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Epidemiology of eltor cholera in rural Bangladesh: importance of surface water in transmission

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In order to define the role of water used for drinking, cooking, bathing, and washing in the transmission of Vibrio cholerae *biotype* eltor *infections in an area with endemic cholera, surveillance was initiated in neighbourhoods with a culture-confirmed cholera index case and others with index cases with non-cholera diarrhoea as controls. In neighbourhoods with cholera infection, 44% of surface water sources were positive for* V. cholerae, *whereas only 2% of surface sources were positive in control neighbourhoods. Canals, rivers, and tanks were most frequently positive. There was an increased risk of infection for families using water from culture-positive sources for drinking, cooking, bathing, or washing and for those using water sources used by index families for drinking, cooking or bathing. Analysis of the results for individuals showed that in this case there was an increased risk of infection associated with using water from culture-positive sources for cooking, bathing, or washing, but not with using water from culture-positive sources for drinking. Individuals who used the same water source as an index family for bathing were more likely to be infected than those using different sources. For families drinking from a culture-negative source, there was an association between infection and bathing in a positive source. For families using a different bathing source from the index family there was an association between infection and drinking from the same source as the index family, and for families using a different drinking source from the index family there was an association between infection and bathing in the same source as the index family. These data suggest that use of surface water is important in the transmission of* V. cholerae *and that, in addition to providing safe drinking water, education regarding the risk of transmission of infection by water from potentially contaminated sources used for other purposes, especially bathing, may also be necessary to control transmission in areas where eltor cholera is endemic.*

Transmission of *Vibrio cholerae* by contaminated drinking water was first documented 130 years ago (*1*). However, the importance of drinking water in transmission of cholera in an area with endemic cholera in rural Bangladesh is still debated (*2, 3*) because the anticipated reduction in cholera case rates has not been observed for persons with easy access to tube-well water of presumed good microbiological quality (*4*) or for those who usually drink tube-well water (*5–7*). A number of hypotheses have been proposed to explain the failure of the use of tube-well water to protect individuals from cholera infection (*8*), but none have satisfactorily explained the relationship of water use to cholera transmission.

To evaluate the relation between water used for drinking and for other purposes and the transmission of cholera in Matlab Bazar Thana, a rural area in Bangladesh (*9*), longitudinal studies were conducted in neighbourhoods with a resident who had symptomatic, culture-confirmed *V. cholerae* infection and in control neighbourhoods with a resident with non-cholera diarrhoea. The methods used varied with community size. Studies in small neighbourhoods were designed to assess the role of water in cholera transmission and to define the clinical spectrum of cholera. Studies in large neighbourhoods were designed to assess transmission of *V. cholerae* in families of persons with cholera. The results reported in this paper confirm the observation that surface

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water in proximity to persons with *V. cholerae* infection is frequently contaminated with *V. cholerae* (*10, 11*) and suggest that the water used for drinking and other purposes, especially bathing, is important in cholera transmission in this environment.

MATERIALS AND METHODS

Index patients were selected from persons who had diarrhoea, lived in villages in the Matlab vaccine trial surveillance (VTS) area, and were seen as either inpatients or outpatients at the Cholera Hospital. Each candidate for the study had a positive rectal swab culture for *V. cholerae* the day the neighbourhood study was begun; if more than one patient had a positive culture, we used a table of random numbers to select the index case. Patients' residences were visited the morning after presentation at the hospital, frequently before the patient had returned home. Using a table of random numbers, we selected control patients from all inpatients and outpatients with diarrhoea who lived in the VTS area and had a negative rectal swab culture for *V. cholerae* the day each study was begun.

Study areas included all families living in a *bari* (a cluster of houses located on the same elevated courtyard or compound and inhabited by patrilineally related families) in which the index patient lived. A neighbourhood was defined as all households on the same elevated piece of land and was arbitrarily classified as "small" if it contained 17 or fewer families and "large" if it contained 18 or more families. Studies were conducted in 14 cholera and 14 control neighbourhoods between December 1973 and February 1974 during the cool dry post-monsoon period. Ten cholera and 9 control neighbourhoods were defined as small.

A family was defined as all individuals sharing the same dwelling or dwellings and eating food prepared in one kitchen. After obtaining the free and informed consent of all families in each neighbourhood, a questionnaire was completed on the first day of the study by interviewing an adult family member, usually a female. Information was obtained on the age and sex of all family members and guests and the source(s) of water currently used by all persons in the family for drinking, cooking, bathing, and washing clothes and utensils.

Tanks were defined as rectangular ponds formed when monsoon rains fill depressions resulting from removal of earth to build mounds on which houses were built. Tanks retain water all the year round. Ditches were defined as smaller depressions that contain water during part of the year.

Information about stool patterns of each individual during the previous week was obtained on the first day; on subsequent days, information was obtained about stool patterns during the previous 24 hours, either by interviewing the individuals concerned or an adult family member. Diarrhoea was defined as a history of stools that were looser or more watery or occurred more frequently than normal for that individual. Cholera infection was diagnosed on the basis of a positive culture for *V. cholerae*. A clinical case of cholera was defined as the presence of diarrhoea within one day of the person's having a positive culture for *V. cholerae*.

In small neighbourhoods, rectal swabs were obtained each day of the study from all available residents; when a positive culture was obtained, no more swabs were taken from that person. If an individual had a second epidsode of diarrhoea (defined as being separated by at least two days with a normal stool pattern), daily culturing was resumed. In large neighbourhoods rectal swabs were taken on three consecutive days from all individuals with diarrhoea. Rectal swabs were also obtained each day from all family contacts of culture-positive individuals throughout the remainder of the study. Studies were discontinued when no new culture-positive individuals were identified for nine consecutive days.

Data for individuals were included in the questionnaire survey if they were questioned on at least five days or had a history of diarrhoea. They were included in the culture survey if they had a positive culture or three negative cultures for *V. cholerae*.

Rectal swabs were cultured for *V. cholerae*, and isolates were biotyped as described by Sommer & Woodward (*4*). Approximately 60 ml of water was collected from each tube well, ditch, tank, canal, and river used by residents of both small and large neighbourhoods for drinking, cooking, bathing, or washing. Individual samples were obtained on several days beginning on the first day of each study near the periphery of each source at a site where villagers obtained water. Each water sample was placed in approximately 30 ml of triple-strength bile peptone water; tellurite was added to a dilution of 1:200 000, and the sample was incubated at 37 °C for 6 hours and then subcultured onto tellurite-taurocholate-gelatin (TTGA) agar. Colonies thought to be *V. cholerae* were identified (*4*). Cultures were recorded as either positive or negative; no quantitative results were obtained. Sources were considered adequately cultured if a positive culture or at least three negative cultures were obtained.

Statistical analyses were performed using the two-tailed Fisher's exact test, the chi-square test with Yates' correction, the *t*-test on proportions with variance adjusted for cluster effect, and the Mantel-Haenszel test.

RESULT

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All infections were caused *eltor*. Cholera infection rates groups. Case rates were hig years of age and were signif rate in adults (Table 1). Sex-s matic or asymptomatic infe Ninety-four percent of infec were identified by day 12 of day five, only 59% of infectio been identified.

Rates of infection identifie neighbourhoods were signifi families (23%) than other fa bourhood ($P < 0.001$); rates *bari* (11%), when data for excluded, than in other *bari* (4%) ($P < 0.01$). Similar s control neighbourhoods did *V. cholerae* infection.

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Table 1. Infection and case ra neighbourhoods

Age group (years)	No. cultured
< 1	30
1 – 4	76
5 – 9	79
10 – 14	76
⩾ 15	182
Total	443[b]

[a] $P = 0.037$

[b] Index cases excluded.

RESULTS

In the small cholera neighbourhoods, 504 of 617 individuals (82%) participated in the questionnaire survey and 476 of 617 (77%) participated in the culture survey. When the 10 index cases are eliminated, only one of 56 infections (2%) identified in small neighbourhoods involved diarrhoea severe enough to require medical attention whereas 32 (57%) involved mild diarrhoea, and 23 (41%) were asymptomatic.

All infections were caused by *V. cholerae* biotype *eltor*. Cholera infection rates were similar for all age groups. Case rates were highest in individuals 5 – 9 years of age and were significantly higher than the rate in adults (Table 1). Sex-specific rates for symptomatic or asymptomatic infection were comparable. Ninety-four percent of infections and 98% of cases were identified by day 12 of the studies (Fig. 1). By day five, only 59% of infections and 59% of cases had been identified.

Rates of infection identified in both small and large neighbourhoods were significantly higher for index families (23%) than other families (8%) in the neighbourhood ($P < 0.001$); rates were higher in the index *bari* (11%), when data for the index family were excluded, than in other *baris* in the neighbourhood (4%) ($P < 0.01$). Similar studies conducted in 14 control neighbourhoods did not document a single *V. cholerae* infection.

Eleven of 14 (79%) neighbourhoods with an index *V. cholerae* infection had at least one water source contaminated with *V. cholerae*, as did only one of 14 (7%) control neighbourhoods ($P < 0.001$). In cholera-infected neighbourhoods, 44% of all cultured surface water sources were positive for *V. cholerae*, as were only 2% of surface sources in control neighbourhoods (Table 2). Rivers were most frequently positive, and then canals, tanks, and ditches in that order. Positive cultures for *V. cholerae* were obtained from one tube well on days 2, 3, and 4 of one study. Cultures of water obtained from this well on day 1 and on days 5 – 10 were negative. Cultures of water obtained from two tube wells in two other cholera neighbourhoods were negative.

Table 1. Infection and case rates, by age group, in small neighbourhoods

Age group (years)	No. cultured	No. infected (%)	No. ill (%)
< 1	30	4 (13.3)	2 (6.7)
1 – 4	76	11 (14.5)	6 (7.9)
5 – 9	79	12 (15.2)	10 (12.7)[a]
10 – 14	76	10 (13.2)	6 (7.9)
≥ 15	182	19 (10.4)	9 (4.9)[a]
Total	443[b]	56 (12.6)	33 (7.4)

[a] $P = 0.037$
[b] Index cases excluded.

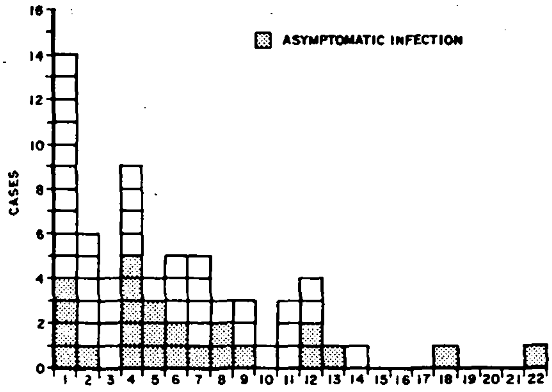

Fig. 1. *Vibrio cholerae* cases and asymptomatic infections, by day of detection, large and small neighbourhoods, Bangladesh.

Similar types of water source were available in cholera and control neighbourhoods. When the percentages of families in cholera and control neighbourhoods that used water from each of the five types of source were compared (Table 3), more families in neighbourhoods with a cholera index case used canal and river water for drinking, cooking, bathing, and washing, or water from ditches for washing. Conversely, significantly fewer families in neighbourhoods with a cholera index case than families in control neighbourhoods used water from tanks for cooking, bathing, and washing, and water from tube wells for drinking.

When the choices of water source for drinking, cooking, bathing, and washing in small neighbourhoods with a cholera index case were evaluated, only one significant association was found. Families with an infected individual were more likely to drink from tube wells than were families without infection ($P < 0.01$); however, only eight infected families used tube-well water for drinking. Six of these eight infected families lived in the same neighbourhood, which had a contaminated tube well, and the families drank water from that well.

In small neighbourhoods with a cholera index case, families using at least one culture-positive water source for drinking, cooking, bathing, or washing were significantly more likely to have a person

Table 2. Results of water cultures for *V. cholerae* in small and large neighbourhoods, with and without cholera infection

Water source	Cholera neighbourhoods (n = 14)					Control neighbourhoods (n = 14)				
	No. with source	Total no. of sources	No. cultured	No. positive	% positive	No. with source	Total no. of sources	No. cultured	No. positive	% positive
Surface water										
River	5	5	4	3	75	7	7	4	0	0
Canal	8	8	8	5	63	7	7	5	0	0
Tank	9	23	22	10	44[a]	11	44	41	1	2[a]
Ditch	7	21	14	3	21	6	9	6	0	0
Subtotal	–	57	48	21	44	–	67	56	1	2
Tubewell	4	4	3	1	33	6	8	7	0	0

[a] $P < 0.001$.

Table 3. Percentage of families using water sources, by type and purpose, in small and large neighbourhoods, with and without cholera infection

	Tubewell	Ditch	Tank	Canal	River
Drinking					
Cholera	12[a]	5	16	26[a]	53[a]
Control	34	8	21	12	36
Cooking					
Cholera	0	21	41	51[a]	28[a]
Control	0	14	77[a]	11	10
Bathing					
Cholera	0	7	34	28[a]	51[a]
Control	0	13	61[a]	13	33
Washing					
Cholera	0	31	43	32[a]	23[a]
Control	0	15[a]	83[a]	11	6

[a] Significantly different from control, $P < 0.001$.

infected with *V. cholerae* than those using only culture-negative sources (Table 4). Infection rates for families using culture-positive sources for drinking and other purposes (51%) and those for families using culture-negative sources for drinking but culture-positive sources for cooking, bathing, or washing (58%) were similar; however, infection rates for both groups were higher than for families using culture-negative sources for all purposes (14%, $P < 0.001$, and $P < 0.01$, respectively). Families using the same water source(s) as the index family for drinking, cooking, or bathing were significantly more likely to have a person infected with *V. cholerae* than those using different sources (Table 5).

Analysis of data for individuals in small neighbourhoods with a cholera index case revealed that persons who drank from at least one culture-positive source were not significantly more likely to be infected than those who drank only from negative sources. However, those who cooked with, bathed in, or washed with water from at least one positive source were significantly more likely to be infected than those who used only negative water sources for these purposes (Table 6). The proportion of individuals using water from culture-positive sources for drinking and other users who were infected was similar (0.167) to that for those using water from culture-negative sources for drinking, but culture-positive sources for cooking, bathing, and/or washing (0.194).

Individuals who used the same water sources as those in the index family for bathing were significantly more likely to be infected than those who used different sources (Table 7). Individuals who used the same sources as members of the index family for drinking, cooking, or washing were no more likely to be infected than those who used different sources.

In an attempt to define the relative importance of drinking and bathing in the transmission of *V. cholerae*, families were stratified according to positivity of the drinking and bathing source (Table 8) and according to whether they used the same sources as the index family for drinking or bathing (Table 9). For families bathing in positive sources (Table 8), there was no association between infection and use of

Table 4. Family infection rates, according to culture status of water sources, small neighbourhoods

Water use	Total no. of families	No. of families infected	Percentage infected	P value
Drank water from ⩾ 1 positive source	43	22	51.2	0.017
Drank water from negative sources	47	12	25.5	
Cooked with water from ⩾ 1 positive source	54	29	53.7	0.0001
Cooked with water from negative sources	36	5	13.9	
Bathed in ⩾ 1 positive source	55	29	52.7	0.0003
Bathed in negative sources	35	5	14.3	
Washed with water from ⩾ 1 positive source	55	29	52.7	0.0003
Washed with water from negative sources	35	5	14.3	

Table 5. Family infection rates, according to use of index-family water source, small neighbourhoods

Water use	Total no. of families	No. infected	Percentage infected	P value
Drank from same sources	55	22	40.0	0.004
Drank from different sources	25	2	4.0	
Cooked from same sources	41	17	41.5	0.03
Cooked from different sources	39	7	17.9	
Bathed in same sources	50	19	38.0	0.05
Bathed in different sources	30	5	16.7	
Washed in same sources	41	15	36.6	0.09
Washed in different sources	39	9	23.1	

Table 6. Proportion of individuals infected, according to culture status of water source, small neighbourhoods

Water use	Total no. of individuals	No. infected	Proportion infected (SE)
Drank water from ⩾ 1 positive source	265	44	0.166 (0.027)
Drank water from negative sources	211	22	0.104 (0.032)
Cooked with water from ⩾ 1 positive source	328	57	0.174 (0.026)[a]
Cooked with water from negative sources	148	9	0.061 (0.029)
Bathed in ⩾ 1 positive source	332	57	0.172 (0.026)[a]
Bathed in negative sources	144	9	0.063 (0.030)
Washed with water from ⩾ 1 positive source	332	57	0.172 (0.026)
Washed with water from negative sources	144	9	0.063 (0.030)[a]

[a] Significantly different from those using negative sources, $P < 0.01$.

Table 7. Proportion of individuals infected, according to use of water source used by index family, small neighbourhoods

Water use	Total no. of individuals	No. infected	Proportion infected (SE)
Drank water from same sources	295	37	0.125 (0.022)
Drank water from different sources	127	7	0.055 (0.034)
Cooked with water from same sources	223	28	0.126 (0.024)
Cooked with water from different sources	199	16	0.080 (0.028)
Bathed in same sources	255	34	0.133 (0.026)[a]
Bathed in different sources	167	10	0.060 (0.024)
Washed with water from same sources	207	25	0.121 (0.025)
Washed with water from different sources	215	19	0.088 (0.027)

[a] Significantly different from those using different sources, $P < 0.05$.

Table 8. Family infection rates, according to culture positivity of drinking and bathing water sources, small neighbourhoods

Drinking source	Bathing source	Total no. families	No. infected	Percentage infected
+	+	43	22	51.2[a]
+	–	0	0	–
–	+	12	7	58.3[a, b]
–	–	35	5	14.3[b]

a For families with culture-positive bathing source, not significant.

[b] For families with culture-negative drinking source, $P = 0.005$.

Table 9. Family infection rates, according to use of same or different water sources used by index family for drinking and bathing, small neighbourhoods

Drinking source	Bathing source	Total no. families	No. infected	Percentage infected
same	same	46	17	37.0[a, c]
same	different	9	5	55.6[b, c]
different	same	4	2	50.0[a, d]
different	different	21	0	0[b, d]

Mantel-Haenszel test: $P = 0.06$ drinking (controlling for bathing)
$P = 0.88$ bathing (controlling for drinking)

[a] For families with same bathing source as index family, not significant.

[b] For families with bathing source different from index family, $P = 0.001$.

[c] For families with same drinking source as index family, not significant.

[d] For families with drinking source different from index family, $P = 0.02$.

positive sources for drinking. In contrast, for families drinking from negative sources, there was an association between infection and use of positive sources for bathing. For families using the same source as the index family for bathing (Table 9), there was no association between infection and drinking from the same source used by the index family; however, for those bathing in different sources, there was an association between infection and using the same source used by the index family for drinking. For families drinking from the same source as the index family, there was no association between infection and bathing in the same source used by the index family; however, for those drinking from sources different from the index family, there was an association between infection and bathing in the same source used by the index family. For all families, Mantel-Haenszel analysis indicated that there was a borderline association between drinking and infection when controlling for bathing but not between bathing and infection when controlling for drinking.

DISCUSSION

Previously reported studies of the epidemiology of *V. cholerae* biotype *eltor* infections in Matlab Bazar have failed to demonstrate convincingly a significant role for contaminated drinking water in transmission (*4–7*). Explanations include the possibility that cholera is not primarily water-borne in this environment, that people report using tube-well water when they do not, that only some family members use tube-well water while others use alternative sources, or that the protection provided by use of tube-well water is negated by the use of contaminated surface water for cooking, bathing, or washing (*7, 8*). Results of this study, although qualified by the possibility that not all water sources used by each family member were specified and by the lack of information on water storage practices and possible contamination in the home, suggest that contaminated surface water used for drinking and for other purposes, especially bathing, is important in transmission of *V. cholerae* in this environment.

Rates of infection with *V. cholerae* in the neighbourhood studies were comparable for all age groups. From 1968–77, the age-specific cholera case rate for patients seen at the Matlab Hospital was highest for children 2–4 years old (4.5/1000) followed by that for children 5–9 years old (3.8/1000) (*12*). Results of our neighbourhood surveillance indicate that case rates were highest for children 5–9 years old and were significantly higher for this group than for persons aged 15 years or over but not significantly higher than for other age groups. These differences probably reflect the different case detection techniques in the two studies. In our study, no *V. cholerae* infections were detected in control neighbourhoods, an observation consistent with earlier reports that classical *V. cholerae* cases occurred in localized outbreaks in both Dacca (*13*) and Matlab (*9*).

The highest infection rate was in cholera index families, in which 23% of individuals were infected. This infection rate is comparable with infection rates of 11%, 13%, 21%, and 25% reported for families with classical *V. cholerae* infection (*9, 14–16*) and with infection rates of 21% and 31% reported for families with *V. cholerae* biotype *eltor* infection in Bangladesh (*16, 17*). However, in contrast to observations in the study of eltor infection in Dacca, which indicated that none of 136 neighbourhood residents was infected, index *bari* residents were significantly more likely (11%) than residents of other *baris* in the same neighbourhood (4%) to be infected. Only 59% of all infections were identified by day 5 of the study in each *bari*, in contrast with 86% of all infections during the first five days of a ten-day study of classical cholera infections in Dacca (*16*). These observations suggest that *V. cholerae* biotype *eltor* frequently infects other members of index households and *baris* in this environment and that the risk of acquiring infection exists for at least 1–2 weeks.

It is well documented that eltor strains survive longer than classical strains in both water and food (*18*). In one study, *V. cholerae* biotype *eltor* survived 19.3 ± 5.1 days in shallow well-water whereas classical strains survived 7.5 ± 1.9 days (*18*). The isolation of eltor strains from 44% of surface water sources in infected neighbourhoods is comparable with the 45% rate reported from an urban environment where classical *V. cholerae* cases were occurring (*13*) and with the 57% rate in Matlab in neighbourhoods with infections caused by eltor organisms (*11*). The observation that over 60% of canals and rivers used by cholera-infected neighbourhoods were positive is noteworthy because organisms entering these bodies of water would be diluted; however, this observation is consistent with earlier observations that use of water from these sources is associated with increased risk of classical (*10*) and *V. cholerae* biotype *eltor* infections (*5*). Although the availability of canals and rivers in neighbourhoods with and without cholera index cases was comparable, families in neighbourhoods with cholera were significantly more likely to use canal and river water for drinking as well as for cooking, bathing, and washing. Whether water usage patterns might reflect differences in socio-economic status which might in turn influence susceptibility to *V. cholerae* infection was not addressed.

Only one water source in a neighbourhood not infected with *V. cholerae* was positive; in a study conducted in Matlab in 1965–66, only 10 of 5670 surface water cultures were positive for classical *V. cholerae*, and all positive samples were from neighbourhoods with documented *V. cholerae* infection (*9*).

One of three tube wells tested by culture was positive for *V. cholerae* on three consecutive days. The use of water from this well by six families that had at least one person infected with *V. cholerae* accounts for the observed association of tube-well use with infection. This tube well was in good repair and was not primed by adding water. However, neighbourhood residents admitted to hanging their laundry on the pump to dry. Contaminated water may have leaked into the well around the vertical pump rod. The observation of Spira et al. that none of 12 wells they cultured was contaminated (*11*) suggests that tube-well water contamination with *V. cholerae* is uncommon.

The importance of water in the transmission of cholera is illustrated by the fact that, in small neighbourhoods where case-finding techniques were most intensive, families who used a culture-positive water source for drinking, cooking, bathing, or washing were signficantly more likely to have a cholera infection than families who used negative sources. These findings are compatible with observations by Levine et al. that high cholera case rates were associated with use of contaminated canal water (*19*) and by Spira et al. that the infection rate for families increased as the percentage of positive water cultures in the home increased (*11*). Spira's observations strongly suggested that water was contaminated almost exclusively at the source rather than in the home. We found that families who used the same water source(s) as the index family for either drinking, cooking or bathing were more likely to have an infected individual.

Several findings imply that drinking contaminated water may not be the only important factor in the transmission of eltor cholera, a hypothesis suggested previously by others (*4, 7, 10, 11*). Families who drank from culture-positive sources were no more likely to be infected that those who drank from culture-negative sources but used positive sources for cooking, bathing, or washing; both groups were more likely to be infected than families using only culture-negative sources. In addition, when data from individuals rather than families were considered, those who drank from culture-positive sources were no more likely to be infected than those who drank from culture-negative ones but used culture-positive sources for other purposes. Individuals who used the same water source as members of the index family for bathing were significantly more likely than those using different sources to be infected.

For families with culture-negative drinking sources, the association between infection and bathing in a positive source suggests that bathing in contaminated water is a risk factor for infection, independent of drinking, but could also be interpreted as indicating that infected persons defaecate where they bathe. However, the association between infection and drinking from the same source as the index family, in families bathing in different sources from the index family, and between infection and bathing in the same source as the index family, in families drinking from different sources than the index family, suggest that both drinking and bathing in contaminated water are risk factors for *V. cholerae* infection in this environment. The association of bathing and infection is compatible with a previous suggestion that ingestion of water while bathing may be important in the transmission of classical cholera (*10*) and raises a question concerning the relative concentrations of *V. cholerae* in contaminated water stored in the home and that at bathing sites. This hypothesis is compatible with the custom in West Bengal of taking handfuls of water into the mouth during bathing (*20*).

In summary, extensive environmental contamination occurred in neighbourhoods with residents who were infected with *V. cholerae*. Although not providing information regarding the mode of introduction of *V. cholerae* into a neighbourhood, the data support a role for contaminated water in transmission once the organism is introduced. These observations suggest that, in addition to providing safe drinking water, the education of persons about the risk of transmission of infection by water from potentially contaminated sources used for other purposes, especially bathing, may be necessary to control transmission in areas where *V. cholerae* biotype *eltor* is endemic.

RÉSUMÉ

ÉPIDÉMIOLOGIE DU CHOLÉRA ELTOR DANS LES ZONES RURALES DU BANGLADESH: LE RÔLE DE L'EAU DE SURFACE DANS SA TRANSMISSION

La transmission de *Vibrio cholerae* par de l'eau de boisson contaminée a été démontrée pour la première fois il y a 130 ans. Le rôle de l'eau de boisson dans la transmission du choléra dans une région endémique rurale du Bangladesh est toutefois encore controversé. Cette étude devait permettre de déterminer le rôle de l'eau utilisée pour la boisson, la cuisine, les ablutions et la lessive dans la transmission de *V. cholerae* biotype *eltor* dans la région rurale de Matlab Bazar Thana au Bangladesh. On a procédé à des études longitudinales dans des zones où des cas signaux de choléra avaient été détectés et confirmés par culture, et dans des zones témoins où les cas signaux de diarrhée n'étaient pas liés au choléra. Au cours de visites quotidiennes chez les habitants de ces deux zones, on a recueilli des antécédents sur les cas de diarrhée, des cultures d'écouvillonnages rectaux et des échantillons d'eau utilisée par les habitants pour des cultures de *V. cholerae*.

Dans les zones où avaient été enregistrés des cas signaux de choléra, 44% des sources d'eau de surface étaient contaminées par *V. cholerae*, alors que dans les zones témoins ce pourcentage n'était que de 2%. Les canaux, les cours d'eau et les réservoirs étaient très souvent contaminés. Bien que l'on trouve les mêmes types de sources d'eau dans les régions de choléra et dans les régions témoins, les familles des régions touchées avaient davantage tendance à utiliser l'eau des canaux et des cours d'eau pour la boisson, la cuisine, les ablutions et la lessive que les familles des zones témoins.

Les risques d'infection étaient plus importants chez les familles utilisant de l'eau contaminée pour la boisson, la cuisine, les ablutions et la lessive. Les taux d'infection étaient toutefois les mêmes pour les familles utilisant de l'eau contaminée pour la boisson et pour d'autres usages et pour les familles qui consommaient de l'eau non contaminée pour la boisson mais de l'eau contaminée pour la cuisine, les

ablutions et la lessive; dans ces deux derniers groupes, les taux d'infection étaient plus élevés que chez les familles n'utilisant que de l'eau non contaminée. Le risque plus élevé d'infection chez les familles était également lié à la consommation pour la boisson, la cuisine ou les ablutions d'eau provenant de sources également utilisées par les familles indicatrices.

Chez les individus, les risques plus élevés d'infection étaient liés à la consommation d'eau provenant de sources contaminées pour la cuisine, les ablutions ou la lessive, mais pas à la consommation d'eau de boisson contaminée. Les individus qui utilisaient pour les ablutions les mêmes sources d'eau qu'une famille indicatrice étaient plus exposés que ceux utilisant de l'eau provenant d'autres sources. On a pu établir chez les familles consommant de l'eau de boisson provenant d'une source non contaminée un lien entre l'infection et l'utilisation d'eau contaminée pour les ablutions. En ce qui concerne les familles n'utilisant pas pour leurs ablutions la même source que la famille indicatrice, on a pu établir un lien entre l'infection et la consommation de la même eau de boisson que la famille indicatrice; on a également trouvé pour les familles ne consommant pas la même eau de boisson que la famille indicatrice une corrélation entre l'infection et l'utilisation de la même source pour les ablutions.

Ces données donnent à penser que l'eau de surface joue un rôle important dans la transmission de *V. cholerae* et que, outre le fait de permettre de disposer d'une eau de boisson saine, l'éducation en ce qui concerne les risques de transmission de l'infection par de l'eau provenant de sources potentiellement contaminées et utilisées à d'autres fins, notamment pour les ablutions, peut également être nécessaire pour lutter contre la transmission dans les zones où le choléra *eltor* est endémique.

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