Acute Watery Diarrhoea Outbreak from Contaminated Municipal Water Supply in Jashore, Bangladesh, 2015

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Abstract

Background: Diarrhoeal outbreaks commonly occur during pre- and post-monsoon seasons in Bangladesh. On October 12, 2015, the Superintendent of the 250-bedded General Hospital, Jashore, informed the Institute of Epidemiology, Disease Control and Research, Bangladesh, of an increase in admission of patients with acute watery diarrhoea from Jashore Municipality. We investigated the event to ascertain the cause of the outbreak and its associated risk factors.

Methods: We conducted a descriptive study followed by a case–control study in Jashore Municipality from October 13 – 20, 2015. We defined a case as any person living in Jashore Municipality having three or more episodes of loose motion per day with symptoms lasting ≤7 days. A control was defined as any person living in Jashore Municipality without a history of loose motion in the preceding 7 days. Stool samples of untreated patients were tested for a rapid dipstick test for *Vibrio cholerae* O1 and culture sensitivity. Water samples from the municipal water pump and households were tested for microbial contamination. Cases were enrolled from hospitals and asymptomatic controls were identified by convenience sampling from the same hospitals' outpatient clinics, matched by municipal residence and household access to municipal water. Descriptive analysis and logistic regressions were performed. We calculated adjusted odds ratios (AOR) and 95% confidence intervals (CI).

Results: Between 9–14 October, 214 patients were admitted to the hospital; 115 (53.7%) lived in Jashore municipality. Cases were from all age groups, with 57% males. We enrolled 27 cases and 49 controls. Drinking municipal supplied water in the preceding 24 hours was significantly associated with illness (AOR 4.5; 95% CI: 1.3–15.3; p=0.015). In stool samples, Vibrio cholerae O1 was identified by rapid test in 3/8 (37.5%) samples and two were confirmed by culture. Household-level municipal water had total coliforms up to 8,000 CFU/ml. Environmental inspection found multiple breaches in water supply pipes running through open drains.

Conclusion: The investigation confirmed a cholera outbreak in Jashore district, most likely spread through the contaminated municipal water supply. We recommended repairing leakages, chlorination, and public education to prevent future outbreaks in similar urban settings.

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Introduction

Globally, municipal water has been implicated in acute watery diarrhoea outbreaks where breaches in infrastructure or flooding allow faecal contamination of water lines.[1,2] A recent population-based study in sub-Saharan Africa and Asian countries estimated an annual incidence of cholera at 2.3 cases per 1,000 persons, underscoring its persistent threat in urban and peri-urban settings.[3] In Bangladesh, acute watery diarrhoea is an important public health challenge, commonly in cities and municipalities.[4,5] A biannual peak for these outbreaks usually coincides with pre- and post-monsoon periods, aggravated during flooding or heavy rainfall.[6,7]

Previous outbreak investigations of acute watery diarrhoea in Bangladesh commonly found strong associations between unsafe water consumption, poor personal hygiene, and diarrhoeal diseases, including cholera.[8,9] Despite progress in sanitation and disease surveillance, the densely populated cities and municipalities are at high risk of diarrhoeal outbreaks due to aging routine water supply networks, which often overlap with unplanned sewage and drainage systems.[6]

Jashore Municipality, located in southwestern Bangladesh, has a population of over 280,000 and a partially piped water system supplied through 30 pumps and six overhead tanks.[10] On October 12, 2015, the Superintendent of the 250-Bedded General Hospital in Jashore notified the Institute of Epidemiology, Disease Control and Research (IEDCR) through its 24-hour hotline about an unusually high number of diarrhoeal admissions since the beginning of the month. Preliminary information indicated a cluster of cases from Jashore Municipality, suggesting a localized outbreak. The hospital had previously used a threshold of >20 diarrhoea admissions/day to detect suspected outbreaks, based on historical data. In response, a multidisciplinary rapid response team, including field epidemiologists and laboratory experts from IEDCR conducted a field investigation from October 13-20, 2015. The objectives were to ascertain the cause of the outbreak and its associated risk factors.

Methods

Study Design and Site

The investigation was performed among the adult medicine and paediatric departments of 250-Bedded General Hospital in Jashore and in the wards of Jashore Municipality, Bangladesh, October 13 – 20, 2015. We collected hospital admission information from January, 2015. Initially, we conducted a cross-sectional analysis of hospital admissions from January to October, 2015. This was followed by a case–control study to identify potential risk factors associated with illness.

Operational definition

- **Cases:** Any person living in Jashore Municipality who reported an acute onset of three or more episodes of loose stools within 24 hours from October 12 to October 18, 2015.
- **Controls:** Any person living in Jashore Municipality without any history of diarrhoea during the same period.

Sample Size and Sampling

We used an unmatched case-control design with an estimated 2:1 control-to-case ratio. Sample size was calculated based on previously reported odds ratios for risk factors such as municipal water use and consumption of street-vended food, assuming 80% power and 5% significance level. The estimated sample size was 18 cases and 36 controls. We selected cases from among hospitalized patients with acute watery diarrhoea who met the case definition. Controls were selected from patient attendants in the same hospital,

matched by age, municipal residence and household access to municipal water.

Data Collection

Data were collected by face-to-face interviews using a pre-tested semi-structured questionnaire based on previous diarrhoeal outbreak investigations. Information collected included demographics, water source and handling practices, food consumption history, and contact with diarrhoeal patients.

Laboratory Investigation

We collected stool samples from inpatients with diarrhoea who had not received antibiotics. Rapid diagnostic tests (dipstick) for *Vibrio cholerae* O1 were performed after four hours of enrichment in alkaline peptone water. Samples were subsequently sent to the Microbiology laboratory of IEDCR in Dhaka for culture and sensitivity testing. Water samples were purposively collected from ten sites: three from municipal water pumps, three from tube wells, and four from household municipal water taps. Samples were transported to International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) for microbiological analysis, including quantification of total coliforms, faecal coliforms, faecal streptococci, and aerobic bacteria.

Environmental Investigation

We conducted a field survey of the municipal water distribution system, visually inspected water pipelines for breaches and illegal connections, and interviewed municipal water supply staff about supply schedules and known infrastructural issues.

Statistical Analysis

We performed descriptive analysis of hospitalised diarrhoea patients by time, place, and person. To find out high-risk wards in the municipality, we calculated the diarrhoea incidence per 10,000 population for each ward. In the case-control study, initially, we calculated crude odds ratios (OR) with 95% confidence intervals (95%CI). Variables that were statistically significant ($p<0.05$) in univariable analyses were included in the multivariable model. Statistical analyses were conducted using SATA version 12.

Ethical Considerations

The investigation was conducted as part of the national public health emergency response under the IEDCR, Ministry of Health and Family Welfare, Bangladesh. Verbal informed consent was obtained from all participants prior to interviews, and data were anonymized to protect confidentiality. Laboratory and environmental sampling followed national guidelines for outbreak investigations.

Results

Descriptive Epidemiology

Time

As per the action threshold of hospital admission of 20 diarrhoea cases/day was set by the hospital authority, which exceeded from October 9, 2015 onwards. From September 14 to October 14, 2015, a total of 497 diarrhoea patients were admitted to the 250 Bedded General Hospital, Jashore.
(Figure I)

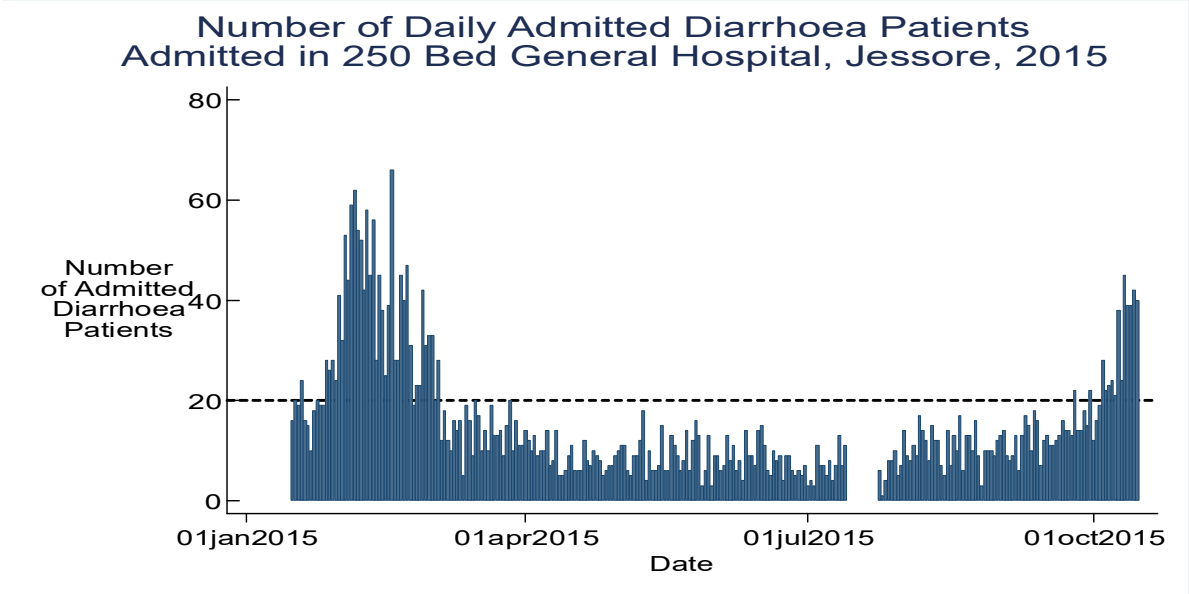

Figure 1. Number of Diarrhoea Patients Admitted in 250 Bed General Hospital, Jashore

Place

Based on residential addresses, 115 patients (53.7%) resided within Jashore Municipality. The remaining patients came from subdistricts surrounding the municipality (44; 20.5%), outside the municipality (17; 8.0%), other subdistricts within Jashore district (31; 14.5%), and neighbouring districts (7; 3.3%). (Figure II)

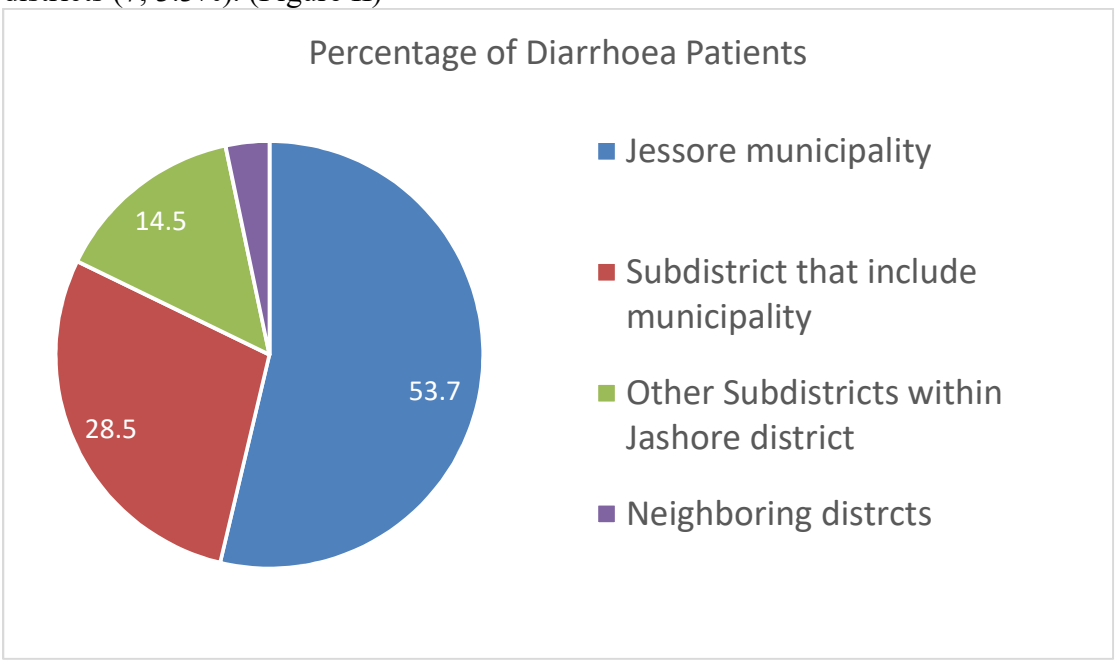

Figure 2. Distribution of Admitted Diarrhoea Patients by Location (n=214)

Within the municipality, cases were distributed across all nine wards. Wards 4, 3, and 6 had the highest admission rates per 10,000 population: 15.6, 9.8, and 9.1, respectively. (Table I) The lowest rates were observed in wards 1 and 2 (1.3 and 1.2 per 10,000, respectively).

Table I: Distribution of Diarrhoea Cases by Municipality Wards in 250 Bed General Hospital Jashore from October 9 – 14, 2015

Municipality wards	Total population[7]	Number of Admitted Diarrhoea Cases	Rate of Admitted Diarrhoea Patients (per 10,000 population)
Ward 1	26,401	3	1.3
Ward 2	16,377	2	1.2
Ward 3	17,382	17	9.8
Ward 4	20,472	32	15.6
Ward 5	39,407	16	4.1
Ward 6	17,642	16	9.1
Ward 7	26,103	14	5.3
Ward 8	15,081	6	3.9
Ward 9	22,931	9	3.9
Total Cases	201,796	115	5.7

Person

Of the 214 patients admitted between October 9 – 14, 2015 (during the outbreak peak), 122 (57%) were male and 92 (43%) were female. Patients ranged in age from under five to over 55 years. The highest number of cases occurred among those aged 15–24 years (56 cases; 26.1%), followed by 25–34 years (48; 22.5%) and 35–44 years (42; 19.6%). Only 18 patients (8.4%) were younger than 15 years (Table II).

Table II: Characteristics of Diarrhoea Cases by Age Group and Gender Admitted in 250 Bedded General Hospital Jashore from October 9 – 14, 2015

Characteristics	Number of Diarrhoea Patients (n=214) (%)
Age group	
<15 years	18 (8.4%)
15-24 years	56 (26.1%)
25-34 years	48 (22.5%)
35-44 years	42 (19.6%)
45-54 years	27 (12.6%)
≥ 55 years	23 (10.8%)
Gender Distribution	
Male	122 (57.0%)
Female	92 (43%)
Clinical Features	
Acute watery diarrhoea	214 (100%)
Nausea	126 (59%)
Abdominal pain	67 (31.3%)
Vomiting	60 (28%)
Fever	45 (21%)

Case-Control Study Findings

We enrolled 27 cases and 49 controls for the case-control study; among them, 13 cases (48.2%) were male, compared with 19 controls (38.8%), while 14 cases (51.8%) and 30 controls (61.2%) were female. Housewives were the largest occupational group among cases(11; 40.7%) and controls (26; 53.1%) (Table III).

Table III: Distribution of variables among cases and controls in acute watery diarrhoea outbreak in Jashore, October 17 – 19 , 2015

Characteristics	Cases (n=27)	Control (n=49)
Age group		
<15 years	3 (11.1%)	2 (4.1%)
15-24 years	6 (22.2%)	8 (16.3%)
25-34 years	7 (25.9%)	20 (40.8%)
35-44 years	4 (14.8%)	11 (22.5%)
45-54 years	5 (18.5%)	4 (8.2%)
≥ 55 years	2 (7.4%)	4 (8.2%)
Gender Distribution		
Male	13 (48.2%)	19 (38.8%)
Female	14 (51.8%)	30(61.2%)
Occupations		
House wife	11 (40.7%)	26 (53.1%)
Business	4 (14.8%)	8 (16.3%)
Students	5 (18.5%)	7 (14.3%)
Service	2 (7.4%)	3 (6.2%)
Farmer	2 (7.4%)	2 (4.1%)
Others	3 (11.1%)	3 (6.1%)

Univariable Analysis

In the univariable analysis exploring potential risk factors, three exposures demonstrated statistically significant associations with diarrhoeal illness. We found those drank municipality supplied water in the 24 hours (OR:6.7;95%CI: 1.8–25.0), ate food from a local restaurants or street vendors (OR: 4.8;95% CI: 1.6–15.6), and drank water from a local restaurant or street vendors (OR 4.2; 95% CI: 1.4–13.1) were associated with diarrhoea. (Table IV)

Multivariable Analysis

After adjusting for confounding factors, only drinking municipal supplied water in the 24 hours before illness onset remained significantly associated with diarrhoea (AOR 4.5; 95% CI: 1.3–15.3; p=0.015) (Table V).

Laboratory Findings

Of eight stool samples collected, three (37.5%) tested positive for *Vibrio cholerae* O1 by rapid dipstick test. Among these, two samples (25%) were culture-confirmed as *Vibrio cholerae*.

Environmental Investigations

The environmental investigation focused on four wards within Jashore Municipality that reported higher numbers of diarrhoea admissions. Field teams visually inspected the municipal water distribution system and found multiple visible breaches and leaks in the pipes, often due to unauthorized household connections. Several of these leaks were submerged in open drains frequently used as informal sewerage channels.

Interviews with municipal water workers confirmed that the water supply network was highly interconnected across wards and operated on an intermittent schedule, which could allow contaminants to enter the system when pressure drops.

Table IV: Factors related to acute watery diarrhoea outbreak in Jashore Municipality, 2015

Variables	Diarrhoea, n (%)		Crude Odds Ratio (95% CI)
	Cases (n=27)	Controls (n=49)	
Male	13 (48.2%)	19 (38.8%)	1.5 (0.5, 4.2)
Work outside home	16 (59.3%)	23 (46.9%)	1.6 (0.6, 4.8)
Drink municipality supplied water in last 24 hours	13 (48.2%)	6 (12.2%)	6.7 (1.8,25.0)
Contact with diarrhoea patient in last 24 hours	17 (63.0%)	18 (36.7%)	0.3 (0.1, 1.0)
Take food **from a local** restaurant/ street vendor in **the** last 24 hours	19 (70.4%)	16 (32.7%)	4.8 (1.6, 15.6)
Drink water from **a local** restaurant/ street vendor in **the** last 24 hours	15 (55.5%)	11 (22.9%)	4.2 (1.4, 13.1)

Table V: Multivariable analysis of factors related to acute watery diarrhoea outbreak in Jashore Municipality, 2015

Variables	Adjusted Odds Ratio	95% CI	p
Drank municipality s**upplied** water in last 24 hours	4.5	1.3, 15.3	0.015
Ate food in restaurant/ street vendor in last 24 hours	3.7	0.7, 19.6	0.119
Drank water from restaurant/ street vendor in last 24 hours	1.0	0.2, 5.4	0.9

Water Test Findings

Microbiological analysis of water samples supported these observations. All four household-level samples of municipal supply water showed evidence of heavy faecal contamination, with total coliform counts reaching up to 8,000 colony-forming units (CFU) per millilitre, faecal coliforms up to 5,000 CFU per 100 millilitres, faecal streptococci up to 13 CFU per 100 millilitres, and faecal aerobic bacteria up to 2,100 CFU per millilitre. Importantly, *Vibrio cholerae* was not detected in any water samples collected. Samples taken directly from municipal water pumps and nearby tube wells showed no contamination, suggesting that contamination likely occurred downstream

within the distribution system, particularly at the household level.

Discussions

This investigation confirmed an outbreak of acute watery diarrhoea in Jashore Municipality, Bangladesh, during October 2015, most plausibly linked to the municipal water supply system. The case–control study identified drinking municipal supply water in the 24 hours before illness as the primary exposure associated with disease. Laboratory testing detected Vibrio cholerae O1 in stool samples from patients. Environmental investigations documented breaches and leakages in water distribution pipes running through open drains, and water testing revealed high levels of faecal contamination at the household level. However*, V. cholerae* could not be isolated from water samples. Together, these findings suggest that contaminated municipal supply water was a plausible source of the outbreak.

Similar outbreaks were reported in urban areas of Bangladesh and neighbouring countries where ageing water infrastructure and intermittent supply enable pathogen infiltration.[10] A recent study in sub-Saharan Africa and Asian countries found that drinking untreated municipal water was associated with cholera.[3] In India, a cholera outbreak following a cyclone was traced to contaminated supply lines, with an attack rate exceeding [12] per 1,000 population.[10] These parallels reinforce the structural vulnerability of piped water systems that operate under negative pressure, especially where pipelines cross open drains.[11]

The detection of V. cholerae O1 in patient samples, combined with consistent clinical presentation of acute watery diarrhoea, supports cholera as the probable aetiology. Seasonal trends further support this interpretation; cholera in Bangladesh typically peaks during the post-monsoon months of September to December when flooding and elevated water tables increase the risk of contamination.[5] A population-based study estimated that up to 66% of clinical cholera cases in Bangladesh occur during these seasonal peaks.[6] The inability to isolate V. cholerae from water samples does not rule out waterborne transmission, as contamination may be intermittent and bacterial loads may fall below detection thresholds. A study in Bangladesh, similarly, reported household-level contamination without consistent isolation of V. cholerae from water samples, despite stool confirmation in patients.[14]

Environmental findings in Jashore underscored the risk created by an ageing, interconnected water distribution system with multiple unauthorised connections and documented breaches. These vulnerabilities allow faecal contamination of water, particularly during interruptions in supply when negative pressure can draw contaminated drain water into the system. Municipal water samples from household taps showed high total and faecal coliform counts (up to 8,000 CFU/ml), exceeding the WHO-recommended limits for safe drinking water.[15] In contrast, samples taken upstream from pumps and tube wells were free of contamination, suggesting contamination occurred within the distribution network.

Behavioural risk factors, such as consumption of food and water from street vendors, were also associated with illness in bivariate analysis but did not remain statistically significant after adjusting for confounding. It is plausible that street vendors themselves relied on municipal supplied water, serving as an indirect exposure pathway. A similar cholera outbreak in Sierra Leone in 2012 was found to be associated with the consumption of street-vended water, which was ultimately traced to an unsafe municipal supply.[9]

From a public health perspective, this outbreak highlights critical systemic gaps in water safety management. An estimated 72% of households in Jashore Municipality had access to municipal water supply, yet only about 6% used it for drinking, preferring tube well water.8 Nonetheless, residents could still be exposed at workplaces, schools, or through consumption of beverages prepared with contaminated supply water. A coordinated multiagency effort should be made to repair leakages, eliminate illegal connections, and maintain positive pressure throughout the system. The outbreak response recommended immediate interventions, including chlorination, community education on water treatment using chlorine tablets, and promotion of hand hygiene.

The outbreak investigation included epidemiological, laboratory, and environmental approaches. The case–control study identified contaminated municipality supplied water as a possible source, supported by laboratory confirmation of faecal contamination in the supply water; and environmental investigation identified infrastructural vulnerabilities. This multidisciplinary approach aligned with guidelines for cholera control, which emphasized the need to combine surveillance, rapid response, and structural interventions.[15]

This investigation had several limitations. In the investigation, we primarily collected information from hospital-admitted cases, which may overrepresent patients with more severe disease and miss milder community cases, potentially biasing exposure estimates. In the case control study, controls were recruited from hospital visitors unlike community residents. Third, recall bias may have affected self-reported exposures; however, the use of a standardized questionnaire and focusing on the preceding 24 hours may have reduced this bias.

Conclusion and Recommendations

This investigation confirmed a cholera outbreak in Jashore Municipality in October 2015, strongly associated with the consumption of contaminated municipal supplied water. Epidemiological findings, combined with stool confirmation of *Vibrio cholerae* O1 and evidence of faecal contamination in household water, highlight the vulnerability of ageing distribution systems with leakages and illegal connections. Although *V. cholerae* was not isolated from water samples, the epidemiological and environmental evidence collectively supported waterborne transmission as the most plausible source. To prevent future outbreaks, immediate measures should include repairing water pipe breaches, maintaining positive pressure in distribution lines, and introducing regular chlorination. Municipal authorities should strengthen routine water quality monitoring, eliminate illegal household connections, and ensure rapid response to suspected outbreaks. Public education on household water treatment, safe storage, and hygiene should be reinforced, particularly during high-risk post-monsoon periods. Strengthening surveillance and intersectoral coordination will be essential for sustained cholera prevention in urban Bangladesh.

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Competing Interests: The authors declare no conflict of interest.

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