospital- and home-based intervention led to a significant increase in knowledge of cholera transmission and prevention which was sustained 6 to 12 months post-intervention. These findings suggest that the CHoBI7 intervention presents a promising approach to increase cholera awareness among this high-risk population.

BACKGROUND

The World Health Organization (WHO) estimates that there are 3–5 million cholera cases worldwide per year with 100,000 of these cases resulting in death. In Bangladesh alone, there are estimated to be over 200,000 cholera cases annually. Previous studies have identified being a first-degree relative of a cholera patient as a risk factor for cholera. Studies in Bangladesh and India have found that the household contacts of cholera cases are at more than a 100 times higher risk of developing a subsequent cholera infection than the general population during the 1-week period after the initial case presents in the hospital. Most recently, a study in urban Dhaka, Bangladesh found that 21% of household contacts of cholera patients had a stool sample positive for *Vibrio cholerae* during the 3-week period after the index cholera patient was identified, with 73% of these infections being symptomatic.

There are no published studies, to our knowledge, that have focused on assessing knowledge of cholera transmission and prevention among cholera patients and their household contacts. Recently, a community-based study in Dhaka, Bangladesh, found that 54% of household members that were surveyed had poor knowledge of cholera transmission and prevention. Another cross-sectional study conducted in Tanzania to determine knowledge, attitudes, and practices regarding cholera outbreaks, found that while knowledge of cholera transmission and prevention was high, actual prac-

In an effort to initiate a standard of care for household contacts of cholera patients during the 1-week high-risk period after the presentation of the index case, we developed and evaluated the efficacy of Cholera-Hospital-Based-Intervention-for-7Days (CHoBI7), a hospital-based handwashing with soap and water treatment intervention in Dhaka, Bangladesh. We found that this low-cost intervention resulted in a significant reduction in symptomatic cholera infections. ¹² Furthermore, this intervention led to sustained handwashing with soap and improved household drinking water quality 6 to 12 months post-intervention. ¹³

The objective of our current investigation is to assess the effectiveness of the CHoBI7 intervention in increasing knowledge of cholera transmission and prevention among highly susceptible household members of cholera patients in Dhaka, Bangladesh. This is the first study, to our knowledge, to assess the ability of a water, sanitation, and hygiene (WASH) intervention to increase cholera awareness among highly susceptible household members of cholera patients.

METHODS

The efficacy of the CHoBI7 intervention was evaluated by conducting a cluster randomized controlled trial (RCT) in Dhaka, Bangladesh, from June 2013 to November 2014. Suspected cholera cases, defined as patients presenting at the International Centre for Diarrhoeal Disease Research,

tices to reduce cholera transmission were low.¹¹ In Calcutta, an intervention study targeting cholera through promotion of water treatment and improved water storage practices led to a significant reduction in cholera infections among household contacts of cholera cases. However, this study did not assess changes in knowledge of cholera transmission and prevention in this population.⁹

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Bangladesh (icddr,b) Dhaka hospital with acute watery diarrhea (three or more loose stools over a 24-hour period) and moderate to severe dehydration using the WHO definition, were screened for the presence of Vibrio cholerae in their stool using the Crystal VC Rapid Dipstick test (Span Diagnostics, Surat, India). 14,15 All positive findings by dipstick were confirmed by bacterial culture. All suspected cholera cases admitted to icddr,b Dhaka hospital residing within a police thana (ward) of Dhaka city were eligible for the CHoBI7 trial. Cholera cases were defined as suspected cholera cases with a stool bacterial culture result positive for V. cholerae. Cholera cases were excluded from the study if they had a household contact already enrolled (currently or previously), or if they had received cholera vaccine, to avoid confounding from an ongoing vaccine trial. Household contacts were defined as individuals sharing the same cooking pot as the index cholera case for the past 3 days. To be eligible for the study, household contacts had to plan to reside in the household of the index case for the next week, and had not received cholera vaccine. Eligible household contacts present in the hospital at the time of case enrollment were invited to participate, and a household visit was made to recruit household contacts within 36 hours of case enrollment. A cluster was defined as the index cholera case and their corresponding household contacts.

The CHoBI7 intervention includes: 1) a pictorial ("Chobi" in Bangla) module on how cholera can spread through the environment (e.g. contamination of household drinking water sources and stored water), how people can spread cholera to each other through contaminating food and water in their home, and instructions on proper handwashing with soap and water treatment practices; and 2) a cholera prevention package containing Aquatabs[®] (Medentech, Wexford, Ireland, UK) chlorine tablets (sodium dichloroisocyanurate) for water treatment, soapy water bottles (a low-cost alternative to bar soap made using detergent), a handwashing station, a sealed water vessel with cover to ensure safe water storage, and cue to action cards with instructions on promoted behaviors. Handwashing with soap was promoted in the CHoBI7 intervention at the following key times: 1) after using the toilet, 2) after cleaning a child's anus, 3) after removing child's feces, 4) before eating, 5) before feeding a child, and 6) before preparing food. Three trained health promoters at icddr,b Dhaka hospital delivered this pictorial module and cholera prevention package to cholera cases and their accompanying family members during a consultation session in the hospital. These messages were then reinforced through daily household visits by the health promoters for the 1-week intervention period.

Study recruitment at the Dhaka icddr,b hospital occurred from Saturday to Thursday every week during the study period. Each week, half of surveillance days were randomly selected to be intervention days and half were randomly assigned to be control days using a random number generator. Randomization was assigned by the study principal investigator (C. M. George). This randomization scheme limited the likelihood of seasonal variations in study arm assignment and selection bias. The control arm received the standard message given at health facilities in Bangladesh on the use of oral rehydration solution (ORS) for the treatment of diarrhea, and the intervention arm received this standard message and the CHoBI7 intervention. The standard message given at health facilities on ORS was a verbal statement given by the hospital staff

that ORS should be given to prevent dehydration during episodes of diarrhea. No information on handwashing with soap was provided to the standard message arm. To minimize bias, there were two separate teams for the intervention and evaluation activities.

Cholera patients and household contacts were administered a structured questionnaire tool at baseline and 1 week and 6–12 months after enrollment to assess household clinical characteristics and knowledge of cholera transmission, prevention, and the key times to handwashing with soap promoted in the CHoBI7 intervention. Only households that had been recruited for the CHoBI7 intervention trial at least 6 months prior were eligible for the 6 to 12 month follow-up survey which was conducted from August 2014 to January 2015.

Measurement of knowledge. To assess knowledge of cholera among cholera patients and their corresponding household contacts, a structured questionnaire with three open-ended questions were administered to household members that were ≥ 12 years of age. Participants were asked, "Can you name three important ways cholera is spread?" (cholera transmission) (1 point for each correct response, total possible score of 3 points); "Can you name three important ways cholera can be prevented?" (cholera prevention) (1 point for each correct response, total possible score of 3 points); and "Can you please name the 4 key times for handwashing with soap?" (key times for handwashing with soap) (1 point for each correct response, total possible score of 4 points). These open-ended questions were coded. Correct answers for cholera prevention were responses related to handwashing with soap, safe water storage, avoidance of street food, and water treatment. Correct answers for the key times for handwashing with soap were the following: 1) after using the toilet, 2) after cleaning a child's anus, 3) after removing child's feces, 4) before eating, 5) before feeding a child, and 6) before preparing food. Correct answers for spread of cholera were related to human feces and contaminated drinking water, hands, and food. The overall cholera knowledge score was calculated by summing the points for correct answers from all three questions, therefore the total possible overall cholera knowledge score was 10 (range 0-10).

Power calculation. The power calculation was based on the primary objective of the RCT which was to determine whether the CHoBI7 intervention could significantly reduce cholera infections among household members of cholera patients. Optimal Design software (University of Michigan, Ann Arbor, MI) was used for the sample size calculation to determine the number of cholera patients (clusters of household members) needed to reject the null hypothesis that there was no significant difference in the incidence of cholera infection by study arm at a 95% confidence interval (CI) and 80% power. 16 We assumed that 20% of household members in the control arm would become infected with cholera and that the intervention would reduce this rate to 10% with an average cluster size of three household members. Based on these assumptions, we estimated that we would require 156 cholera patients and 468 household members (78 patients and 234 household contacts in each study arm).

Statistical analysis. To compare knowledge scores for cholera transmission, prevention, and the key times for handwashing with soap between the intervention and control arm at baseline and the 1-week and 6- to 12-month follow-up, we conducted two sample t tests. To compare the proportion of household members that reported three correct transmission for cholera, three

correct preventive measures for cholera, and four correct key times for handwashing with soap events between the intervention and control arm, a χ^2 test or Fisher's exact test was performed (Fisher's exact test was used when frequencies were less than five). In addition, linear regression models were conducted to compare the overall knowledge score between the intervention and control arm, where overall knowledge was the outcome and study arm was the predictor at each time point.

Ethical approval. Informed consent was obtained from all study participants (household contacts and index cholera cases); this included adult participants (≥ 18 years of age) signing an informed consent and/or parental consent form and children between 12 and 17 years of age signing an assent form.

RESULTS

A total of 344 household members (cholera patients and household contacts) enrolled in the CHoBI7 trial were ≥ 12 years of age and were administered the structured knowledge questionnaire at baseline and the 1-week follow-up (170 intervention household members and 174 control household members). There were no significant differences in these participants by study arm for age (P = 0.79), gender (P = 0.78), educational level (P = 0.03), refrigerator ownership (P = 0.5), or television ownership (P = 0.5). The mean age for participants was 31.5 years (standard deviation [SD] = 12.6, range = 12-75), and 65% were female. There were 135 households that had been enrolled at least 6 months prior when the 6- to 12-month follow-up survey was conducted, and 76% (103/135) of these eligible households were enrolled. In these households, there were a total of 159 enrolled participants that were ≥ 12 years of age (74 intervention household members and 85 control household members).

At baseline, there was no significant difference in knowledge of cholera transmission (Can you name three important ways cholera is spread?) (median score = 1) by study arm (P = 0.19) (Table 1). Seven percent (24/344) of respondents were able to report three correct transmission routes for cholera at baseline; this did not differ significantly by study arm (P = 0.43). In addition, at baseline, 46% (159/344) of participants reported cholera was spread by water, this was followed by food at 34% (116/344) (Table 1). At the

1-week follow-up, knowledge of cholera transmission was significantly higher in the intervention arm (median score = 2) compared with the control arm (median score = 1) (P <0.0001). Twenty-five percent (43/170) of respondents were able to report three correct transmission routes for cholera in the intervention arm compared with 7% (15/174) in the control arm (P < 0.0001). Seventy-three percent (124/170) of intervention household participants reported water as an important way cholera was spread compared with 34% (60/174) in control households. Furthermore, 42% (72/170) of intervention household participants reported that cholera was spread by feces compared with only 4% (7/174) of control household participants. At the 6- to 12-month follow-up, knowledge of cholera transmission did not significantly differ between the intervention (median score = 1) and control arm (median score = 1) (P = 0.32). Fifteen percent (11/74) of respondents were able to report three correct transmission routes for cholera at in the intervention arm compared with 11% (9/85) in the control arm (P = 0.42). Fifty-one percent (38/74) of intervention household participants reported that cholera was spread by water compared with 38% (32/85) of control participants. None of the control participants reported feces as a transmission report for cholera compared with 32% (24/74) of intervention participants.

There was no significant difference in knowledge of cholera prevention at baseline (Can you name three important ways cholera can be prevented?) (median score = 1) (P = 0.96)(Table 2). Two percent (8/344) of respondents were able to report three correct methods to prevent cholera at baseline; this did not differ significantly by study arm (P = 0.72). Fortynine percent (170/344) of participants mentioned safe water as a cholera prevention method; this was followed by handwashing with soap at 27% (92/334) (Table 2). At the 1-week follow-up, knowledge of cholera prevention was significantly higher in the intervention (median score = 1) compared with the control arm (median score = 1) (P < 0.0001). Sixteen percent (28/170) of respondents were able to report three correct methods to prevent cholera in the intervention arm compared with 3% (5/174) in the control arm (P < 0.0001). Sixty-one percent (104/170) of intervention household participants mentioned safe water compared with 49% (84/174) of control participants. Forty-six percent (79/170) of intervention household participants reported handwashing with soap as a method to

Table 1

Reported cholera transmission routes: Can you name three important ways cholera is spread?

Cholera transmission									
Major themes*	Baseline $(N = 344)$		1-week follow-up ($N = 344$)		6-12 month follow-up ($N = 159$)				
	Control % (n)	Intervention % (n)	Control % (n)	Intervention % (n)	Control % (n)	Intervention % (n)			
Water	47 (82)	45 (77)	34 (60)	73 (124)	38 (32)	51 (38)			
Food	37 (65)	30 (51)	36 (63)	9 (15)	39 (33)	12 (9)			
Hygiene	22 (38)	25 (43)	17 (30)	6 (11)	25 (21)	9 (7)			
Feces	2 (4)	2 (4)	4 (7)	42 (72)	0 (0)	32 (24)			
Lack of handwashing (soap mentioned)	22 (38)	16 (27)	26 (46)	33 (56)	24 (20)	27 (20)			
Lack of handwashing after toileting (soap not mentioned)	16 (27)	15 (25)	17 (30)	30 (51)	22 (19)	36 (27)			
Food is not covered properly	7 (15)	7 (11)	7 (15)	1 (2)	6 (5)	5 (4)			
Air	5 (9)	4 (7)	6 (10)	2 (3)	4 (3)	1 (1)			
Unclean environment	5 (9)	5 (9)	5 (9)	1 (1)	0 (0)	0 (0)			
Dirty hands	3 (5)	5 (9)	1 (2)	9 (16)	6 (5)	7 (5)			
Eating food outside the home	3 (6)	9 (15)	7 (16)	1 (1)	5 (4)	4 (3)			

^{*}Multiple responses per participant.

Table 2
Reported preventive measures for cholera: Can you name three important ways cholera can be prevented?

Cholera prevention								
	Baseline $(N = 344)$		1-week follow-up ($N = 344$)		6-12 month follow-up ($N = 159$)			
Major themes*	Control % (n)	Intervention % (n)	Control % (n)	Intervention % (n)	Control % (n)	Intervention % (n)		
Safe water	49 (85)	49 (85)	49 (84)	61 (104)	41 (35)	50 (37)		
Handwashing with soap	28 (48)	26 (44)	37 (65)	46 (79)	38 (32)	36 (27)		
Eating good food	26 (46)	19 (32)	32 (56)	2 (3)	19 (16)	23 (17)		
Handwashing after toileting (soap not mentioned)	13 (22)	14 (23)	14 (25)	31 (53)	12 (10)	34 (25)		
Handwashing before eating (soap not mentioned)	9 (16)	12 (21)	13 (22)	25 (43)	11 (9)	43 (32)		
Covering food	6 (10)	9 (15)	9 (15)	4 (6)	7 (6)	5 (4)		

^{*}Multiple responses per participant.

prevent cholera compared with 37% (65/174) of control participants. At the 6- to 12-month follow-up, knowledge of cholera prevention was significantly higher in the intervention (median score = 2) compared with the control arm (median score = 1) (P=0.02). Twenty-six percent (19/74) of respondents were able to report three correct methods to prevent cholera in the intervention arm compared with 4% (3/85) in the control arm (P<0.0001). Fifty percent (37/74) of intervention household participants mentioned safe water compared with 41% (35/85) of control participants.

There was no significant difference in knowledge of the key times for handwashing with soap between the intervention and control arm at baseline (Can you please name the four key times for handwashing with soap?) (median score = 2) (P = 0.14)(Table 3). Furthermore, only 3% (10/344) of respondents were able to report four key times for handwashing with soap; this did not differ significantly between the intervention and control arm (P = 0.059). Eighty-eight percent (302/344)of participants reported handwashing with soap after toileting as a key time, followed by before eating at 70% (240/344). At the 1-week follow-up, 55% (94/170) of intervention study participants were able to report four key times for handwashing with soap compared with 5% (8/174) of participants in the control arm (P < 0.001). Furthermore, knowledge of the key times to wash hands with soap was significantly higher in the intervention (median score = 4) compared with the control arm (median score = 2) (P < 0.0001). Seventy-nine percent (134/170) of intervention participants stated handwashing with soap before food preparation as a key time compared with only 25% (43/174) of control participants. In addition, 24% (40/170) of intervention household participants reported handwashing with soap after cleaning a child's anus as a key time compared with only 2% (4/174) of control household participants. At the 6- to 12-month follow-up, 28% (21/74) of intervention arm participants reported four key times for handwashing with soap compared with 7% (6/85) of control arm participants (P = 0.001). Knowledge of the key times for handwashing with soap was also significantly higher in the intervention (median score = 3) compared with the control arm (median score = 1) (P < 0.0001). Handwashing with soap before food preparation was mentioned as a key time for 70% (52/74) of intervention participants compared with 18% (15/85) among control arm participants. Twenty-six percent (19/74) of intervention household participants reported handwashing with soap after cleaning a child's anus as a key time compared with 2% (2/85) of control participants.

The median overall cholera knowledge score at baseline was 4 (SD = 1.77); this did not differ significantly between the intervention and the control arm (baseline score coefficient = 0.0068 [95% CI = -0.37, 0.38]) (Figure 1). At the 1-week follow-up, the overall cholera knowledge score was significantly higher in the intervention arm (median knowledge score = 7; SD = 1.74) compared with the control arm (median knowledge score = 4; SD = 1.79; score coefficient = 2.34 [95% CI = 1.96, 2.71]). Overall cholera knowledge score was also significantly higher in the intervention compared

 $T_{ABLE\ 3}$ Reported key times for handwashing with soap: Can you please name the four key times for handwashing with soap?

Key times for handwashing with soap								
Major themes*	Baseline $(N = 344)$		1-week follow-up ($N = 344$)		6-12 month follow-up ($N = 159$)			
	Control % (n)	Intervention % (n)	Control % (n)	Intervention % (n)	Control % (n)	Intervention % (n)		
After toileting event	86 (150)	89 (152)	94 (163)	95 (166)	91 (77)	91 (67)		
Before eating event	67 (116)	73 (124)	72 (126)	93 (158)	69 (59)	94 (70)		
Before food preparation	21 (37)	25 (42)	25 (43)	79 (134)	18 (15)	70 (52)		
After eating	17 (30)	19 (33)	13 (22)	11 (18)	15	10		
If hands get dirty	12 (21)	12 (21)	12 (20)	2 (3)	22 (19)	4 (3)		
After cooking or after food preparation	9 (15)	7 (12)	10 (17)	5 (8)	24 (20)	15 (11)		
After removing child's feces	7 (13)	7 (12)	7 (12)	43 (74)	2 (2)	7 (5)		
After waking up in the morning	6 (10)	2 (3)	8 (14)	0	9 (8)	1 (1)		
After coming into the home from the outside	5 (8)	5 (9)	3 (6)	2 (4)	9 (8)	11 (8)		
Before going to sleep	5 (8)	2 (3)	3 (5)	1 (1)	4 (3)	0		
Before feeding event	2 (3)	1 (2)	2 (3)	2 (3)	5 (4)	4 (3)		
After cleaning a child anus	1 (1)	0	2 (4)	24 (40)	2 (2)	26 (19)		

^{*}Multiple responses per participant.

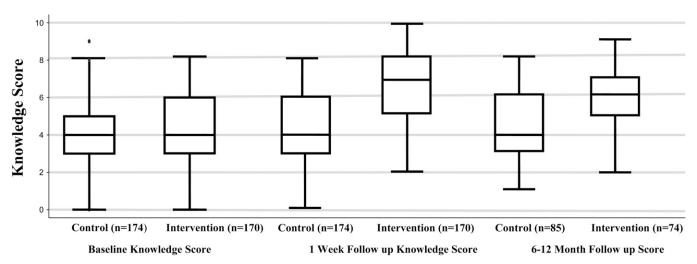


FIGURE 1. Overall knowledge score at baseline and 1 week (170 intervention and 174 control participants) and the 6- to 12-month follow-up (74 intervention and 85 control participants).

with the control arm at the 6- to 12-month follow-up (score coefficient = 1.59 (95% CI = 1.05, 2.13) with a median score of 6 (SD = 1.76) and 4 (SD = 1.67), respectively.

DISCUSSION

The CHoBI7 intervention led to a significant increase in cholera knowledge 1 week and 6–12 months post-intervention. This result complements our previous findings for the CHoBI7 trial which found that this intervention significantly reduces symptomatic cholera and reduces overall *V. cholerae* infections by 47%. Furthermore we found the odds of handwashing with soap at key events during the structured observation period 6–12 months post intervention were four times higher in the intervention arm compared to the control arm. ¹² These findings suggest that the CHoBI7 intervention presents a promising approach to deliver WASH messages on cholera awareness to highly susceptible households of cholera patients.

Despite household contacts of cholera patients being at a very high risk of contracting a cholera infection, we found their baseline knowledge of cholera to be low. This is consistent with previous community- and hospital-based studies in Dhaka, Bangladesh, which found low cholera awareness. ^{10,17} Similar studies from the Democratic Republic of Congo and Tanzania also found low cholera awareness despite the presence of a cholera outbreak. ^{18,19}

Our study identified several misconceptions around cholera transmission and prevention, and the key times to wash hands with soap. At baseline, some study participants reported that cholera was spread by bad air, traveling by bus, and that cholera could be prevented from behaviors such as reduced oily food intake. For the key times for handwashing, at baseline, participants reported after eating or after cooking or after preparing food. These findings demonstrate a lack of understanding of the etiology and prevention of cholera in this highly susceptible population. In addition, even after delivery of the intervention many participants were still not able to identify food as a potential source that could spread cholera. These findings suggest that further emphasis needs to be placed on how poor hygiene practices can cause food to be contaminated with feces that contains cholera. Furthermore,

although the majority (64%) of respondents reported that lack of handwashing could cause cholera at the 6- to 12-month follow-up, in intervention households, less than half mentioned soap. This suggests that further reinforcement on handwashing with soap message may be needed during the 1-week intervention period.

We attribute the significant increase in cholera knowledge in the CHoBI7 intervention arm to the timing of intervention delivery. The CHoBI7 was delivered at the time of a severe illness in these households, when perceived severity of diarrheal disease was probably high. Previous studies in Africa and Asia have observed higher perceived severity of diarrheal disease and benefits of water treatment during cholera outbreaks. 20–22 In addition, the handwashing station, chlorine tablets, sealed water vessel, and cue to action cards probably led to an environment that facilitated habit formation of the promoted handwashing with soap and water treatment behaviors and increased awareness on cholera transmission and prevention through serving as a reminder to perform the promoted behaviors.²³ The inclusion of these intervention components was informed by Tobias and others, who found that development of habits depends on the availability of reminders to increase remembering.²⁴ Furthermore, increased cholera awareness, although likely not the only motivator for the observed handwashing with soap practices may have facilitated previously identified behavioral determinants of this behavior such as self-efficacy and response efficacy.^{25–27}

The CHoBI7 intervention was highly effective in increasing awareness on the importance of handwashing with soap before food preparation, and water and feces as transmission routes for cholera. A previous study in Bangladesh found handwashing with soap before food preparation to be an important missed opportunity for hygiene promotion.²⁸ We observed in our recent RCT of the CHoBI7 intervention that observed handwashing with soap before food preparation was more than six times higher in the intervention compared with the control arm during the 1-week intervention period (47% versus 7%).¹² Furthermore, in our recent analysis of psychosocial factors associated with handwashing with soap in the RCT of CHoBI7, we found disgust messages focusing

on feces as a transmission route for cholera to significantly mediate the effect of the CHoBI7 intervention at the 6- to 12-month follow-up.²⁹ Therefore, CHoBI7 presents an effective approach to increase awareness on key times for handwashing with soap, transmission routes for cholera, and observed handwashing with soap behavior.

This study has a few limitations. First, the study could not be blinded because of the presence of the intervention hardware. Therefore, the interviewers knew the study arm of the households they visited. However, to minimize potential bias, the evaluation and intervention team were separate. Second, our RCT was an efficacy trial and involved daily visits to reinforce study messages. Future studies should conduct an effectiveness trial to see whether a less intensive intervention could result in similar increases in cholera knowledge among study participants. Finally, we focused on households of cholera cases and therefore cannot conclude on the impact on increasing cholera knowledge in other populations.

CONCLUSION

In our study, CHoBI7 significantly increased knowledge of cholera transmission and prevention among cholera patients and their household contacts 1 week and 6 to 12 months post intervention. These findings suggest that this 1-week intervention presents a promising approach to not only significantly reduce symptomatic cholera infection, but also increase cholera knowledge in this high-risk population over time. Future studies should investigate the efficacy of the CHoBI7 intervention in other areas affected by cholera globally.

Received May 12, 2016. Accepted for publication September 6, 2016. Published online October 10, 2016.

Acknowledgments: We thank the study participants and the following research assistants that conducted the fieldwork for this study: Ismat Minhaz Uddin, Md. Rafiqul Islam, Al-Mamun, Maynul Hasan, Kalpona Akhter, Khandokar Fazilatunnessa, Sadia Afrin Ananya, Akhi Sultana, Sohag Sarker, Jahed Masud, Abul Sikder, Shirin Akter, and Laki Das. The icddr,b is thankful to the governments of Australia, Bangladesh, Canada, Sweden, and United Kingdom for providing core/unrestricted support.

Financial support: This research was supported by the Center for Global Health at Johns Hopkins University, and the National Institute of Health NIAID-1K01AI110526/R01AI039129.

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REFERENCES

- 1. Zuckerman JN, Rombo L, Fisch A, 2007. The true burden and risk of cholera: implications for prevention and control. *Lancet Infect Dis* 7: 521–530.
- Ali M, Nelson AR, Lopez AL, Sack DA, 2015. Updated global burden of cholera in endemic countries. PLoS Negl Trop Dis 9: e0003832.
- Harris JB, LaRocque RC, Chowdhury F, Khan AI, Logvinenko T, Faruque AS, Ryan ET, Qadri F, Calderwood SB, 2008. Susceptibility to Vibrio cholerae infection in a cohort of household contacts of patients with cholera in Bangladesh. PLoS Negl Trop Dis 2: e221.
- Hughes JM, Boyce JM, Levine RJ, Khan M, Aziz K, Huq M, Curlin GT, 1982. Epidemiology of eltor cholera in rural Bangladesh: importance of surface water in transmission. *Bull World Health Organ* 60: 395.
- Spira W, Khan MÜ, Saeed Y, Sattar M, 1980. Microbiological surveillance of intra-neighbourhood El Tor cholera transmission in rural Bangaldesh. Bull World Health Organ 58: 731.
- Weil AA, Khan AI, Chowdhury F, LaRocque RC, Faruque A, Ryan ET, Calderwood SB, Qadri F, Harris JB, 2009. Clinical outcomes in household contacts of patients with cholera in Bangladesh. Clin Infect Dis 49: 1473–1479.
- 7. Mosley WH, Ahmad S, Benenson AS, Ahmed A, 1968. The relationship of vibriocidal antibody titre to susceptibility to cholera in family contacts of cholera patients. *Bull World Health Organ* 38: 777–785.
- 8. Glass RI, Svennerholm AM, Khan MR, Huda S, Huq MI, Holmgren J, 1985. Seroepidemiological studies of El Tor cholera in Bangladesh: association of serum antibody levels with protection. *J Infect Dis* 151: 236–242.
- 9. Deb BC, Sircar BK, Sengupta PG, De SP, Mondal SK, Gupta DN, Saha NC, Ghosh S, Mitra U, Pal SC, 1986. Studies on interventions to prevent El Tor cholera transmission in urban slums. *Bull World Health Organ 64*: 127–131.
- 10. Wahed T, Kaukab SS, Saha NC, Khan IA, Khanam F, Chowdhury F, Saha A, Khan AI, Siddik AU, Cravioto A, Qadri F, Uddin J, 2013. Knowledge of, attitudes toward, and preventive practices relating to cholera and oral cholera vaccine among urban high-risk groups: findings of a cross-sectional study in Dhaka, Bangladesh. BMC Public Health 13: 242.
- 11. Mpazi VM, Mnyika KS, 2008. Knowledge, attitudes and practices regarding cholera outbreaks in Ilala municipality of Dar es Salaam region, Tanzania. *East Afr J Public Health* 2: 6–11.
- 12. George CM, Monira S, Sack DA, Rashid MU, Saif-Ur-Rahman KM, Mahmud T, Rahman Z, Mustafiz M, Bhuyian SI, Winch PJ, Leontsini E, Perin J, Begum F, Zohura F, Biswas S, Parvin T, Zhang X, Jung D, Sack RB, Alam M, 2016. Randomized controlled trial of hospital-based hygiene and water treatment intervention (CHoBI7) to reduce cholera. *Emerg Infect Dis* 22: 233–241.
- 13. George CM, Jung DS, Saif-Ur-Rahman KM, Monira S, Sack DA, Rashid MU, Mahmud T, Mustafiz M, Rahman Z, Bhuyian SI, Winch PJ, Leontsini E, Perin J, Begum F, Zohura F, Biswas S, Parvin T, Sack RB, Alam M, 2016. Sustained uptake of a hospital-based handwashing with soap and water treatment intervention (cholera-hospital-based intervention for 7 Days [CHoBI7]): a randomized controlled trial. Am J Trop Med Hyg 94: 428–436.
- 14. George CM, Rashid MU, Sack DA, Sack RB, Saif-Ur-Rahman KM, Azman AS, Monira S, Bhuyian SI, Zillur Rahman K, Toslim Mahmud M, Mustafiz M, Alam M, 2013. Evaluation of enrichment method for the detection of *Vibrio cholerae* O1 using a rapid dipstick test in Bangladesh. *Trop Med Int Health* 19: 301–307.
- 15. World Health Organization, 2005. The Treatment Of Diarrhoea: A Manual for Physicians and Other Senior Health Workers. Geneva, Switzerland: World Health Organization.
- 16. University of Michigan. *Optimal Design Software: Building Capacity to Evaluate Group-Level Interventions*. Available at: http://people.cehd.tamu.edu/~okwok/epsy652R/OD/od-manual-20080312-v176.pdf.

- Tamason CC, Tulsiani SM, Siddique AK, Hoque BA, Mackie Jensen PK, 2016. What is cholera? A preliminary study on caretakers' knowledge in Bangladesh. J Health Popul Nutr 35: 3.
- Merten S, Schaetti C, Manianga C, Lapika B, Chaignat CL, Hutubessy R, Weiss MG, 2013. Local perceptions of cholera and anticipated vaccine acceptance in Katanga province, Democratic Republic of Congo. BMC Public Health 13: 60.
- Schaetti C, Khatib AM, Ali SM, Hutubessy R, Chaignat CL, Weiss MG, 2010. Social and cultural features of cholera and shigellosis in peri-urban and rural communities of Zanzibar. BMC Infect Dis 10: 339.
- Figueroa ME, Kincaid DL, 2007. Social, cultural and behavioral correlates of household water treatment and storage. Sobsey N, Clasen T, eds. *Household Water Treatment and Safe Storage*. Geneva, Switzerland: World Health Organization.
- Dunston C, McAfee D, Kaiser R, Rakotoarison D, Rambeloson L, Hoang AT, Quick RE, 2001. Collaboration, cholera, and cyclones: a project to improve point-of-use water quality in Madagascar. Am J Public Health 91: 1574–1576.
- Quick RE, Kimura A, Thevos A, Tembo M, Shamputa I, Hutwagner L, Mintz E, 2002. Diarrhea prevention through household-level water disinfection and safe storage in Zambia. Am J Trop Med Hyg 66: 584–589.
- 23. Dreibelbis R, Winch PJ, Leontsini E, Hulland KR, Ram PK, Unicomb L, Luby SP, 2013. The integrated behavioural model for water, sanitation, and hygiene: a systematic review of behavioural models and a framework for designing and evalu-

- ating behaviour change interventions in infrastructure-restricted settings. *BMC Public Health* 13: 1015.
- 24. Tobias R, 2009. Changing behavior by memory aids: a social psychological model of prospective memory and habit development tested with dynamic field data. *Psychol Rev 116:* 408–438.
- Contzen N, Inauen J, 2015. Social-cognitive factors mediating intervention effects on handwashing: a longitudinal study. *J Behav Med 38*: 956–969.
- Contzen N, Mosler HJ, 2015. Identifying the psychological determinants of handwashing: results from two cross-sectional questionnaire studies in Haiti and Ethiopia. Am J Infect Control 43: 826–832.
- Contzen N, Meili IH, Mosler HJ, 1982. Changing handwashing behaviour in southern Ethiopia: a longitudinal study on infrastructural and commitment interventions. Soc Sci Med 2015: 103–114.
- Nizame FA, Unicomb L, Sanghvi T, Roy S, Nuruzzaman M, Ghosh PK, Winch PJ, Luby SP, 2013. Handwashing before food preparation and child feeding: a missed opportunity for hygiene promotion. Am J Trop Med Hyg 89: 1179–1185.
- 29. George CM, Jung D, Thomas A, Rashid M, Sack DA, Sack RB, Saif-Ur-Rahman KM, Monira S, Bhuyian SI, Rahman KM, Mahmud MT, Mustafiz M, Parvin T, Winch P, Leontsini E, Perin J, Begum F, Zohura F, Biswas S, Thomas E, Zhang X, Alam M, 2016. Psychosocial factors mediating the CHoBI7 intervention's effect on handwashing with soap: a randomized controlled trial. Health Education & Behavior.