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SHORT REPORT

Cholera outbreak secondary to contaminated pipe water in an urban area, West Bengal, India, 2006

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Abstract

Outbreaks of cholera are common in West Bengal. In April 2006, Garulia municipality reported a cluster of diarrhea cases. We investigated this cluster to identify the etiological agent, source of transmission and propose control measures. We defined a case of diarrhea as occurrence of ≥3 loose/watery stools a day among the residents of Garulia since April 2006. We searched for cases of diarrhea in health care facilities and health camp. We conducted a gender- and age-matched case–control study to identify risk factors. We inspected the sanitation and water supply system. We collected rectal swabs from diarrhea patients and water specimens from the affected areas for laboratory investigation. Two hundred and ninety-eight cases of diarrhea were reported to various health care facilities (attack rate: 3.5/1000, no deaths). The attack rate was highest among children (6.4/1000). *Vibrio cholerae* El Tor O1 Inaba was isolated from two of 7 rectal swabs. The outbreak started on 10 April 2006, peaked on 26 April and lasted till 6 May. Cases clustered in an area distal to leaking water pipelines. Drinking municipal water exclusively was significantly associated with the illness (OR 13, 95% CI=6.5–27). Eight of the 12 water specimens from the affected area had fecal contamination and poor chlorine content. This outbreak was due to a contaminated municipal piped water supply and *V. cholera* 01 Inaba was possibly the causative organism.

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Introduction

Cholera continues to be transmitted in environments characterized by inadequate water supply and poor sanitation.[1] To control outbreaks, WHO recommends emergency interventions, including excreta disposal, sanitary measures and water quality monitoring.[2,3] However, cholera persists in India, including in West Bengal,[4,] Delhi,[5] Chandigarh,[6] Orissa[7] and Andaman.[8] Garulia is located by the Hooghly river, close to Kolkata. The municipality ranked third in the state of West Bengal as per the proportion of the population living in slums (62%) and had experienced cholera (Census data).[9] On 24 April 2006, the Garulia municipality reported a sudden increase in diarrhea cases. We investigated this cluster to identify the etiological agent, the source of transmission and to propose control measures.

Methods

We reviewed diarrhea surveillance data from 2002 to 2006. We defined a case of diarrhea as the occurrence of three or more loose stools a day in a resident of Garulia between April and May 2006. We searched for cases in all health facilities and collected information regarding date of onset, age, sex and place of residence. We described clinical symptoms among a random sample of case-patients. We calculated attack rates by age, sex and ward (the local geographic sub-division) using projected, standardized 2006 population estimates. We constructed an epidemic curve, drew a map and interviewed a group of case-patients and health workers to collect information on drinking water, drainage system and any recent common events.

The clustering of cases distal to a pipeline leakage led us to suspect this fault as the source of the outbreak. To test this hypothesis, we conducted a case–control study and compared each of the cases aged 5 or more with one control matched for neighborhood, age (± 2 years) and sex. We used a pre-tested, close-ended questionnaire to collect information regarding demographic characteristics, clinical features and potential risk factors. We calculated matched odds ratio

(MOR) and 95% confidence interval (CI). We estimated the population attributable fraction (PAF) for the exposures for which we suspected causality.

We inspected the water pipelines, other sources of water supply, the drainage system and the sewage lines, and collected piped water specimens from different wards and sent them for water quality testing.

We protected the confidentiality of participants through use of codes. However, ethical committee review did not apply as this was a public health response to an outbreak.

Results

We identified 298 cases (attack rate: 3.5/1000, no death) of diarrhea. Two of seven rectal swabs grew *Vibrio cholerae* O1 El Tor, Inaba, while the other five did not grow any pathogen. The initial case-patient, aged 45 years was admitted for severe dehydration on 10 April 2006. Subsequently, cases increased and peaked on 26 April (Fig. 1) and declined. The attack rate was highest among the 0–4 age group (6.4/1000) and both sexes were equally affected. A total of 163 (55%) patients were admitted to the hospital. Among 90 case-patients selected at random, 72 (80%) had vomiting, 27 (30%) abdominal cramps and 32 (36%) severe dehydration. A total of 215 cases (72%) clustered in a specific location. There was no common festival, ceremony or event to be suspected as common source.

We recruited all 247 cases (median age 31 years; 140 women) and 247 controls for the matched case–control study (Table 1). Compared with control subjects, case-patients were more likely to exclusively drink municipal piped water (MOR). This exposure accounted for the majority of cases (PAF: 86%). Compared with control-subjects, case-patients were more likely to engage in open air defecation (MOR 2.2) and to ignore that cholera was transmitted through dirty food and water (MOR 4.0) Case-patients were less likely to exclusively drink tube well water (MOR 0.09).

The municipality supplied piped water four times a day. Chlorination was irregular and unreliable. Most water pipelines were old and irregularly maintained and had leaks. They ran side-by-side in close proximity to sewerage drainage. The leaks would have allowed suction of the sewerage water during the moments of negative pressure. Tube wells were the only alternate source of water supply. The initial case-patient indicated that her soiled clothing was washed near the leaks. Of the 12 tap water specimens collected from the affected area, eight were positive for fecal contamination with estimates ranging from 23 to 130 coliform/100 mL. On 28 April, the municipal authorities chlorinated the piped water, and then repaired the leaks. This intervention was followed by a decrease of incidence and the outbreak came to an end on 6 May 2006.

Discussion

This outbreak was possibly caused by *V. cholerae* O1 Inaba, as in 2005 in different wards of the same municipality.[9] The municipality grew fast in the absence of proper planning, leading to insufficient water and sanitation infrastructure. Environmental unsanitary conditions, dense population and large slum population facilitate cholera outbreaks.[4,9] *V. cholerae* has a free-living cycle with a natural reservoir in the aquatic environment. It does not survive in dry and acidic conditions and survives better in saline water than in fresh water.[10] The affected areas were located near to the river Hooghly that is saline.

Epidemiological and environmental evidence indicated that this outbreak was waterborne. Waterborne cholera is common worldwide.[1,4] The Millennium Development Goals (MDG) propose to decrease by half the population without access to safe water and sanitation by 2015.[3] While the MDG consider piped water as an improved water source, transmission of waterborne pathogens may occur when the pipes not periodically maintained. The absence of functioning tube

Table 1 Distribution of case–control sets (n=247) according to exposure status of the case and control

Characteristics	Number of case–control pairs					
	Concordant for exposure status		Discordant for exposure status			
	All exposed	All unexposed	Case exposed	Case unexposed	MOR[1]	95% CI[2]
Monthly family income <US$ 30	12	175	37	23	1.6	0.96–2.7
No primary education	132	41	31	43	0.72	0.45–1.1
Household members <5	71	82	36	58	0.62	0.41–0.94
Homemaker	55	167	16	9	1.8	0.79–4.0
Exclusive municipal piped water intake	123	10	106	8	13	6.5–27
Exclusive tube well water intake	8	136	9	94	0.09	0.05–0.19
Open air defecation	67	109	49	22	2.2	1.3–3.7
Ignorance regarding cholera transmission	34	158	44	11	4.0	2.1–7.7

[1]Matched odds ratio; [2]Confidence interval

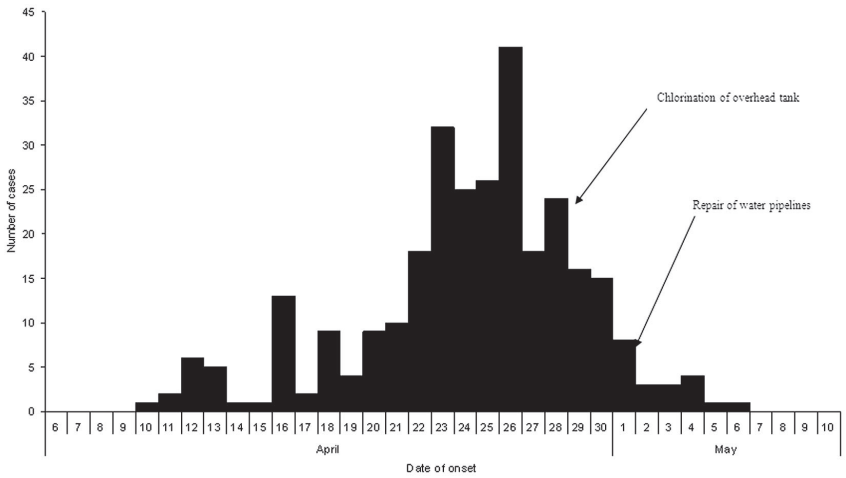

Fig. 1 Cases of diarrhea by date of onset, Garulia municipality, North 24 Parganas, West Bengal, India, April–May 2006

wells in the highly affected areas forced people to drink contaminated water. Cholera outbreaks have been reported in municipal areas supplied with piped water systems that suffer from breaks in quality system and maintenance, including lack of chlorination.[4] This study suffered from one main limitation. We considered the predominant drinking water use habit of the population and did not collect information about the possibility of multiple sources of water supply. While this may have decreased our ability to describe in better detail the association between the disease and various sources of water supply, it is unlikely to affect our conclusions.

This outbreak affected a high-risk slum supplied by an old piped water supply with no regular chlorination. The probable source of infection was contaminated, non-chlorinated piped water that had sucked the nearby sewage been contaminated by an index case-patient suffering from cholera. As a result of our investigation, authorities repaired the damaged water pipelines and chlorinated the water.

To prevent recurrences in the longer term, we recommended that water pipelines and open drainage system should not run side-by-side and that the old water pipelines should be replaced in a phased manner.[11] Since such changes are unlikely to happen rapidly, the municipality may remain at risk in the future. Till then, the population will have to rely on rapid detection and investigation of diarrhea outbreaks to prevent death and disease.

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