Assessment of Epidemiological Factors in a Cholera Outbreak in an Urban Area of Western India

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ABSTRACT

Background: Cholera is a preventable disease, still it remains a major public health problem among developing countries like India. Access to safe water and a sanitary environment can easily control many gastrointestinal infections including Cholera. In the last week of June 2021 large number of acute diarrhoeal cases were reported which was higher than expected subsequently confirmed as an outbreak of Cholera.

Objective: The objectives of the study were to verify the diagnosis, identify risk factors and institute appropriate control measures to control the outbreak.

Materials and Methods: A cross-sectional study was undertaken to identify the time, place and personal distribution of the disease. Based on the findings of the study, sanitary survey and environmental examination a hypothesis was formulated. A case-control study was carried out to test the hypothesis.

Results: A total of 158 cholera cases were reported with one death. Male and females were affected equally. All age groups affected, 18.35% of the cases were reported among children aged 0-5 years old. It was a common source epidemic and water was source of infection. The water sample reported faecal contamination. Those households not using water purification methods were 1.454 times more affected (OR=1.454) than those using water purification methods.

Conclusion: The Vibrio Cholerae bacterium caused the cholera outbreak in Nadiad. Infection was caused by contaminated drinking water.

Key words: Cholera, Outbreak, Nadiad, Waterborne, Diarrhoea, faecal contamination

INTRODUCTION

India made remarkable progress on the issue of clean water and sanitation after 1960. Despite many challenges, "Swachh Bharat Mission" leads to outstanding results in sanitation. According to the Sustainable Development Goal Index for 2019, India ranks 115 out of 162 countries. Clean water and sanitation are included in Sustainable Development Goal (SDG) Goal 6. In 2019, India achieved 56.6% of SDG-6 targets.[1,2]

Many acute diarrheal diseases in developed countries are controlled by access to safe water and sani-

tation. Cholera, once a public health problem now eliminated in high-income countries. Cholera, on the other hand, is a significant health problem in many developing countries, including India.[3]

Acute diarrhoeal disease was the eighth leading cause of death. There are 1.3 to 4 million cases of cholera and 21000 to 143000 deaths reported worldwide every year due to cholera. The real problem may be much higher because of the large number of cases under-report and lack of laboratory diagnosis facility at the primary care level.[4,5]

Cholera is a type of acute diarrheal disease caused by

Vibrio cholerae. Which is transmitted through contaminated water and food.[3,6,7]

Cholera has a significant historical and public health importance. Cholera has been present in India since ancient times. In 1884, Robert Koch isolated and cultures Vibrio cholerae at Kolkata Medical College. Since time immemorial, Cholera has been an endemic disease in the Ganges Delta. In the 19th century, several cholera epidemics originated in India and spread to western countries. The seventh pandemic, which began in Indonesia in 1961, has spread to over 80 countries in Asia, Africa, and Europe.[6,8,9]

Cholera primarily affects the gastrointestinal tract (acute gastroenteritis); the exotoxin produced by Vibrios may lead to sudden painless passage of a large volume of rice watery stool, leading to excessive fluid and electrolyte loss resulting in severe dehydration, circulatory failure, shock and electrolyte imbalance. A cascade of events may lead to acidosis, myocarditis, heart failure, tubular necrosis and eventual death if not timely treated.[3,6,7]

Cholera is a unique disease that can occur in sporadic cases, epidemics, or even pandemic.[8] There is no way to prevent the introduction of cholera in any community but it persists in the environment and creates acute public health problems in communities having overcrowding, poor sanitation, unsafe drinking water and poor personnel hygiene.[6,9,10] In India, this disease is a major threat as a result of poor sanitation, unclean drinking water, overcrowding, and an ageing subterranean pipeline with multiple leaks that runs alongside sewage lines.[10,11] The short incubation period (2-5 days), a large number of subclinical cases, disease carrier and constant changes in biotypes and serotypes promote easy survival of the organism in environment and increase infectivity; rapid spread when suitable environment sets.[8-11] For every symptomatic case, there are approximately five asymptomatic cases of classical cholera and 25 cases of El Tor cholera.[8] It has been shown that short-term carriers contribute significantly to cholera recurrence.[11]

In India, 559 cholera outbreaks were reported between 2009 and 2017. 36 outbreaks of cholera reported in the year 2018.[12,13]

It is easy to prevent cholera by providing safe and wholesome water, yet outbreaks continue to occur with variable intensities throughout India. A similar cholera outbreak was reported in the Nadiad city of central Gujarat. Outbreak investigation was carried out to identify epidemiological determinants and implement control measures.

MATERIALS AND METHODS

An epidemiological study was conducted in an urban area of Nadiad city of Gujarat.

The outbreak: The 55-year-old male reported acute diarrhoea with rice watery consistency. This was the probable case of cholera, later confirmed by a laboratory. This was the index case of cholera reported on 25th June 2021. Many cases of acute diarrhoea reported and admitted to district hospitals and medical college.

Compared with the previous two-year data, the number of diarrhoeal cases was higher than expected. Therefore, an epidemic has been confirmed. Fourteen outbreaks and 17 laboratory-confirmed cases of cholera have been reported in the Kheda district between 2011 and 2020. The last outbreak of cholera was reported in Nadiad City in 2019.

Case definition used: According to Integrated disease surveillance programme, a case of cholera should be suspected when in an area where the disease is not known to be present, a patient develops severe dehydration or dies from acute watery diarrhoea; or in an area where there is a cholera epidemic, a patient develops acute watery diarrhoea, with or without vomiting. A case of cholera is confirmed when *V. cholerae* O1 or O139 is isolated from any patient with diarrhoea. We have used the same case definition for the sake of conducting this field investigation.[14]

Study settings: Nadiad city has a population of 2540037 (Census 2011). The Source of water is underground water, drawn from the ground by a deep well and supplied to the entire city via a network of underground pipelines and distribution tanks. Many acute diarrhoeal cases were reported from different areas of Nadiad city. The most common area affected by the cholera outbreak was Saibabnagar, Jawahar Nagar, and Kanipura. The affected areas are slum areas. Water provided to slum dwellers through house-to-house water pipelines; open defecation practised in those slum areas. The majority of the slum dwellers were labourers.

Investigation team: Rapid response teams consisting of faculty members and medical social workers from the community medicine department of the medical college visited the urban slum area. As needed, a district health epidemic team assisted to rapid response team.

Epidemiological data collection: We conducted an environmental survey in affected areas to assess the water distribution system, sewer system, water source, and environmental hygiene. Water samples collected from different areas were sent to the public health laboratory for bacteriological examination. We carried out an Orthotoduline test to check residual chlorine on water samples collected from households of the affected area.

House-to-house surveys were conducted to detect active cases. All probable cases and confirmed cases reported in the affected area were listed. Data was collected on a structured questionnaire on basic demographic variables, symptoms, date of onset, water source, water treatment method, history of food consumed outside the home, laboratory diagnosis, and

type of treatment. Stool samples were collected from all the probable cases of diarrhoea. Treatment was started using antibiotics; ORS packets were distributed, and demonstration of how to use them and moderate to severe cases were referred to the district hospital and medical colleges.

A hypothesis was formulated based on the descriptive epidemiological data and tested using a case-control study. According to a hypothesis, water was the likely source of infection. Cases were households affected by cholera, while controls were non-affected households in the same area. Those using some methods of purification were considered not exposed, and those not using any method of purification were considered exposed.

A chlorine tablet was distributed in all affected areas and demonstrated how to use it. Public health education was delivered through various channels of communication. We provided health education about washing hands with soap and water after defecating and before eating, drinking boiled water, using chlorine tablets to decontaminate water, and making oral rehydration solution.

In order to improve treatment facilities; medications, oral rehydration solutions, and intravenous fluids mobilized to urban health centres. Health care workers were trained for early intervention. Symptomatic patients were treated with antibiotics and those in need were quickly transferred to a higher centre. In addition, surveillance was strengthened; all private practitioners were informed to report suspected cases to the district health department.

Statistical analysis: Data were entered into MS office 2007, and statistical analyses were performed using the Epi info-7 software. Data collected were descriptively analyzed in terms of time (epidemic curve), place (spot map and clustering) and person characteristic to reach an epidemiological diagnosis. A plausible hypothesis was formulated based on analysis and tested by a comparative study.

RESULT

In total, 158 cases of acute diarrhoea were reported. All cases were suggestive of cholera by clinical presentation. The case fatality rate was 0.63 %.

The cholera epidemic curve (figure 1) shows that the first cholera case was reported on 25th June 2021, and the peak was on 2nd July 2021. Following this, the number of new cholera cases gradually decreased. The last case was recorded on the 19th of July 2021. Then, active surveillance was conducted for two weeks, and no new case was reported after 19th July 2021.

Table 1 shows that almost equal numbers of cases were observed from both sexes. Out of the total 158 cases, 82 (51.90 %) were males, and 76 (48.10%) were females.
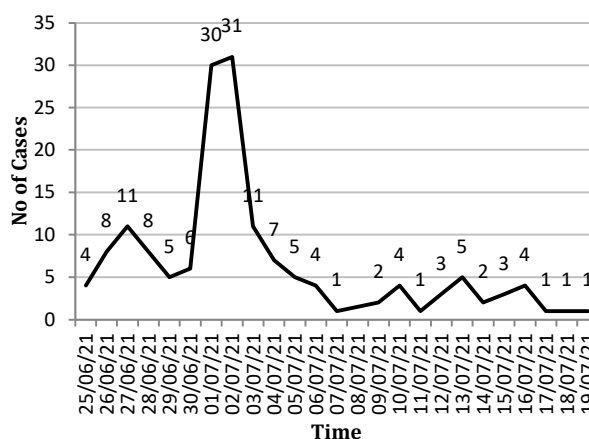

Figure 1: Time distribution of cholera cases during the epidemic. (Epidemic curve)

Table 1: Sex wise distribution of cholera cases (n=158)

Sex	Cases (%)
Male	82 (51.90)
Female	76 (48.10)
Total	158 (100)

Table 2: Clinical symptoms of the cases (n=158)

Clinical Symptoms	Cases (%)
Diarrhea	84 (53.16)
Diarrhea & Vomiting	74 (46.84)
Total	158 (100)

Table 3: Age wise distribution of cholera case and comparison with age structure of Kheda

Age group	Case (n=158)	Proportion of cases (%)	Population proportion of Kheda (%)
0-5	29	18.35	11.57
6-10	17	10.76	10.26
11-15	15	9.49	10.71
16-20	13	8.23	10.02
21-25	9	5.70	9.29
26-30	13	8.23	8.78
31-35	13	8.23	8.11
36-40	12	7.59	7.85
41-45	12	7.59	6.68
46-50	8	5.06	5.89
51-55	8	5.06	4.55
56-60	5	3.16	2.95
61-65	1	0.63	2.14
66-70	3	1.90	1.20

Table 2 reflect the symptoms reported by cholera patients. Symptoms include diarrhoea and vomiting, the first signs of the disease. Most cases developed diarrhoea only, and others developed diarrhoea and vomiting. In 84 (53.16%) cases, diarrhoea was the only manifestation, and in 74 (46.84%) cases, diarrhoea and vomiting were both present.

The majority of cases were required to treat at an indoor health facility. 107 cases (67.72%) were admitted to an indoor health facility for the treatment, while 51 (32.28 %) were treated at an outdoor health facility.

According to Table 3, many cases were reported from the younger age group. To remove analysis bias of the age structure difference, age-wise proportion of cases compared with the age structure of Kheda district (Census 2011). The proportion of cholera cases reported from each age group is similar to the proportion of population in that age group. Only higher cases were reported in 0-5 years of age; 29 (18.35%) cases were reported from 0-5 years of children.

A red outlined area on the map of Nadiad city (Figure 2) indicates the geographic area from where cholera cases are reported. Most cases are reported from Saibabanagar, Jawaharnagar, and Kanipura. Water was distributed to the affected areas by a common water pipeline

Observation of sanitary survey and environment samples

a) No history suggests food poisoning, for example, participating in a large gathering or recent function. The cases had no recent travel or outside food consumption in the last week.

b) The public water work had been carried out before some time. In various places, water leaks have been reported.

c) The affected area has very poor sanitation, and many people dispose of their waste in the street. Several people noted that the tap water was turbid.
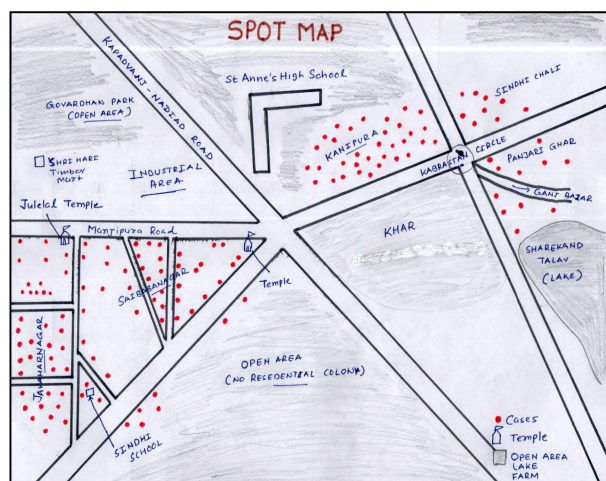

Figure 2: Geographical distributions of Cholera cases. (Spot map)

Table 4: Distribution of Cases and control by uses of water purification method

	Affected household	Non affected household
No method of water purification using	19 (63.33)	38 (54.29)
Any method of water purification using	11 (36.67)	32 (45.71)
Total	30	70
Odds Ratio = 1.45, Chi square = 0.7014, P value = 0.4023		

Considering the above finding, clinical presentation of cases and laboratory confirmation of cholera in cases led us to a probable diagnosis of an outbreak of cholera. We eliminated other possible diagnoses such as food poisoning for such epidemics. It was hypothesized that water had been contaminated with sewage through pipeline leaks and that the water was the source of infection.

Bacteriological water analysis was carried out to prove faecal contamination of water and water was the source of infection. Water samples were collected from three different highly affected areas and sent to a public health laboratory to detect coliform bacteria by multiple tube methods. One out of three samples showed the presence of the bacteria, and the same sample showed no free chlorine.

As depicted in Table 4, the findings of the analytical epidemiological study revealed that households not using water purification methods were 1.454 times more affected than households using any method of water purification. This difference was not statistically significant.

DISCUSSION

The cause of this epidemic was confirmed as cholera. The outbreak included a total of 158 cholera cases. A single peak in the epidemic curve was observed in our study. Outbreak investigation conducted in Kolar, South India, by R. Deepthi et al. shows the single peak.[10]

From a demographic perspective, this study did not find significant sex discrimination. However, in the Cholera outbreak in Assam, females were more affected.[15] Cholera outbreak in Wardha, Maharashtra reported by Goswami S. et al shows that males were most affected compared to females.[3] But it may be by chance because no biological characteristics are identified yet that make males or females more susceptible.

Younger age group (0-5 years) of age were more affected in this outbreak. A study of Goswami S. et al. also shows the highest attack rate in the 0-10 years age group.[3] In the Cholera outbreak in the tea garden of Assam maximum affected was from 21-30 years of age.[15] A higher number of cases may be due to a higher proportion of the population from the younger age group. Under-five children may be more susceptible because of lack of acquired immunity.

The main symptom of cholera is diarrhoea. 53.16 % of cases reported only diarrhoea as the main symptoms. Rest cases reported diarrhoea with vomiting. Cases range from mild symptoms to severe infections. The majority of the cases in this outbreak required to take indoor treatment shows that they may be suffering from the moderate to severe nature of the illness. Only one death was reported. The case fatality rate is 0.63%. Cholera Outbreak in Panchkula reported by Manoj et al shows that the majority of infections are mild or asymptomatic.[9] Early diagnosis

and timely treatment can reduce the significant case fatality.

The intervention began on 1st July 2021. The public works department checked water pipelines and found some leakages, which were corrected. Chlorination of the water was carried out, so the residual chlorine was maintained at 0.5 ppm at the household level. The number of cholera cases declined steadily after 1st July, suggesting chlorination is effective against faecal contamination and prevents the spread of cholera.

In India, water contamination has been commonly identified as the source of infection during outbreaks of cholera.[11] This outbreak occurred because of water contamination. In our study, the presumptive Coliform count was not satisfactory based on the multiple tubes' method, and there was no residual chlorination. An outbreak investigation carried out by Goswami S. et al. also showed that microbiological examination of water shows water contamination and water was the source of infection.[3]

CONCLUSION

Clinical, epidemiological, and microbiological evidence confirmed that the present outbreak was of cholera. From the explosive nature of this outbreak, it was common source epidemic. It appeared that the most probable cause was contamination of drinking water sources and transmission through the faecal-oral route. Additionally, the environment was contaminated by indiscriminate defecation and low personnel and household hygiene levels, which perpetuated the community's infection.

The contamination of drinking water was caused by leaks in water pipelines coupled with poor environmental sanitation. Health education, repairs of leaking pipes, and chlorination of water supply led to the early control of the outbreak.

Safe drinking water, proper sewer system, and clean environmental sanitation must be available to everyone, especially in slums.

The introduction and spread of cholera in non-endemic zones are an epidemiological curiosity. Long-term preservation of cholera bacteria in the environment calls for further research.

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