Outbreak of Cholera in Vea-Gunga, Upper East Region, Ghana, 2015: Interfamilial and household-level transmission

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Abstract

Background: Cholera is an acute infectious illness with profuse watery diarrhoea caused by toxigenic *Vibrio cholerae* serogroup O1 or O139. An estimated 1.4–4.3 million cases and 28000-142000 deaths occur yearly. In 2014, the Upper East Region (UER) of Ghana recorded 289 cholera cases with case-fatality of 3.1%.

On June 28, 2015, Bongo-District Hospital prompted the Bongo-District Health Directorate of a cholera outbreak at Vea-Gunga, in the Bongo District (BD), UER. We investigated to verify the diagnosis, determine the magnitude, identify etiological agent, source of infection and recommend control measures.

Methods: We perform a descriptive study. A suspected cholera case-patient was a person having acute watery diarrhoea with or without vomiting at Vea-Gunga from June1to July 20, 2015. Data was obtained by record review, interview with stakeholders and active case-finding from health facilities and communities. Stool from case-patients were taken for laboratory diagnosis and the environment was assessed. Data was analysed by person, place and time with Epi-info-version-3.5.1.

Results: Of 933 community members, 13 were affected and 69.2% (9/13) were females. The overall attack rate was 1.4% (13/933) and case-fatality 15.4% (2/13). The median and intra-quartile-range age of case-patients was 28.5 (1-50) years old. Sex-specific attack rates were 0.9% (4/447) and 1.6% (9/486) for males and females respectively. Almost all 85% (11/13) of affected cases-patients were close family members of the primary case, living on the same compound. *Vibrio cholerae* serotype *ogawa* was isolated from stool samples. We observed inadequate and unsafe water supply coupled with pollution of Vea-Dam.

Conclusions: *Vibrio cholerae* serotype *ogawa* caused the Vea-Gunga cholera-outbreak. Children and females were mostly affected. The probable sources of infection were person-to-person, contamination of drinking water or food. Boiling or chlorination of water, hand washing with soap and water were initiated and this played a significant role in controlling the outbreak.

1. Introduction

Cholera is an acute infectious illness with profuse watery diarrhea caused by toxigenic *Vibrio cholerae* serogroup O1 or O139. The short incubation period of 2 hours to 5 days enhances the potentially explosive pattern of outbreaks. Cholera is transmitted principally through fecal contamination of water or food. Among people who develop symptoms, the majority have mild or moderate symptoms, while a minority develops acute watery diarrhoea with severe dehydration. The disease can kill within hours if left untreated (1).

Cholera remains a significant public health problem in many parts of the world. There have been several outbreaks of the disease across the world (2). There is an estimated 1.4–4.3 million cholera cases and 28,000-142,000 deaths due to cholera every year. In 2015, 42 countries reported a total of 172,454 cases including 1,304 deaths, resulting in an overall case fatality ratio (CFR) of 0.8%. Of the cases reported globally, 41% were from Africa, 37% from Asia and 21% from Hispaniola. The number of cases reported from West Africa dramatically declined to 6,267 in 2015 as compared to 68,384 in 2014 (3).

Ghana recorded a massive outbreak of cholera in June 2014. Although The World Health Organization recommends that cholera case fatality rates (CFR) should not exceed 1% if cases are properly treated, cholera outbreaks have continued to kill >1% of the cases (4). For instance n the outbreak in Ghana, were 28,944 cases and 347 deaths (CFR: 1.2%). The Upper East Region reported 287 cases with nine deaths (CFR: 3.1%) within 11 out of the 13 districts. Bongo District of the Upper East Region (UER) had recorded no case of cholera from 2010 until June 2015 (5).

Environment-to-person transmission of cholera results from ingestion of contaminated water from environmental sources. Direct transmission results from exposure to food, water, and surfaces shared by a cluster of individuals, such as a household, and contaminated by an infectious member of the cluster. About 100 million bacteria must typically be ingested to cause cholera in a normal healthy adult (6). The relative contributions of environment-to-person and direct exposure to endemic cholera transmission are subject to ongoing debate (6**,** 7). Environment-to-person exposure is a well-established mode of transmission for cholera infection, whereas the relative contribution of direct exposure is poorly quantified (8, 9). Understanding how the diffusion of the pathogen responsible for cholera is facilitated by common daily interactions and behaviors can inform prevention efforts for this disease and those of a similar nature.

On June 28, 2015, Bongo District Hospital prompted the Bongo District Health Directorate (DHD) of a confirmed case of cholera in a 45-year-old man from Vea-Gunga village in the Bongo District (BD), UER. He presented with diarrhoea and vomiting at the hospital. On examination, he had sunken eyes and was lethargic. He had been referred from the Vea Health Centre. As a statutorily mandated duty and as part of disease outbreak and response, the Bongo District Disease Outbreak and Response Team immediately commenced an investigation into the outbreak. The composition of the team was the District Director of Health Services, The District Disease Control Officer, a physician assistant and the District Environmental Health Officer. On July 4, the Regional Disease Outbreak and Response Team was informed of the outbreak, and on July 5, joined the local team in the investigation.

We report the epidemiological investigation conducted to characterize the Vea-Gunga outbreak: verify and determine

the magnitude of the outbreak, identify etiologic agent, the source of infection and inform appropriate control measures.

2. Methods

2.1. Study Setting

The outbreak investigation was conducted from the June 28 to July 7, 2015, in Vea Gunga village of the Bongo District in the Upper Eastern Region of Ghana.

Bongo district is one of the 13 Districts in the Upper East Region with an estimated population of 84,545 based on 2010 census projections and has a total area of 459.5 square kilometers (11). The district has one hospital, six health centers and 36 community-based health planning and services (CHPS).

Vea Gunga is a remotely located village in the district. It has 933 inhabitants, a land area of about three square kilometers, and a dam which serves as the major source of drinking water for most of the community members. There is no health facility in the village. Most of the community members live close to each other in few compound houses leaving the vast land unoccupied (Figure 1).

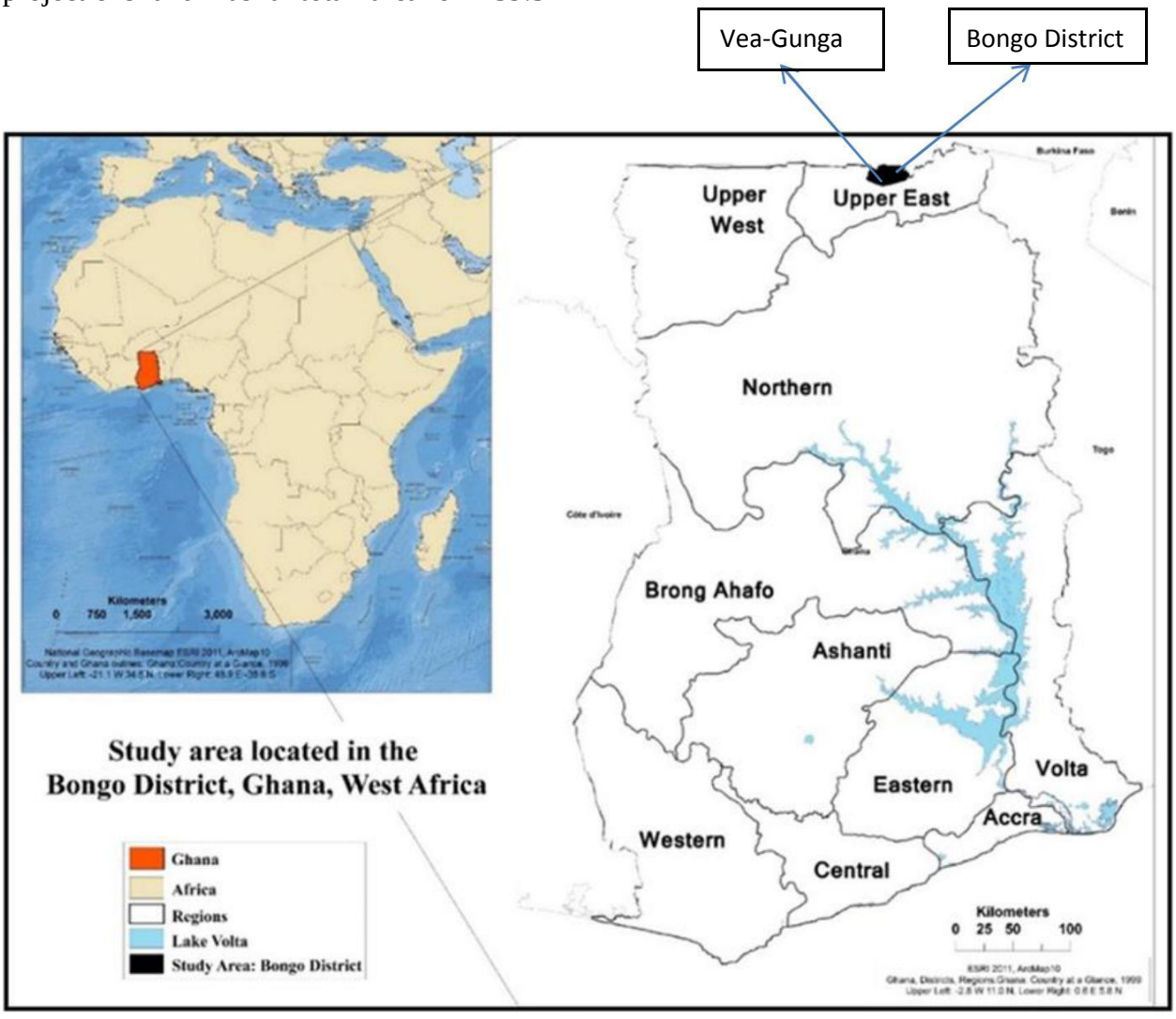

Figure 1: Map of Africa showing the location of Ghana, Upper East Region, Bongo District and the Vea-Gunga village.

The disease control systems in Bongo District fall within the purview of the Disease Control Unit of the Ghana Health Service, the Environmental Health Unit of the District Assembly and a number of Non-Governmental Organizations. No case of cholera had been confirmed in Bongo District of the Upper East Region from 2010 (5).

2.2. Study Design

We performed a descriptive study. We interviewed the District Health Management Team to obtain first-hand information on the outbreak. We reviewed surveillance data and the initial line-list generated by the District Disease Control Officer using a Microsoft Excel spreadsheet.

2.3. Case Definition and case finding

Based on the initial information gathered we defined a cholera case-patient as a person having acute watery diarrhoea with or without vomiting at Vea Gunga from June 1st to July 20th, 2015.

The demographic and clinical details of the suspected case-patients were collected from the hospital records, the community and denominator data from the records of the Subdistrict.

We conducted an active case search from nearby health facilities, interviewed health staff and community members to trace other cases and contacts to identify a common source of infection. Data abstracted included age, sex, date of onset, date of presentation at the health facility, signs and symptoms and outcomes. We drew a spot map, constructed an epidemic curve, and calculated the attack rates by age-groups.

2.4. Laboratory Investigations

We collected five stool samples from affected community members and tested them with the rapid diagnostic test kits (RDTs) [16IC101-10, Span Diagnostics, Surat, India] for cholera. One sample tested positive and was cultured for Vibrio. Colonies of growth were evaluated and vibrio cholera-positive isolates were serogrouped and serotyped using agglutination tests with commercial antisera.

2.5. Environmental Survey

We inspected the Vea-Gunga community for different sources of water used for drinking, cooking, domestic purposes, refuse dumping sites and toilet facilities to identify the possible sources of the outbreak. We also inspected conditions for food preparation and handling in the community.

2.6. Data Management and Statistical Analysis

Data were entered into Epi Info software version 7™ [US Centers for Disease Control and Prevention, Atlanta, Georgia] for data aggregation, cleaning, and analysis. We performed descriptive analysis of the outbreak data by person, place and time using frequency distributions, percentages, means, standard deviation and rates (i.e., attack rates, case-fatality rates)

2.7. Ethical considerations

This investigation was conducted as part of health system process improvement and service-based learning in the Upper East Region. Official permission was obtained from the Regional Director of Health Services for the use of the data. We ensured the confidentiality of the Cholera case-patients through the use of de-identified and coded data.

3. Results

3. 1. Distribution of cholera cases by person

Among the 933 community members, 13 were affected by cholera. The overall attack rate was 1.4% (13/933) with a case fatality of 15.4% (2/13). The median and intra-quartile range age of case-patients were 28.5 (1-50) years old. Female case patients were mostly 69.2% (9/13) affected (Figure 2). Sex-specific attack rates were 0.9% (4/447) and 1.6 % (9/486) for males and females respectively. Almost all 85% (11/13) of the affected cases patients were close family members of the primary case, and they lived on the same compound.

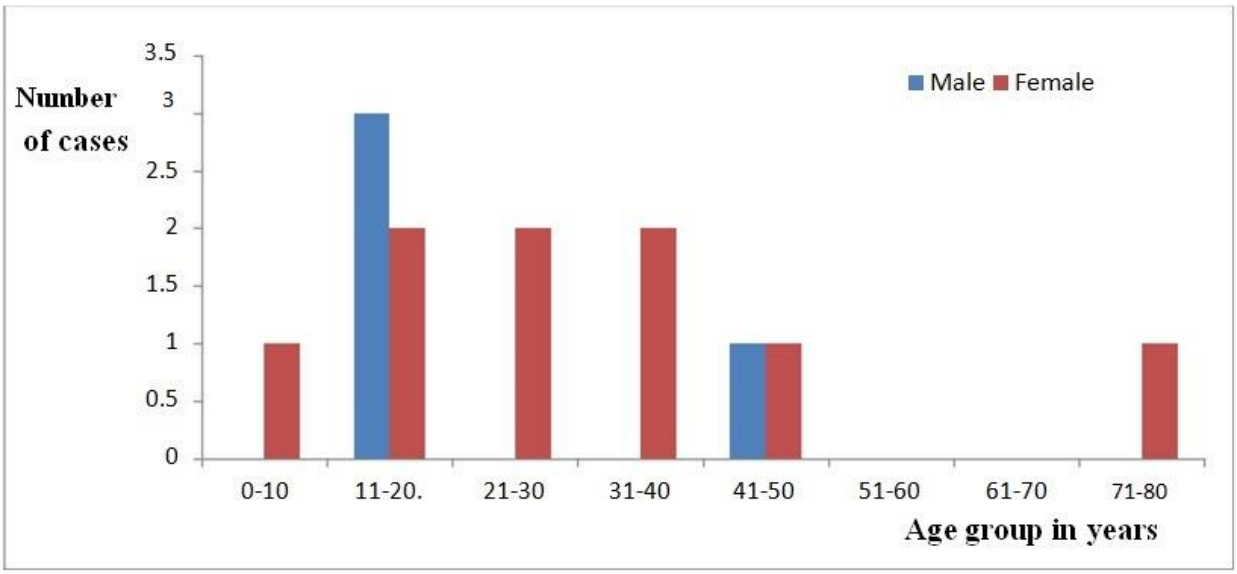

Figure 2: **Age and Sex Distribution of Cholera Cases-patients in Vea-Gunga, Bongo-Upper East Region, July 2015**

3.2. Distribution of cholera cases by date of onset

The onset of diarrhoea and vomiting in the community was on June 22 and peaked on the June 25. No case was reported on the June 29. However, two cases were reported on June 30 and July 1. Subsequently, there were no further cases in the community. Two deaths from cholera were recorded on June 22 and 28 (Figure 3). The primary case was an 85-year-old woman; she had returned from a village in Ashanti region of Ghana that had a recent cholera outbreak where 15 people had been affected but no death. Two days after her arrival she developed diarrhoea and vomiting. She was given a herbal concoction and died on the following day. Her close family members took care of the preparation and burial of the corpse. The Environmental Health Authority in the district was not notified to disinfect the corpse before the burial.

The second case, apparently from the same house had complained of diarrhea and vomiting at the same period. She did not seek medical attention and died on June 28. She was one of the family members who cared for the primary case-patient.

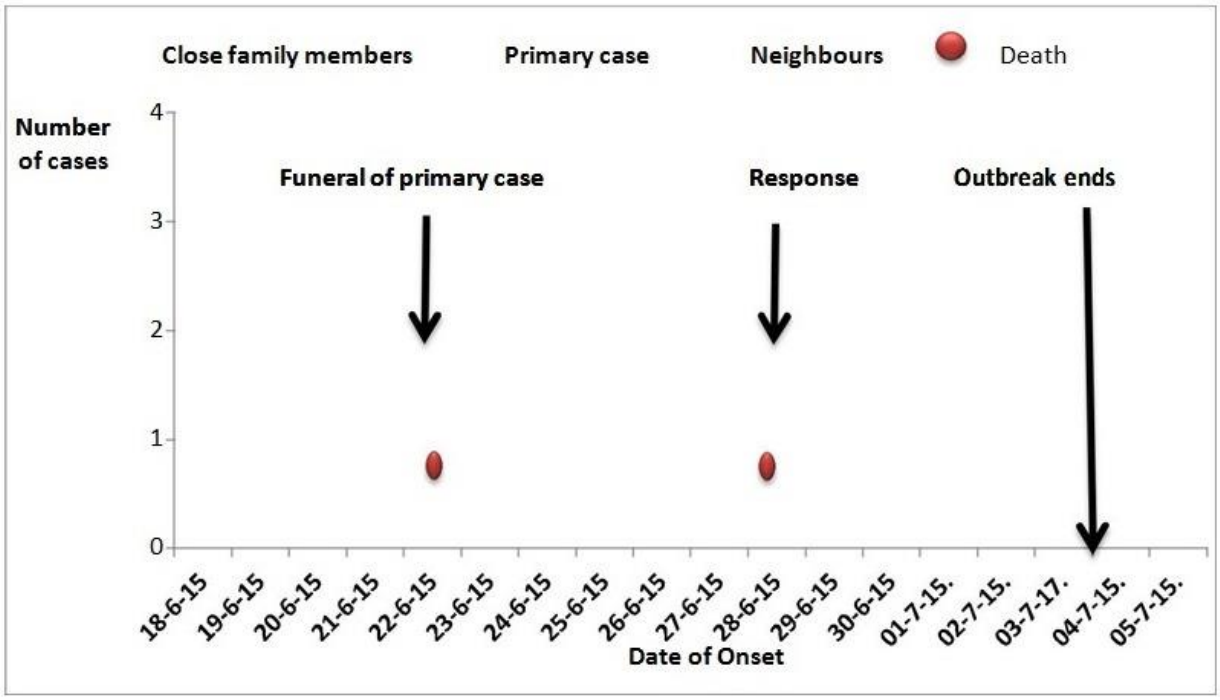

Figure 3: Distribution of cholera cases by date of onset of symptoms, Vea-Gunga, Bongo-UER, July 2015

The index case was a 45-year-old man; he reported at the Bongo District Hospital on June 28. He also took care of the primary case and participated in the preparation and burial of the corpse. He fell ill shortly after the death of the primary case, with diarrhea and vomiting and was rushed to the Vea Health Centre. At the Vea Health Centre, he was managed with oral replacement fluids, and his stool sample was taken. Due to the severity of his medical condition, he was immediately referred to the Bongo District Hospital for further management. The stool sample was later diagnosed positive for *Vibrio cholerae* by Rapid Diagnostic Test (RDT) and culture methods.

Though he had severe diarrhoea and vomiting, he survived.

3.3. Distribution of Cholera cases by Place

All 13 case-patients were found within three houses on the same compound close to each other in Vea-Gunga community. These houses were located about a kilometer from Vea Health Centre and about 10 kilometers from Bongo District hospital. No further cases were recorded from other health facilities in Valley Zone Sub-district where Vea-Gunga is located (Figure 4)

3.4. Laboratory Investigations

Out of the five stool samples which were taken from the case patients and sent to the Bongo District Hospital for laboratory diagnosis, one (from index case) was confirmed positive for *Vibrio cholerae* serotype *ogawa*.

Figure 4: Distribution of cholera cases by place, Vea-Gunga,Bongo-UER, July, 2015

3.5. Environmental Investigations

One borehole and an uncovered well were found in the community. The uncovered well was macroscopically dirty. No refuse disposal site was located in the community. The inhabitants practiced open defaecation and no public latrine was found in the community. There is a dam located about half a kilometer from the community where some community members take their bath and wash their clothes. We noticed a recent human and animal excreta pollution of main water source - the Vea Dam due to a concomitant increase in nomadic activities.

4. Discussion

Our investigation revealed a cholera outbreak in Vea-Gunga village of Bongo district of the Upper East Region that affected young adults and more females. The source of the infection was likely from a secondary transmission at the interfamilial and household-level from a family member who was infected from a village in Ashanti region of Ghana.

Cholera continues to be an important public health problem among many poorer and vulnerable communities, despite the detailed understanding of the bacteriology, epidemiology, and public health aspects for more than a century (12).

In our outbreak investigations, we found out that there was an interfamilial and household-level transmission of the cholera infection from the primary case to the close family contacts. The investigation revealed that, when the primary case died, most of the very close people who took care of the preparation and burial of the corpse, shortly experienced diarrhea and vomiting and one person passed away. The outbreak was confined to the compound of the primary case. Household person to person contact and the use of contaminated drinking water or food could be the modes of transmission

of the infection. Person to person transmission of cholera is not common, but cases have been documented (13). Concentration of cholera within families and households has also been identified in Gaza, and in Calcutta (14, 15). Certain studies identified the specific household-level risk factor, such as consuming water from a storage container in which hands had been placed (16), eating from a common cooking pot (17), and eating leftovers that were contaminated within the household setting (18). Eating food prepared by a member of the household who recently was ill or in contact with another sick individual is also potentially related to additional infections within the household (19, 20). Improved understanding of disease transmission dynamics is critical for public health. While improvements in sanitation, socioeconomic status, and education (including personal hygiene) have helped reduce rates of diarrheal disease in Ghana and other countries in the developing world, it remains a priority to identify specific pathways of transmission and thus develop effective intervention methods.

The study also revealed that most of the case-patients were attendees of the burial ceremony of the primary case. Some studies in West Africa have suggested that funerals may contribute to cholera transmission. Most of the persons with cholera apparently became infected during the large community meal, water served at the funeral as well as person to person contact (14, 15). It has also been observed that, transporting, washing or wrapping the non-disinfected body of a person who died of cholera, and eating afterward is practiced which clearly might result in faecal–oral transmission of cholera. There is, therefore, the need to enforce the Local Authority by-laws in the country on restricting attendance of funerals of persons who die from cholera and other infectious diseases. Environmental health officers and family heads should ensure the maximum use of disinfectants (bleach), simple hand washing with soap and running water during the preparation, burial of persons who die of cholera.

The study revealed that the cholera outbreak affected all age groups in the village and more especially the females and young adult. A similar observation had been made in several places including Uganda and India (22). On the contrary, incidence of cholera among higher adult age groups had been documented in Bangladesh (23). The primary case was a female who had returned from a village in the Ashanti region of Ghana, where a cholera outbreak had been confirmed recently. This observed increase in the number of cases among young adults and females could be because, traditionally, in a typical African setup, females and the young adults are mostly involved in the washing of clothes of other females especially when they are sick.

They also fetch water and prepare food for the household. This study finding underscores the importance of female education on health-related matters since they play a crucial role in health delivery at home.

The study also revealed that *Vibrio cholerae*, serotype *ogawa* was the likely cause of the outbreak. A serotype usually associated with cholera outbreaks across Africa including Ghana (18,19). A similar observation was made among others in an outbreak of cholera in the East Akim Municipality in the Eastern Region of Ghana (26). This finding also corroborates with the observation made in the intermittent outbreak of cholera in Greater Accra, Ghana in 2014 (27).

We also, elicited from the study that early reporting and appropriate rehydration had a positive link with survival. The third case-patient survived probably because he

sought an earlier medical attention. This observation had been documented in similar studies in Haiti during an outbreak of cholera in the country (28). Among Rwandan refugees in Goma, Zaire in 1994, the same conclusions were made, early reporting of cases of cholera resulted in better health outcomes (29). Stakeholders need to intensify education on prevention of cholera using targeted messages and lay the appropriate emphasis on the need to seek timely medical attention. Health care managers need to ensure the availability the requisite cholera replacement fluids and other medicines to manage cholera case patients timely since the disease can kill within a very short period.

The primary limitation to interpreting our key finding was that, although we strongly suspected a direct transmission of cholera within the household of the primary case, there could also be a community-to-person direct exposure outside the primary case's household. If the source of the infection was the use of the polluted Vea Dam, a community-wide cholera outbreak could occur, but instead, this outbreak was limited to the compound of the primary case. Secondly, samples of water from the Vea Dam and the food consumed during the funeral activities of the primary case could not be readily tested at the laboratory for cholera pathogens due to the non-availability of such laboratory facilities in the region. Despite these concerns, the study has provided some useful information that may inform stakeholders' actions in controlling cholera outbreaks by strictly enforcing local by-laws on preparation and burial of death of cholera case-patients.

We conclude that *Vibrio cholerae* serotype *ogawa* likely caused the Vea-Gunga cholera-outbreak. Children and females were mostly affected. The probable sources of infection were person to person, contamination of drinking water or food. Early treatment at a health facility helped survival. We, however, recommended that community members boil or chlorinate water for drinking, practice frequent hand washing with soap and water while avoiding open defecation. The local authority was prompted to provide a potable drinking water source, regulate use and sanitation of Vea Dam, build a public latrine and discourage open defecation. As a part of a comprehensive cholera prevention programme, public health officials must consider requiring bleach disinfection and rapid burial of all bodies of persons dying of cholera and other infectious diseases to reduce the risk of transmission to persons who will have direct contact with the body during the burial and funeral activities.

Based on our recommendations, the community members practiced boiling or chlorination of drinking water, observed hand washing with soap and water and the Local Authority constructed community pit latrine.

Competing interests

Authors have declared that no competing interests exist.

Authors' contributions

This work was carried out in collaboration between all authors.

JKLO: is the principal author and also directed the data gathering and writing of the paper.

JKAW, JO, DKA and OSO: took part more in the conception of methodology and interpretation of results. They also contributed in the coherence of the text and language used. They also supervised the statistical analysis and the interpretation of results. All authors read and approved the final manuscript.

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