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Cholera outbreak in a village in south India — Timely action saved lives

R. Deepthi[a,*], S.R. Sandeep[b], M. Rajini[c], H. Rajeshwari[a], Achal Shetty[a]

[a] *Department of Community Medicine, Sri Devaraj Urs Medical College, Sri Devaraj Academy of Higher Education and Research, Kolar, India*
[b] *Sri Devaraj Urs Medical College, Sri Devaraj Academy of Higher Education and Research, Kolar, India*
[c] *Department of Microbiology, Sri Devaraj Urs Medical College, Sri Devaraj Academy of Higher Education and Research, Kolar, India*

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Summary Cholera remains a public health concern in developing countries because of its high morbidity and mortality. This study was designed to assess the magnitude of and factors responsible for an outbreak in a South Indian village and to implement measures for containing and preventing the recurrence of such outbreaks. Data was obtained by surveying households in the village to identify cases and assess factors responsible for the outbreak. A sanitary survey of the water supply system was performed to identify the cause of the outbreak. Preventive measures were implemented by setting up a rapid response team to manage cases and provide safe drinking water and health education regarding the prevention of such outbreaks. A total of 73 cases were reported during the outbreak, an attack rate of 17.5%. Attack rates were similar among males and females, and the highest rates were observed among the elderly (33.3%), while the lowest rates were observed among adults (14.7%). There were no deaths reported due to cholera in the village. Most households (81%) surveyed did not use any method of water purification, 79.7% practiced open field defecation and 58.2% practiced inadequate hand washing, indicating poor sanitary practices. Cases were most commonly observed in houses which did not practice any method of water purification ($p < 0.001$) and among people living below the poverty line ($p = 0.02$). Despite the high attack rate, no deaths were reported, largely thanks to timely medical and preventive interventions.

Introduction

Cholera remains a global threat to public health and a key indicator of a lack of social development

* Corresponding author at: No — A3 (Upstairs), SDUMC Staff Quarters, SDUMC, Tamaka, Kolar 563101, Karnataka, India. Tel.: +91 9731885405; fax: +91 8152243006.
E-mail address: drdeepthikiran@gmail.com (R. Deepthi).

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[1]. Cholera outbreaks typically occur in developing countries that lack access to safe drinking water and proper sanitation [2]. More than 150 years after John Snow famously removed the water pump handle in London, outbreaks of cholera continue to be reported worldwide. In the year 2008, the World Health Organization (WHO) registered a total of 190,130 cases, including 5143 deaths, with a case-fatality rate of 2.7% [3]. In the Asian region, the Indian subcontinent continues to harbor a major percentage (78%) of the cholera cases. Outbreaks of cholera, including major epidemics, have occurred repeatedly in various places in India [4–8].

The availability of potable drinking water for a large proportion of the Indian population is a major public health concern [9]. Ageing subterranean pipelines with multiple breakages are a common phenomenon in India. In addition, in many parts of India with a piped water supply system, water pipes and sewage channels are laid beside each other, possibly for engineering convenience [9,10]. Cholera outbreaks have resulted in deaths in India when there is delay in the diagnosis and treatment of cases [6,11]. Therefore, an outbreak investigation was conducted when a cholera outbreak occurred in the village Chikkapura to assess the magnitude of and the factors responsible for the outbreak and to implement suitable medical and preventive measures for containing and preventing the recurrence of such outbreaks.

Methods

Case definition

The definition of cholera is ''any person 5 years of age or older in whom severe dehydration develops or who dies from acute watery diarrhea; caused by *Vibrio cholera*'' the age limit can be lowered to 2 years for cases associated with confirmed cholera outbreaks, as recommended by the WHO [12].

Epidemiological data collection

A cross-sectional study was performed in a rural area called Chikkapura, Kolar district, Karnataka, South India. On the 15th of February 2010, our index case, a 38-year-old pregnant mother from Chikkapura, Kolar, presented with acute gastroenteritis to R.L. Jalappa Hospital, Kolar. She reported that many others in the village were suffering from similar complaints and seeking treatment from various hospitals. A stool culture of the patient grew *Vibrio cholerae*, Ogawa serotype. A rapid survey of the village was conducted by a team of doctors using a structured questionnaire. A house-to-house survey was performed to collect basic demographic information, including socioeconomic status, to identify cases with diarrhea and vomiting and to obtain detailed epidemiological information. The questionnaire contained information regarding the date of diarrhea onset, associated symptoms and nature of treatment undertaken. Residents were also questioned about food eaten outside the home in the week preceding the illness, their history of travel outside of the village and similar illnesses in other family members in the preceding week. The questionnaire also inquired into the source of drinking water, the method of drinking water purification, hand washing practices and the use of sanitary latrines for individual households. Stool samples were collected from five active cases to confirm the diagnosis. An area map of Chikkapura was drawn, and houses with cases were identified. The village was declared free of cholera when twice the incubation period, i.e., 10 days, had elapsed since the death, recovery or isolation of the last case.

Families were classified as below the poverty line (BPL) or above the poverty line (APL). BPL for rural areas in India is based on the degree of deprivation with respect to 13 parameters, with scores from 0 to 4: landholding, type of house, clothing, food security, sanitation, consumer durables, literacy status, labor force, means of livelihood, status of children, type of indebtedness, reasons for migrations and a family of five spending less than Rs 3905. Accordingly, families having less than 15 marks out of a maximum of 52 marks were classified as BPL, and the remaining families were classified as APL families [13].

Sanitary inspection of the water supply system

The source of the water supply, which was a borewell, a pipeline from the borewell to an overhead tank, valves, and a pipe system supplying the houses, was inspected. Water samples were taken from the borewell, tank, stand post, from a house where water is stored and from tankers temporarily supplying water. Water samples were tested for presumptive coliform counts and for the presence of *V. cholerae* using standard methods.

Key informant interviews

Interviews were carried out with the treating medical officer, a female junior health assistant, a health worker from the village, the Gram panchayat

Table 1 Age, gender, socioeconomic status specific cholera attack rates among study population — person distribution.

	Frequency (%)	No. of cases (%)	Attack rates in % (95% CI)
Gender			
Male	203 (48.7)	36 (49.3)	17.7 (13.1—23.6)
Female	214 (51.3)	37 (50.7)	17.3 (12.8—22.9)
Age			
<5 years	28 (6.7)	5 (6.9)	17.9 (7.9—35.6)
6—17 years	94 (22.5)	19 (26.0)	20.2 (13.3—29.4)
18—59 years	265 (63.5)	39 (53.4)	14.7 (11.0—19.5)
>60 years	30 (7.2)	10 (13.7)	33.3 (19.2—51.2)
Socioeconomic status			
BPL	209 (50.1)	41 (56.2)	19.6 (14.8—25.5)
APL	208 (49.9)	32 (43.8)	15.4 (11.1—20.9)
Total	417 (100)	73 (100)	17.5 (14.2—21.4)

president, the Taluk health inspector and a few residents of the village.

Statistical analysis

Data were entered into Microsoft Excel 2007, and statistical analyses were performed using the Epi Info 7 software. Attack rates with 95% confidence intervals (CIs) were calculated. A two-tailed χ^2 test was used to test for differences in proportions between affected and unaffected households.

Results

Study area and population

Chikkapura is a village located 25 km from the Kolar district headquarters and around 35 km from Sri Devaraj Urs Medical College. In 2010, the total population of the village was 417 and was composed of 214 females and 203 males in 79 households predominantly consisting of people from the backward caste. Of the total households, 50.6% were below the poverty line,. The village is covered by the Huralegere subcenter under the Lakkur Primary Health Centre. It has an Anganwadi, which is a government organization for villages that caters to the needs of preschool children and pregnant and lactating mothers.

Attack rates of cholera

Table 1 shows the age, gender and socioeconomic status distribution, the distribution of cases and the age, gender and socioeconomic status-specific attack rates with 95% CIs for the outbreak. There were a total of 73 reported cases of cholera, amounting to an attack rate of 17.5%. The attack rates among males and females were nearly equal, at 17.7% and 17.3%, respectively. Five (6.9%) of the cases were children under five, and 10 (13.7%) of the cases were elderly. The attack rates were highest among the elderly, at 33.3%, and lowest among adults, at 14.7%. There were no deaths reported due to cholera in Chikkapura.

Fig. 1 shows the epidemic curve of the cholera outbreak and indicates the key actions taken in Chikkapura. Narayanamma, a 50-year-old female, was the primary case, reported on February 11th 2010. She complained of severe watery stools and vomiting, for which she was admitted to the Government Hospital, Malur. She did not provide a history of travel outside the village or eating outside the house in the past month. This report was followed by four cases on February 15th. Cholera was confirmed when stools were sent for identification. On February 16th, there were 41 reported cases of diarrhea, and a rapid response team was immediately set up in the Anganwadi center of the village. The cases were treated with antibiotics, an oral rehydration solution and intravenous fluids according to the severity of the case in the village itself. Critical cases requiring further care were referred to the Taluk hospital for more intensive treatment. All stool samples showed darting motility in hanging drop preparations, and the organism was cultured on thiosulfate citrate bile salt sucrose media.

Findings of the sanitary survey

The source of water for the village is a borewell situated approximately one kilometer from the village. Water from the borewell is pumped into a water tank situated near the Anganwadi. Every day,

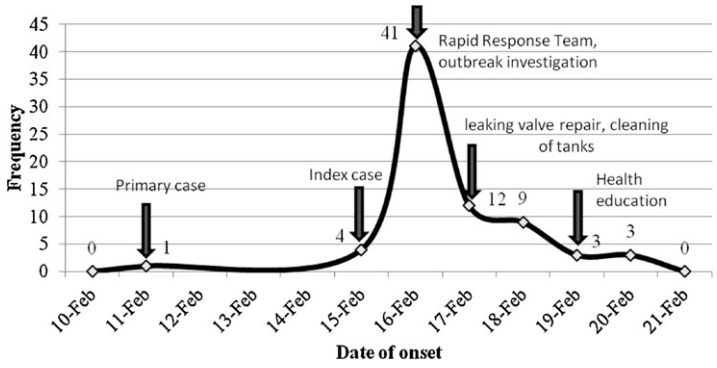

Figure 1 Epidemic curve of cholera outbreak including key actions taken — time distribution.

the morning water is supplied through pipes to the village houses. A leaking valve was identified near the water tank. The water distribution pipe ran through the drainage floor. All houses use this water for domestic use and drinking. Water is generally stored in pots, vessels and drums, although a few houses use sumps. Water samples collected from all sources were not potable, as the water contained coliform organisms. On the spot map, the whole village was affected, and no clustering of cases was observed.

Table 2 shows the association between sanitary practices and the occurrence of disease in households. According to the results of the questionnaire, 81% of households did not purify their drinking water. The remaining 19% used boiled water, candle-filtered water or packaged drinking water. Of the affected households, 52 (92.9%) did not drink purified water, a difference that was identified as statistically significant. Forty-four (78.6%) of households practiced open field defecation, a practice which showed no association with the occurrence of disease in the household. We observed that hand washing practices were similar for all members of a given household. Hence, hand washing practices were considered on a per-household basis. All households washed their hands after defecation and before consuming food, but 33 (58.9%) of the households washed only with water and did not use soap or ash. Washing hands with only water displayed no statistical association with occurrence of the disease. There were a significantly higher number of cases from households belonging to BPL compared to APL households.

Management of water supply

The water supply to houses from the village tank was stopped completely. Water was supplied in tankers from Taluk headquarters and people were provided with packaged water for drinking. The leaking valve on the water distribution pipe running through the drainage floor was replaced, and the location of the pipe was shifted. The tank was cleaned with bleaching powder. The chlorine demand for the water supply was estimated and

Table 2 Relationship between sanitary practices and socioeconomic status with households affected with cases.

Household characteristics	All households	Affected households	*p*-Value
Method of water purification			
No method of purification	64 (81.0)	52 (92.9)	<0.001
Some method of purification	15 (19.0)	4 (7.1)	
Place of defecation			
Open field	63 (79.7)	44 (78.6)	0.77
Sanitary latrines	16 (20.3)	12 (21.4)	
Hand washing practices			
Only with water	46 (58.2)	33 (58.9)	0.84
Soap and water	33 (41.8)	23 (41.1)	
Socio economic status			
Above poverty line	39 (49.4)	23 (41.1)	0.021
Below poverty line	40 (50.6)	33 (58.9)	
Total	79 (100)	56 (100)	

the water in the tank was chlorinated. The local authority was advised to chlorinate the water every morning. All disease cases were educated regarding the use of boiled water and hand washing practices during house visits and treatment.

Health education on the occurrence, causes, management and prevention of diarrheal diseases was organized and conducted in the village for all residents. Emphasis was given to water purification, adequate hand washing practices and the use of sanitary latrines.

Discussion

This cholera outbreak included a total of 73 cases, with an attack rate of 17.5% and equal attack rates among men and women. Attack rates were the highest among the elderly (33.3%), followed by children between 6 and 17 years of age (20.2%). There were no deaths reported in the village. A single peak in the epidemic curve was observed in our study.

Similar attack rates have been observed in previous studies in India. Deepa et al. and Phukan et al. reported lower attack rates of 13.4% and 11.6%, respectively [6,14]. Previous studies in India have reported case fatality rates of 0.8—4.2%. In the present study, most of the cases were adults (67.1%), a result similar to that observed in other studies [6,11]. Deepa et al. observed a bimodal distribution of cases in their study [6].

The water supply for the village was a single borewell, and the water was contaminated at the source. This contamination may be the result of many (79.7%) households practicing open field defecation in the village. Water in the tank was also contaminated, as the tank was not regularly cleaned. Water collected from a tap near the households was also contaminated, likely due to leaking valves and a damaged water pipe running through the floor drainage.

The availability of potable drinking water for a large proportion of the Indian population is a major public health concern [9,10]. Breakages in water distribution pipes are a common phenomenon in India [10]. In addition, in many parts of India with a piped water supply system, water pipes and sewage channels are laid beside each other, possibly for engineering convenience. When any pathogen with the potential for causing an outbreak enters a water delivery system, there is a marked increase in the likelihood of an outbreak [9]. In most parts of India, the water supply is intermittent, thereby increasing the risk of contamination because of the negative suction pressure during the supply intervals [9].

Water collected from the site of consumption also contained microorganisms, a problem that is exacerbated because 81% of the households did not practice any method of water purification. Fifty-eight percent of the households did not practice adequate hand washing. In rural areas in India, water disinfection relies on single point chlorination. Irrespective of the source of drinking water, purification of water and good hand washing practices play a protective role against acquiring disease among individuals.

Early identification of the outbreak and timely interventions, such as early diagnosis and prompt treatment, are essential in all outbreaks. The provision of safe and wholesome drinking water remains a key to preventing such outbreaks. Continuing preventive measures, such as identification and repair of water distribution systems and regular cleaning and chlorination of tanks should be promoted. Health education on the use of purified drinking water, adequate hand washing practices and the use of sanitary latrines should be conducted on a regular basis to encourage behavioral change.

Conflict of interest statement

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Competing interests: None declared.

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