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Original Research

Cholera outbreak in a rural south - south Nigerian community: A case-control study

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Abstract

Background: Cholera remains a disease of public health importance in Nigeria associated with high morbidity and mortality. On the 4th of June 2024, the Nigeria center for disease and control prevention (NCDC) through the Disease Surveillance and Notification Officer (DSNO) reported an increase in the number of reported cases of vomiting and diarrhea in Toru-Orua village, Sagbama Local Government Area Council, Bayelsa State, Nigeria. A team of researchers were deployed to investigate the outbreak with the objectives of verifying the diagnosis, identifying risk factors and instituting appropriate control measures to control the outbreak.

Methodology: We conducted a case-control study. We defined a cholera case as any person aged ≥5 years with acute watery diarrhea in Toru - Orua community. We identified community controls. A total of 93 cases and 118 controls were recruited. Structured questionnaires were administered to both cases and controls. Four stool samples from case-patients and two water samples from the community water source were collected for laboratory investigation. We performed univariate and bivariate analysis using Epi-Info version

Results: The mean age of cases and controls was 20.3 years and 25.4 respectively (p value 0.09). Females constituted 50% (cases) and 60% (controls). The attack rate was 4.3% with a case fatality rate of 13%. Four stool (100%) specimen tested positive for Vibrio cholerae. The water source and environment were polluted by indiscriminate defecation. Compared to controls, cases were more likely to have drunk from the river forcados (OR 14.2, 95% CI: 5.5–36.8) and living in households (HH) with more than 5 persons/HH (OR 5.9, 95% CI: 1.3–27.2). Good hand hygiene was found to be protective (OR 0.3, 95% CI: 0.1–0.7).

Conclusion: Vibrio cholerae was the cause of the outbreak in Toru - Orua. Drinking water from river forcados, living in overcrowded HH and poor hand hygiene were significantly associated with the outbreak. We initiated hand hygiene and water treatment to control the outbreak.

Keywords: Cholera; Vibro Cholrae; Outbreak; Assymptomatic.

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Introduction

Cholera remains a global threat to public health and a key indicator of lack of social development. Cholera, an acute diarrheal disease caused by gram-negative bacillus *Vibrio cholerae of* serogroup 01 and 0139, is associated with high morbidity and mortality [1,2,3].

The onset of cholera often starts with stomach cramps, vomiting and diarrhoea, and if left untreated may progress to fluid losses of up to 1 litre per hour, resulting in severe dehydration and metabolic acidosis, and consequently kidney failure, shock, coma, and death. About 50% of cholera cases are asymptomatic. Asymptomatic cases shed vibrios in their stools and serve as a potential source of infection to others. Symptomatic patients may also shed vibrios before the onset of illness and will continue to shed the organisms for about 1 to 2 weeks [1, 3, 4].

Cholera is transmitted through the fecal-oral route via contaminated food, carriers and unsanitary environmental conditions. Cholera outbreaks tend to occur because of contamination of food or water with *Vibrio cholera* organisms due to poor personal hygiene, unsafe environmental sanitation conditions compounded by lack of potable water supply. Internal displacement of persons by natural and man-made disasters leading to unstable living conditions with contamination of food and water sources have also been reported to cause cholera outbreaks [5,6,7].

Globally an estimated 3 to 5 million cholera cases and 28,000 to 150,000 deaths occur yearly. However, the infection is common to developing countries in the tropics and subtropics with high human poverty index [2, 8, 9]. Cholera is endemic in Africa, parts of Asia, Middle East, and South and Central America [10]. In Africa, there have been recurrent cholera outbreaks, characterized by a large disease burden and high case-fatality rates. African countries accounted for 3,316,201 (46%) of the suspected cholera cases reported to the WHO from 1970 to 2012. In 2012, sub-Sahara Africa recorded 71% of all reported cases and 86% of cholera deaths [11, 12]. In 2013, a total of 129,064 cases were notified from 47 countries, including 2102 deaths; the World Health Organization (WHO) however believes the officially reported cases account for not more than 5–10% of the actual disease burden. The discrepancy between the reported figures and the estimated burden of the disease could be ascribed to poor surveillance and laboratory systems. Political motives such as fear of trade and travel sanctions have also been implicated [8, 9].

Nigeria is reported to be one of the three major current cholera foci in the world [13]. The first series of cholera outbreaks in Nigeria were reported between 1970 to 1990, subsequently recurrent outbreaks followed [14]. In 2010, Nigeria reported a total of 41,787 cases with 1716 deaths from 18 northern states with case fatality rate [CFR] of 4.1%. This CFR exceeded the mean overall CFR of 2.4% reported in Africa from 2000 to 2005 and the 1% WHO acceptable rate [2, 15]. The 2010 outbreak was attributed mainly to contamination of water supplies with diarrhoea discharge of untreated cholera patients during the rainy season. This therefore, brought to the focus the vulnerability of Nigerian rural communities [1]. On 4th June 2024, the Nigeria center for disease and control prevention (NCDC) through the Disease Surveillance and Notification Officer (DSNO) reported an increase in the number of reported cases of vomiting and diarrhea in Toru-Orua village, Sagbama Local Government Area Council, Bayelsa State, Nigeria. The Bayelsa State Ministry of Health, Public Health department was notified of the outbreak. An outbreak response team was immediately mobilized and deployed to Toru-Orua village. The team investigated the outbreak with the objectives of verifying the diagnosis, identifying risk factors and instituting appropriate control measures to control the outbreak.

Materials and methods

A case control study was conducted to identify associated risk factors of the cholera outbreak. Laboratory analysis of stool and water samples from the community was carried out and appropriate control measures were instituted.

Study area

The case control study was conducted in Toru-Orua community, Sagbama Local Government Area (LGA) *Bayelsa State*. Toru-Orua community in the south – south region of Nigeria has an estimated population of about 2000 people. The main economic activities amongst Toru-Orua community residents are farming, petty trading, and fishing. The River Forcados serves as the major source of drinking for most Toru-Orua community residents. Toru-Orua community has one primary health center (PHC).

Study population

Study participants constituted of 93 recently identified cholera cases and 118 community controls identified in Toru-Orua community, Sagbama Local Government Area (LGA) Bayelsa State. Cases and controls were recruited into the study using the following definitions.

Case definition: *We defined a suspected case of cholera as "any person or patient aged 5 years and above with acute watery diarrhea with or without vomiting living in Toru-Orua community from May 14th to June 14th2024".*

Control definition: *We defined a control as "any person living in Toru-Orua community from May 14th, 2024, to June 9th, 2024". Who did not show any sign of diarrhea between the ages of 5years and above*

Identification of cases and recruitment of controls: We obtained a line list of all cases (previously and currently) admitted at the Toru-Orua community PHC from the Disease Surveillance and Notification Officer. A community active case search was conducted, and all cases meeting case definition were recruited. Information on age, sex, residence, date of onset of illness, signs, symptoms and outcome were obtained from cases and used to generate hypotheses about potential exposures that were common to the cases. In households with multiple cases, all cases were recruited in the study. Controls were systematically recruited in the community. Starting from households that reported cases, we visited the second household to the right of the case household. In the selected households all members of the household were listed, and 1 member selected randomly as a control. Only 1 control was selected even for case households with more than 1 case. Interviews with the control group, household members who had reported a history of vomiting and diarrhea were excluded.

Sample size calculation: Using a 95% confidence interval, power of 80%, odds ratio (OR) of 4 and case to control ratio of 1:1.5, a sample size of 44 cases and 116 controls was calculated using Epi Info version 7.1.3.10 StatCalc. However, 93 cases and 118 controls met the inclusion criteria and were recruited for the study.

Study instrument: Interviewers administered a structured questionnaire to cases and controls in English and Izon languages. The questionnaire captured socio-demographic information, clinical information (for cases), risk factors, and knowledge, attitude, and practice on cholera.

Laboratory investigations: We collected stool samples from four cases, and we tested the samples using cholera rapid diagnostic test kits. Four case samples out of the 93 cases were collected because not all the patients were assessable at the time especially as it was in a time of emergency and in a resource – poor setting where public health infrastructure is limited.

Environmental assessment: We collected water samples from the Forcados River. The samples were sent to University of Africa, Toru – Orua Microbiology Laboratory for isolation of *Vibrio cholerae* using Thiosulfate Citrate Bile Salts Sucrose agar (TCBS) culture media. Activities and practices in and around the source of water supply to the community that is mainly the River Forcados were noted. Using the WHO guidelines for drinking water quality to ensure standardization, drinking water storage facilities were also inspected.

Data management: We conducted univariate and bivariate analysis using Epi Info 7.1.3.10. We characterized the data in person, place and time. We calculated cholera incidence by age and sex. The outbreak timeline was summarized as an epidemic curve. Cases were compared with controls by calculating of odds ratio with 95% confidence intervals.

Ethical considerations

Informed oral consent was obtained from the participants before the interviews because the outbreak was in rural setting and most respondents were uneducated and unable to read and write. Confidentiality of the respondents was ensured through data coding. Due to the exigencies of the response, the Bayelsa State Ministry of Health Research Ethics Committee waived the ethics approval. Permission was obtained from the department of public health Sagbama Local Government Area (LGA) during the response and preliminary report of the outbreak was discussed with the Pere of Toru-Orua community and Sagbama LGA public health team.

Results

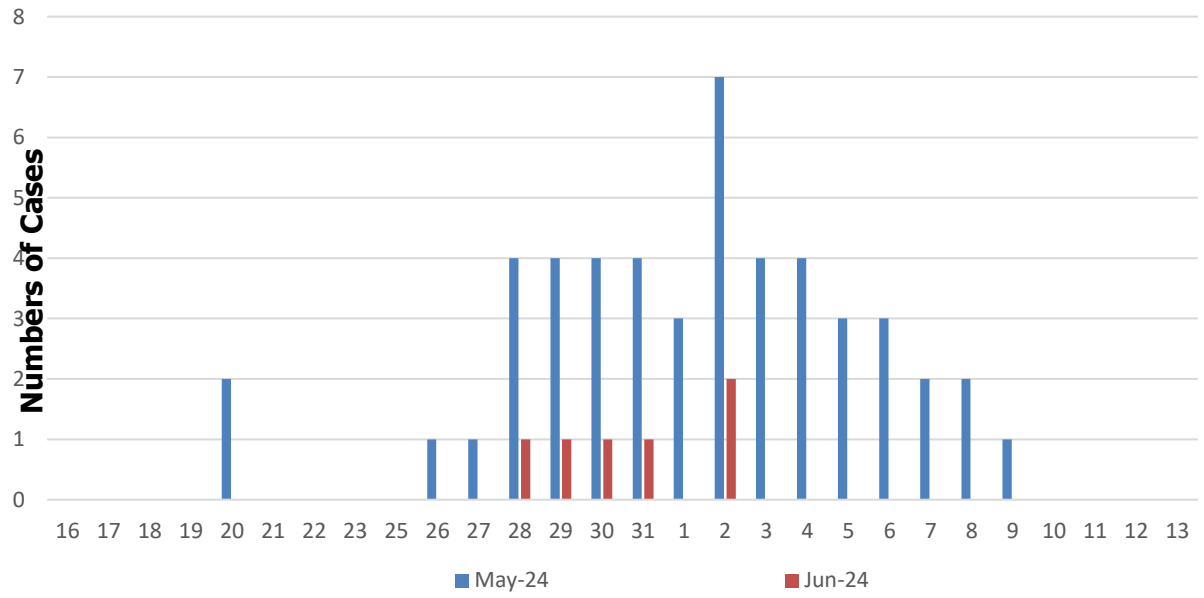
Table 1 shows a total of 211 participants were recruited for the case-control study of which 93 were cases and 118 controls. The mean age of cases and controls was 20.3 years and 25.4 respectively (*p* value 0.09). Females constituted 23.7% (cases) and 28.4% (controls). The proportion of those aged 30 years and above was 10.4% among cases and 17.1% among the controls. Overall, 44.5% of the study participants had secondary education (cases 17.1%, controls 27.4%). Christianity was seen to be the most practiced religion among the participants (cases 36.5%, controls 46.4%). Farming was the most predominant occupation with 18.5% of cases being farmers compared to 28.9% of controls.

TABLE 1

Characteristics	Cases *n* (%)	Controls *n* (%)	Total *n* (%)
Total	93 (44.1)	118 (55.9)	211(100)
Sex			
Female	50 (23.7)	60 (28.4)	110 (52.1)
Male	43 (20.4)	58 (27.5)	101 (47.9)
Age Group			
5–9	28 (13.2)	31 (14.7)	59(24.9)
10–19	16 (7.6)	26 (12.3)	42(20.0)
20–29	28 (13.3)	24 (11.4)	52 (24.7)
30 & above	22 (10.4)	36 (17.1)	58 (27.4)
Religion			
Christian	77 (36.5)	98 (46.4)	175 (82.9)
Muslim	10 (4.7)	15 (7.2)	25 (11.9)
Traditionalist	6 (2.8)	5 (2.4)	11 (5.2)
Occupation			

Characteristics	Cases *n* (%)	Controls *n* (%)	Total *n* (%)
Petty trader	12 (5.6)	16 (7.5)	28 (13.3)
Farmer	39 (18.5)	61 (28.9)	100 (47.4)
Housewife	13 (6.1)	14 (6.7)	27 (12.8)
Student	31 (14.7)	25 (11.8)	56 (26.5)
Education			
None	12 (5.7)	13 (6.1)	25 (11.8)
Primary	25 (11.9)	27 (12.8)	52 (24.7)
Secondary	36 (17.1)	58 (27.4)	94 (44.5)
University	18 (8.5)	22 (10.4)	40 (18.9)

Figure 1 shows the epidemic curve of the outbreak. The index case was reported on the 20th of May 2024 with subsequent cases being reported within 5days of the index case reporting symptoms. The outbreak peaked on the 2nd of June 2024 and the last case was reported on 9th June 2024. The 6 cases that succumbed to death were reported in the second week of the outbreak and occurred before commencement of the response to the outbreak. The response was initiated on the 6th of June when the state authorities were notified of the outbreak. The outbreak was controlled on the 9th of June where no case was been reported.



Date of Onset

Fig 1: Epidemic curve of Cholera cases in Toru -Orua in Sagbama LGA, Bayelsa State from May to June 2024. With BLUE representing the number of persons alive and RED representing the number of deaths

The most frequently reported symptoms by the cases were diarrhea 93(100%), vomiting 48 (51.6%), abdominal cramps 15 (16.1%) and fever 20 (21.5%). The least symptom experienced by the cases was headache 10 (10.8%) (Fig. 2). The overall cholera attack rate was 4.7% with 93 cases and 7 deaths, case fatality rate of 7.5% among 2000 residents of the Toru – Orua community.

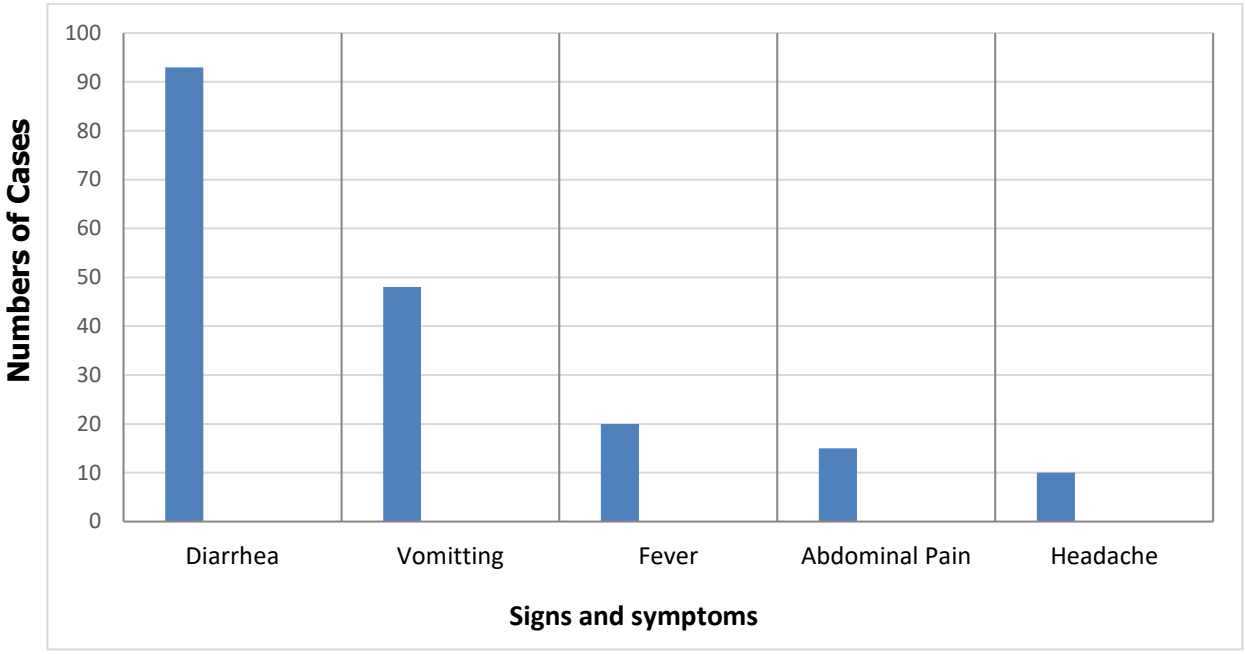


Fig 2: Signs and symptoms of Cholera cases in Toru - Orua, May - June 2024

Compared to the controls (81.7%), cases (23.8%) were more likely to get their drinking water from the river forcados than from other water sources available to them (OR 14.2, 95% CI: 5.5–36.8). Washing hands with soap or ash before eating was found to be a protective factor as controls had a 70% reduction in risk of acquiring the disease following hand washing (OR 0.3, 95% CI:1.4–10.3). Compared to controls, cases were 6 times more likely to come from households with > 5 persons (OR 5.9, 95% CI: 1.3–27.2) (Table 2).

Risk Factors	Cases (93) *n* (%)	Controls (118) *n* (%)	OR	95% CI
Drinking water source				
River Forcados	76 (81.7)	28 (23.7)	14.2	5.5–36.8
Other sources	17(18.3)	90 (76.2)	-	-
Hand washing with soap/ash before eating	16(17.2)	49 (41.5)	0.3	0.1–0.7
> 5 persons per household	87(93.5)	51 (43.2)	5.9	1.3–27.2
Drinking water storage container without cover	2 (4.7)	1 (1.5)	3.2	0.3–36.1
No formal education	22(23.7)	42 (35.6)	0.6	0.3–1.4
Lack of rack for drying plates	11(11.8)	15 (12.7)	1.2	0.5–2.9

Table 2: Risk factors of Cholera outbreak in Toru - Orua, May 2024

All the four stool specimens tested positive for V.cholera using rapid test kit while the river forcados sample yielded material growth of coliforms. The river forcados was found to be macroscopically clean with high current flow, the growth of coliform in the river might have been due to, mass bathing, washing of clothes and indiscriminate defecation in and around the riverbank and inside the river. The community has only three non-functional boreholes at the time of the study. We observed that majority (97%) of the residents defecate at the bushes behind their houses, and 3% used shallow pit latrines. Waste management was found to be poor with refuge heaps littered around houses.

Compared to the controls (81.7%), cases (23.8%) were more likely to have water from the river forcados as their drinking water source than other sources (OR 14.2, 95%CI: 5.5–36.8). Washing hands with soap or ash before eating was found to be a protective factor as controls had a 41.5% reduction in risk of acquiring the disease following hand washing (OR 0.3, 95% CI:1.4–10.3). Compared to controls, cases were 2 times more likely to come from households with > 5 persons (OR 5.9, 95% CI:1.3–27.2) as seen in Table 2.

Discussion

The epidemiologic and environmental evidence indicated that the cholera outbreak resulted from drinking water from the river forcardos. Poor personal hygiene and overcrowding were also identified as major risk factors for acquiring the disease. These findings agree with similar studies in Nigeria [2, 10]. However, many cholera outbreaks in Nigeria are not epidemiologically investigated to identify risk factors for the illness [16, 17] and therefore control measures are empiric without addressing specific risk factors associated with the outbreak. Lack of potable drinking water and insufficient awareness/education of communities on practical drinking water treatment strategies has kept many of the rural communities at risk of cholera once introduced in their communities.

The cholera epidemic affected all age groups in the community; although, age group 5–9 years had the highest proportion of cases. Our findings is in agreement with the studies done in Nigeria but contrary to the study done in Nepal where ≤5-year-olds were mostly affected although our study excluded this age group [2, 18].

From the epidemic curve, it can be suggested household contact could be an underlying factor for community-wide transmission of this outbreak. As the main source of drinking water in the community was contaminated and many of the community members exposed to infection. Given that only 5–10% of cholera cases present with classical symptoms it's likely that nearly half of the community members were infected. Deaths occurred earlier in the outbreak before response activities were instituted. Response activities would have been more effective in preventing cases and death if it was instituted timely. However, timely response is dependent on timely notification and confirmation of the outbreak hence the need for a more sensitive community-based reporting of public health events.

This study showed that washing of hands with soap and water before eating a meal was found to be a protective factor in our study. Similar findings by other studies have also indicated that use of soap and hand washing promotion can achieve a 26 to 62% decrease in the incidence of diarrhoea in developing countries [17, 19, 20]. Likewise, the 1995–1996 cholera outbreaks in Kano state were also attributed to not washing hands with soap before eating food [21]. This indicates that risk communication gaps still exist.

Cholera has been termed the "disease of poverty" as the social risk factor involved plays an important role in its transmission [22,23]. Significant association of cholera infection with overcrowding in our study is concomitant with this fact; moreover, our environmental assessment revealed poor environmental sanitation infrastructure like indiscriminate defecation in the environment due to lack of toilet facilities and improper waste management, these are conditions highly correlated with poverty and low socio-economic status.

Cholera exists as a seasonal disease in most countries [24]. In Nigeria, cholera infections have been reported in both wet and dry seasons, although the burden of cholera tends to increase during beginning of rainy and dry seasons [1, 25]. The Toru-Orua cholera outbreak occurred during the wet season, similar to the pattern observed in Lagos, South-western part of Nigeria, where cholera outbreaks mostly occurred during the wet season [26]. This could be attributed to scarcity of potable water during the wet season and

therefore the tendency of people to obtain drinking and cooking water from alternative sources with higher risk of contamination, which includes stagnant water bodies.

Control of cholera outbreaks requires effective surveillance and response systems which are often sub-optimal in developing countries and therefore this study accentuates the need for an effective surveillance system with the capacity to appropriately detect and contain cholera outbreaks timely [2, 27].

The long-term solution for cholera control lies in economic development through universal access to safe drinking water and adequate sanitation [28, 29]. Crucial cholera epidemic preventive mechanism remains providing a waste management system that separates waste from the water supply [30]. Oral cholera vaccines (OCV) that also are additional efficient tool to control cholera outbreaks are yet uncommonly used in Nigeria [8]. OCVs though not a replacement for conventional control measures like portal safe water and personal hygiene, could serve as a complementary measure [31, 32].

In Guinea, two complete doses of cholera vaccine during an outbreak were found to be associated with significant protection against cholera with 86.6% vaccine effectiveness [33]. Vaccine safety and conferment of 85% immunity for 4–6 months in all age groups was found in Bangladesh and Peru field cholera vaccine trials done, similarly another field trial in Kolkata, India obtained 65% vaccine efficacy of up to 5 years [8].

This finding serves as supporting evidence on the addition of vaccination as part of the response to cholera outbreaks and the need to plan and implement regular cholera vaccination programmes in cholera endemic countries such as Nigeria [33, 34].

Limitations of Study

The study was burdened with the several limitations including late notification of the outbreak which could be attributed to remote nature to the Toru – Orua community evidently delayed initiation of response. Nevertheless, response was commenced by the 6th of June 2024 though not timely but mitigated the outbreak.

We could also not entirely rule out the possibility of misclassification of cases as controls since most cholera cases are asymptomatic. However, we tried to minimize this selection bias by recruiting our controls from every two households to the right of the household of the cases where household members showed no signs and symptoms of diarrheal disease within the study period. Only recent cases were recruited for the study. Furthermore, confounders such as socioeconomic status and differences in age groups in the unmatched case-control study could have influenced the association found.

Despite these limitations, the study provided useful information to stakeholders on actions that will avert future outbreaks by provision of basic water, sanitation and hygiene infrastructures such as functional boreholes and standard pit latrines. Community risk communication and surveillance strategies need significant improvements to ensure prevention of adverse effects of diarrheal diseases in general and cholera in specific.

Conclusion

An outbreak of cholera was investigated in Toru – Orua community in Sagbama Local Government Area of Bayelsa State. It was established that drinking water from the river forcados was the major source of the outbreak. Poor personal hygiene and overcrowding were also identified as risk factors. On the interim health education on proper hand hygiene and chlorination of water were initiated based on our recommendation and this controlled the outbreak.

Implementation of targeted interventions such as rehabilitation of existing boreholes, construction of standard pit latrines and the establishment of proper waste disposal systems and developing innovative educational tools on water, sanitation and hygiene to teach the children in the community are long-term sustainability measures to prevent future outbreaks.

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