Short Report

An urban, water-borne outbreak of diarrhoea and shigellosis in a district town in eastern India

T. SAHA, M. MURHEKAR, Y. J. HUTIN, T. RAMAMURTHY

ABSTRACT

Background. In September 2007, the Gayeshpur municipality reported a cluster of cases with diarrhoea. We aimed to identify the causative agent and the source of the disease.

Methods. We defined a case as the occurrence of diarrhoea (>3 loose stools/day) with fever or bloody stools in a resident of Gayeshpur in September–October 2007. We asked healthcare facilities to report cases, collected stool specimens from patients, constructed an epidemic curve, drew a map and calculated the incidence by age and sex. We also conducted a matched case–control study (58 in each group), calculated matched odds ratio (MOR) and population attributable fraction (PAF), as well as assessed the environment.

Results. We identified 461 cases (attack rate: 46/1000 population) and isolated *Shigella flexneri* (serotype 2a and 3a) from 3 of 4 stool specimens. The attack rate was higher among females (52/1000) and those in the age group of 45–59 years (71/1000). The outbreak started on 22 September, peaked multiple times and subsided on 12 October 2007. Cases were clustered distal to a leaking pipeline that crossed an open drain to intermittently supply non-chlorinated water to taps. The 58 cases and 58 controls were matched for age and sex. Drinking tap water (MOR: 10; 95% CI: 3–32; PAF: 89%), washing utensils in tap water (MOR: 3.7; 95% CI: 1.2–11.3) and bathing in tap water (MOR: 3.5; 95% CI: 1.1–11) were associated with the illness.

Conclusion. This outbreak of diarrhoea and *Shigella flexneri* dysentery was caused by contamination of tap water and subsided following repair of the pipeline. We recommended regular chlorination of the water and maintenance of pipelines.

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INTRODUCTION

Four species of *Shigella* cause bloody diarrhoea or dysentery.[1] *Shigella flexneri* and *Shigella dysenteriae* are found more frequently in developing countries.[2] *Shigella dysenteriae* causes the most severe disease and may occur as an epidemic. Both water-borne and food-borne transmission of *Shigella* are possible.[3–5] The disease is highly contagious because of a low infection dose.[1,6] Hence, secondary person-to-person transmission is common.[1]

Before 1984, *Shigella flexneri* was the predominant *Shigella* species in Calcutta (present Kolkata), West Bengal.[7] In 1984, an epidemic of bacillary dysentery affected eastern India.[8] Since then, laboratories have reported regular changes in the predominant species.[9,10] Reports have indicated resistance to multiple antibiotics, including fluoroquinolones, among cases of *Shigella dysenteriae*.[11–13] However, *Shigella flexneri* accounts for the largest number of isolates.[9,14]

In 2006, the district of Nadia, West Bengal (2001 population: 4.6 million), reported 13 outbreaks of gastrointestinal illness and 58 141 cases of diarrhoea, which accounted for 60 deaths. A total of 4220 cases (7%) were reported as bacillary dysentery (West Bengal Department of Public Health, unpublished data). However, no outbreaks of shigellosis were reported. On 26 September 2007, the Gayeshpur municipality reported a cluster of cases with diarrhoea. We investigated this to identify the agent as well as the source of infection.

METHODS

Descriptive epidemiology

Case definition and case search. We reviewed the data on diarrhoeal diseases available from the municipal health office since 2003. We defined a possible case-patient as a resident of the Gayeshpur municipality who had diarrhoea (>3 loose stools during a 24-hour period) between September and October 2007. We asked healthcare workers in all facilities to report similar cases.

Data collection. We collected information regarding the age, sex, residence and date of onset. As per our case definition, we examined all possible case-patients. We administered hypotheses-generating questionnaires to the initial case-patient and a random sample of others to ascertain clues about probable sources.

Laboratory investigations. We collected stool specimens from hospitalized case-patients and sent them to the National Institute of Cholera and Enteric Diseases (NICED), Kolkata, for culture and smears, following standard procedures.[15]

Environmental assessment. We interviewed selected key informants to collect information regarding recent common gatherings, sources of drinking water, condition of the pipelines, frequency of water supply, chlorination practices and the drainage system. We reviewed the map of the water supply and sanitation system and conducted local inspections. We collected water specimens from different sources and sent them to the Nadia public health laboratory for microbiological testing.

Data analysis. We plotted an epidemic curve to describe the distribution of cases over time and drew a map to identify the distribution of cases within the community. We calculated attack rates by age and sex using the census data.

Analytical epidemiology

Design. The clustering of cases distal to a damaged pipe led us to suspect a leakage. To test this hypothesis, we did a matched case–control study in ward numbers 2, 5, 6 and 8. We used the same case definition and selected one age-, sex- and neighborhood-matched control per case. Municipal health workers collected information among participants regarding demographic characteristics, date of onset, signs and symptoms, outcome, food-handling practices, water intake and sanitation.

Data analysis. We calculated matched odds ratio (MOR) for discordant pairs and their 95% confidence interval (CI). We estimated the population attributable fraction (PAF) for the exposures that were significantly associated with the illness and for which we suspected causality using the formula (Proportion of cases exposed x [MOR–1/MOR]).

RESULTS

Descriptive epidemiology

We identified 461 cases (no deaths) in a population of 10 039 (overall attack rate: 46/1000 population; Table I), higher than the background rate for September–October in the area in 2003–06 (0.9–24 per 1000). We ruled out recent population influx or any change in the reporting system and considered this episode as an outbreak. The attack rate was higher among those in the age group of 45–59 years (71/1000) and females (52/1000). Among 461 possible case-patients, 197 (42%) had blood in the stools, 160 (34%) had abdominal pain, 142 (31%) had fever of ≥38 °C, 54 (11%) had vomiting and 40 (8%) had dehydration. An initial case was reported from ward number 2 on 22 September 2007, then there was a sudden increase on 26 September followed by two peaks and a decrease on 1 October. No cases were reported after 12 October 2007 (Fig. 1). Cases were clustered downstream to a leak in a pipeline (Fig. 2).

Laboratory investigations

Shigella flexneri was isolated from 3 of 4 specimens. Of these, 2 were *Shigella flexneri* type 2a and one type 3a.

Analytical epidemiology

We recruited 58 cases and 58 controls for the matched case–control study (Table I). Cases and controls were comparable with respect to median age (35 years) and the proportion of females (43%). Compared with control-subjects, case-patients were more likely to exclusively drink the municipal tap water (MOR 9.7; 95% CI: 2.9–32). This exposure accounted for the majority of cases (PAF: 89%). Other exposures also significantly associated with illness included washing utensils in tap water (MOR: 3.7; 95% CI: 1.2–11; PAF: 73%) and bathing in tap water (MOR: 3.5; 95% CI: 1.1–11; PAF: 71%).

Environmental investigations

The overhead water tank of the Gayeshpur municipality was located in ward number 2. Non-chlorinated water from that tank was supplied to ward numbers 2, 5, 6 and 8 intermittently, 3 times a day. These wards were within one-kilometre radius and did not require any pump for the supply of water. A network of 25-year-

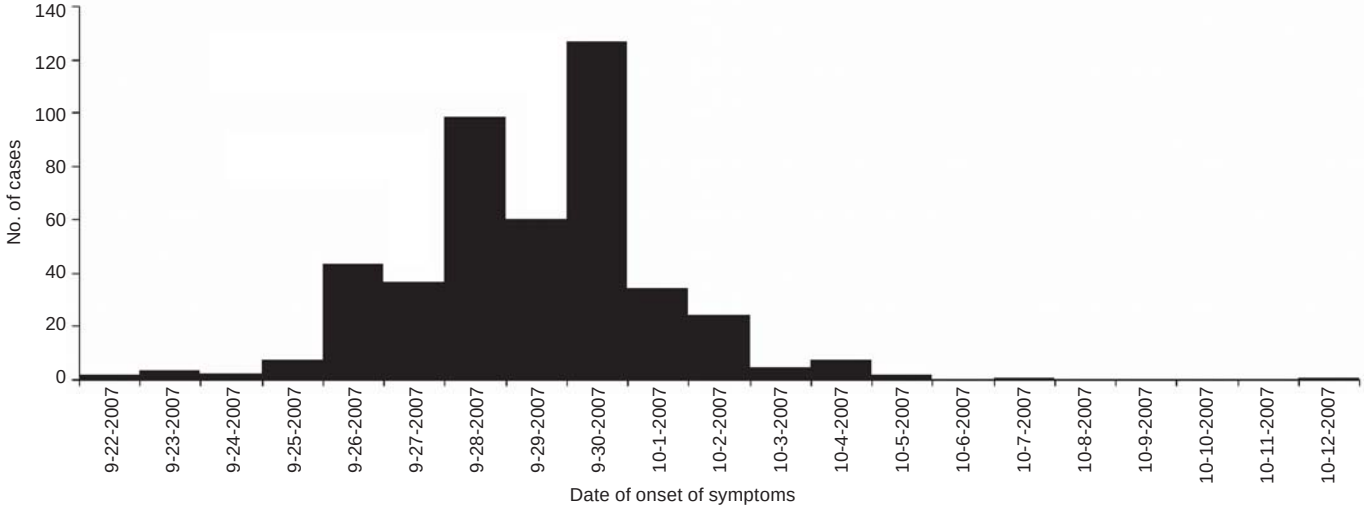


FIG 1. Diarrhoea cases by date of onset, Gayeshpur, Nadia, West Bengal, India, 2007

TABLE I. Distribution of case–control sets according to the exposure status, Gayeshpur, Nadia, West Bengal, India, 2007

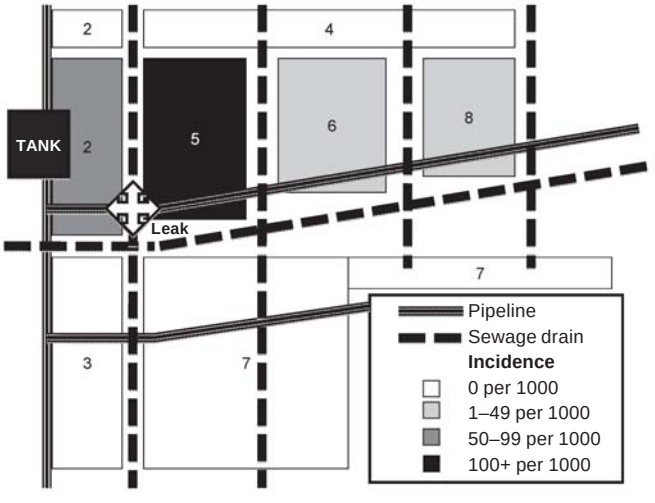
Characteristics	Number of case–control sets according to exposure status				Odds ratio	95% CI
	Concordant		Discordant			
	Case exposed	Case unexposed	Case exposed	Case unexposed		
Monthly family income <Rs 2000	17	15	14	12	1.2	0.5–2.5
Absence of secondary education	34	6	7	11	0.6	0.2–1.6
Drinking exclusively tap water	22	4	29	3	9.7	2.9–32
Washing utensils in tap water	30	9	15	4	3.7	1.2–11
Bathing in tap water	33	7	14	4	3.5	1.1–11
Wide mouth container at home	31	2	16	9	1.8	0.8–4.0

old pipelines crossed the open drainage system at many places to the supply the water tank in the area. In addition to the municipality water supply, there were tubewells in individual households. We identified a leakage in the pipeline at a point where it crossed an open drain in ward number 2 (Fig. 2). On 20 September 2007, during heavy rains, a jeep skidded from the road into the open drain and might have damaged the pipeline. This leak could not be identified before 29 September as the area and the leakage point were flooded. All 4 specimens of water taken from the affected area tested positive for faecal coliforms. A specimen of water taken from another area, where no cases were reported, tested negative.

DISCUSSION

During this outbreak, cases of dysentery caused by *Shigella flexneri* were reported. The profile of signs and symptoms was compatible. *Shigella flexneri* was isolated from 3 of 4 stool specimens. We identified 2 different strains of the bacteria. This could be consistent with a polymicrobial contamination of the water supply following the leak.[6] Epidemic dysentery in developing countries is usually caused by *Shigella dysenteriae* serotype 1 (Sd1).[8] However, *Shigella flexneri* continues to be the most common pathogen isolated during the inter-epidemic period in West Bengal.[9,16,17]

The probable source of this outbreak was the contamination of water in a damaged pipeline. A number of elements supported this hypothesis. First, cases clustered in the distribution area of the damaged pipeline. The density of cases decreased as the distance from the leak increased. In its distal network, the pipeline was supplemented and therefore diluted by safe water from a different boosting centre. Second, the distribution of cases over time was consistent with an event that occurred around the time the pipeline was probably damaged by a car. Third, the case–control study pointed to an association between the consumption of water from the pipeline and illness, with a high proportion of cases exposed and a high PAF in the population. Fourth, bacteriological analysis of the water supply pointed to contamination due to coliforms. Urban water-borne outbreaks caused by damaged pipelines that suck nearby sewage, because of the negative pressure secondary to the intermittent supply, have been reported many times in India.



Each square represents a ward, with the number inside denoting the number of the ward

FIG 2. Incidence of diarrhoea per ward, Gayeshpur, Nadia, West Bengal, India, 2007

Pathogens were as diverse as *Vibrio cholera*,[18] *Salmonella enterica* serotype typhi,[19] and hepatitis E virus.[20]

Our investigation had a limitation. We could organize collection and testing of specimens for <1% of the cases. Thus, this outbreak may have involved other serotypes of *Shigella* or other microorganisms. Such polymicrobial outbreaks have been reported in the context of massive contamination of water supply.[21]

We recommended a number of measures. On the basis of the information we provided, the municipality repaired the pipeline on 29 September and chlorinated the water. The outbreak subsided. For the longer term, we recommended (i) monitoring the quality of the municipal drinking water, (ii) conducting preventive maintenance on the pipelines and (iii) chlorinating the water supply every day. Ultimately, these urban areas would need continuous water supply and separate pipelines and sewage networks. In addition, the departments of environment, health and water will need to collaborate to maintain pipelines, chlorinate water, and detect and investigate outbreaks early.

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