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EXECUTIVE SUMMARY

Background

In July 2012, Sierra Leone began to experience a dramatic rise in the incidence of cholera cases. On 16 August 2012, President Koroma declared the cholera outbreak a “public health emergency,” paving the way for a more robust national and international response. On August 24, 2012, Centers for Disease Control and Prevention (CDC) received a request for assistance from the Sierra Leonean Ministry of Health and Sanitation (MoHS) to investigate risk factors for cholera and to provide laboratory support. The CDC team arrived in Sierra Leone on 30 August 2012 to begin the epidemiologic investigation in collaboration with the World Health Organization (WHO) and the MoHS.

Objectives

- Document risk factors for cholera within heavily affected areas of Freetown
- Explore knowledge, attitudes and practices of this population
- Provide laboratory support with supplies and sample collection
- Systematically evaluate Bombali District cholera surveillance system
- Recommend cholera prevention strategies based on findings

Methods

Case-control study

We conducted a case-control study in the eastern part of Freetown. Cases were defined as persons ≥ 5 years old with acute, watery diarrhea and severe dehydration admitted to the Cholera Treatment Unit (CTU) in Wellington or Kuntorloh Community Health Center (CHC) between September 10 and September 21. To be included in the study, cases had to be the first person in the household with acute watery diarrhea since the start of the outbreak in Western Area (June 23, 2012). Two age- and neighborhood-matched controls were enrolled per case. Cases and controls were interviewed about food and beverage exposures, water sources, and water, sanitation, and hygiene practices in the 5 days prior to illness onset. Additionally, we made household observations and tested household drinking water for the presence of free chlorine residual.

Rapid cholera surveillance system evaluation in Bombali district

Interviews were conducted with the Bombali District Surveillance officers, the community health officer at Makeni Government Hospital (MGH), triage nurses at the Makeni Government Hospital CTU, a ward nurse at the CTU, laboratory staff and a national surveillance officer. Line lists from 1 – 6 September for MGH, Bombali District and the national surveillance system were

reviewed. The review was performed in conjunction with a National Surveillance Officer from the MoHS.

Key findings

Case-control study

- Drinking untreated/unsafe water was a risk factor for cholera
- Consuming water at street vendors was an additional risk factor
- Eating crab was a risk factor for cholera
- Although there was widespread access to improved water sources, water samples from the improved sources we tested did not have detectable chlorine residuals
- Household chlorination rates ranged from 28%–38%

Rapid cholera surveillance system evaluation in Bombali district

- Opportunities exist to improve data management and to strengthen training to ensure consistent application of the cholera case definition in preparation for future outbreaks
- Opportunities exist to strengthen laboratory services and to standardize operating procedures

Recommendations

Case-control study

- Increase water treatment
 - Assure adequate levels of free chlorine residual at all distribution points and chlorination of all piped water networks and stored drinking water
 - Short term: Promote point-of-use water treatment with chlorine at the household to improve water safety
 - Medium to long term: Increase access to safe drinking water through improved water and sanitation infrastructure
- Improve street-vended water, food and drink practices
 - Assure that vended water (bottled or bagged) comes from a source that has been treated
 - Provide hand washing facilities for street vendors and their clients
 - Educate street vendors on proper water, food and drink handling

- Wash hands frequently while preparing food and drink
 - Wash hands after using the toilet
 - Ensure that cooked food is served hot
- Sustain WASH knowledge and practices
 - Continue cholera prevention messaging and social mobilization
 - Promote
 - Increased chlorination of household water sources and stored water
 - Eating cooked foods hot
 - Proper preparation of shellfish
 - Washing hands with soap before cooking and after using the toilet

Rapid cholera surveillance system evaluation in Bombali District

- Consider training DHMT staff on data management, case definitions, and basic laboratory skills
- Consider creating an emergency plan for the DHMT to more effectively respond to outbreak situations through coordination among surveillance, laboratory and NGO partners
- Consider enhancing standard operating procedures in case reporting and laboratory surveillance

BACKGROUND

In February 2012, the Ministry of Health and Sanitation (MoHS) in Sierra Leone was notified of unusually high numbers of acute watery diarrhea cases from three districts (Port Loko, Kambia and Pujehun) (Figure 1). Toxigenic *Vibrio cholerae* O1, serotype Ogawa, biotype El Tor was identified in stool specimens by the Sierra Leone national laboratory on April 2012 and later confirmed by the Centers for Disease Control and Prevention (CDC) on September 10, 2012. By the end of August, 12 of 13 districts in Sierra Leone were cholera-affected. By September 25, 2012, 19,965 cases had been reported in Sierra Leone, over half of them in Western Area.

Cholera outbreaks have previously occurred in Sierra Leone with the last large outbreak occurring in 1995. On August 16, President Koroma declared the 2012 outbreak a public health emergency. On August 24, the outbreak prompted the MoHS to request technical assistance from CDC with an investigation of the outbreak and an assessment of response efforts. In response to this request, CDC Epidemic Intelligence Service Officers Drs. Von Nguyen and Nandini Sreenivasan from the Division of Foodborne, Waterborne and Environmental Diseases arrived in Sierra Leone on August 30, 2012, to join Dr. Eugene Lam from the Global Immunizations Division, in assisting the MoHS with the investigation. The CDC team worked in collaboration with the World Health Organization (WHO) and the MoHS on this investigation. Dr. Molly Freeman, a microbiologist from the Enteric Disease Laboratory Branch, traveled to Sierra Leone after the outbreak investigation team in response to a WHO Global Outbreak Alert and Response Network (GOARN) request. She worked with the Health Protection Agency (HPA) from the UK to build reference laboratory capacity for improved diagnosis and detection of *Vibrio cholerae*.

From 10 September to 21 September, 2012, the outbreak investigation team conducted a case-control study in the Eastern Region of Freetown to compare the characteristics of case-patients who sought treatment in health facilities with healthy community controls. The purpose of this study was to better understand risk factors associated with symptomatic cholera infection and to assess community water- and food-related attitudes and practices, which in turn would help inform disease prevention strategies and resource targeting for the outbreak response.

This report summarizes the findings of our team's field investigation activities in Sierra Leone.

OBJECTIVES

The objectives of this case-control study were to:

- 1) Document risk factors for cholera within heavily affected areas of Freetown
- 2) Explore knowledge, attitudes and practices of this population
- 3) Recommend cholera prevention strategies based on findings

METHODS

Study location

Our study was conducted at the Wellington/Médecins Sans Frontières (MSF) Cholera Treatment Unit (CTU) and the Kuntorloh Community Health Center (CHC) in the Eastern Region of Freetown, and in communities in the catchment area of the health facilities.

Case definition

Cases were defined as persons ≥ 5 years old with acute watery diarrhea and severe dehydration admitted to Wellington/MSF CTU or Kuntorloh CHC between 10 September and 21 September, 2012. To be included in the study, patients had to be the first person in the household with diarrhea since the start of the outbreak in Western Area (June 23, 2012).

Case Enrollment

Field staff reviewed the discharge/observation area of Wellington/MSF CTU and Kuntorloh CHC to identify case-patients. Those consenting to participate in the study were then enrolled and interviewed. Trained enumerators interviewed case-patients (or parents/guardians if case-patient was < 15 years old) in the CTU/CHC in Creole using a standardized questionnaire. Their residential location (e.g., street addresses) in the 5 days before illness onset was ascertained to enable household observations and facilitate control recruitment.

Control Enrollment

Two well (non-ill) neighborhood controls were systematically selected for each case, matched by age category (5- 15 years, 16 to 30 years, 31-45 years, and over 45 years) and neighborhood, as follows. Beginning at the case-patient's home, field staff spun a bottle and one enumerator proceeded to the second nearest house or compound in that direction and another enumerator walked to the second nearest house or compound in the opposite direction. At each house, field staff inquired whether any residents had had diarrhea since June 23, 2012 (date of first case of cholera reported in Western Area); households with diarrhea cases on or after June 23 were excluded. In eligible households, persons were enrolled as controls if they were of the same age category as the patient, and lived at that residence during the 5 days before symptom onset in the patient to whom they were matched. If the control subject was not at home, that home was revisited later. If this person could not be contacted at two return visits, field staff excluded that potential control. If a potential control household had more than one person who fell into the age category of interest, the person closest in age to that of the case was asked to participate.

Data collection

A standardized questionnaire was developed after hypothesis-generating interviews, and was used to interview both case-patients and controls. The questionnaire was developed in English (Appendix A) but enumerators administered the questionnaire verbally in Sierra Leone Creole. They were trained before launching the study to ensure consistency in language used and how questions were asked. Before administration, the questionnaire was pilot tested in a non-study community. Case-patients were asked about exposures in the 5 days before illness onset and controls were asked about exposures in the same 5-day period as the matched case-patient.

The questionnaires included questions about the following: socioeconomic status (SES); water sources and water treatment; food and beverage exposures in the 5 days before illness; access to sanitation; cholera knowledge and treatment; and knowledge, availability, and utilization of ORS. In addition, household observations were conducted and stored household drinking water was tested for the presence of free chlorine residual using the DPD (N,N diethyl-p-phenylenediamine) method. GIS coordinates of home and water sources were measured using a GPS device (Garmin).

Data Analysis

Data were entered into an Epi Info 7 database, and cleaned and analyzed using SAS version 9.3 software (SAS Inst., Cary, NC). Exposures of cases and controls were compared to yield matched odds ratios (mORs) and 95% confidence limits using bivariate analysis. Conditional logistic regression was performed to create a multivariate model that examined interactions and the impact of confounding variables.

RESULTS

Demographic characteristics

A total of 49 case-patients and 98 matched controls were enrolled in this study; 24 (49%) case-patients and 56 (57%) controls were female. The median age of case-patients was 23 years (range 5 to 50 years) and of controls was 25 years (range 6 to 77 years). Twenty-one (47%) case-patients and 53 (59%) controls had completed at least some secondary school. The median household size of both case-patients and controls was 7 persons, ranging from 2 to 27 for cases and 1 to 24 for controls. (Table 1)

Clinical characteristics of case-patients

All 49 (100%) case-patients reported having acute watery diarrhea and severe dehydration requiring IV rehydration (criteria required for inclusion as cases in the study); 40 (82%) experienced nausea or vomiting, 15 (31%) reported having leg cramps, and 21 (43%) experienced loss of consciousness. Thirty-three (67%) case-patients presented for care at the CTU on the same day as symptom onset. Of the 16 case-patients who did not seek care immediately, the median time from symptom onset to hospitalization was 1 day, ranging from 1 to 4 days.

Water sources, storage and treatment

Forty-seven (96%) case-patients and 94 (96%) controls reported access to an improved water source. These included public taps, boreholes, protected wells, protected springs, and sealed packet water. Forty-two (89%) case-patients and 93 (95%) controls stored their drinking water at home. Thirty (71%) case-patients and 41 (43%) controls reported drinking any untreated/unsafe water in the 5 days before the case-patient's illness onset. This was associated with a significantly increased risk of cholera (mOR 4.82, 95% confidence interval [CI] 1.85-14.76). (Table 2) Drinking untreated/unsafe water remained statistically significant in the multivariable analysis (mOR 3.43, 95% CI, 1.07-11.04) (Table 3). A complete listing of bivariable exposures can be found in tables 4 and 5.

A total of 18 (38%) case-patients and 47 (49%) controls reported treating their drinking water at home in the 5 days before illness onset. This difference was not statistically significant. The most commonly reported methods of water treatment for both cases and controls were chlorination followed by boiling. We observed a water treatment product in homes of 33 (34%) controls. Water testing revealed that 11 of 37 (30%) case-patients and 30 of 76 (39%) controls had detectable free chlorine residual in their stored drinking water, an objective marker of water treatment, although this difference was not statistically significant (mOR 0.76, 95% CI, 0.3, 2.0). We found no detectable free residual chlorine in a convenience sample of public water sources (three public taps, two sachets of packet water, and one protected spring).

Food and beverage exposure

Consumption of food or beverages (including bagged water) at a street vendor in the 5 days before illness onset was associated with an increased risk of cholera in the bivariable model; 42 (86%) cases consumed food or drinks at a street vendor, compared to 50 (51%) controls (mOR 5.42, 95% CI 1.86-14.76). Consumption of street-vended food and beverage was not significant in the multivariable analysis.

Vended water was consumed by 38 (78%) cases and 36 (37%) controls and remained significant in both the bivariable and multivariable analyses. In the bivariable analysis, the mOR was 6.36 (95% CI, 2.55-19.04) (Table 4), and in the multivariable analysis, the mOR increased to 9.37 (95% CI, 2.01-43.72) (Table 3).

A number of food items showed statistical significance in the bivariable analysis but not in the multivariable analysis. Omolo (mOR 12, 95% CI 1.46 552) and poyo (mOR 6; 95% CI 1.07 60.79) were risk factors. Potato leaf (mOR 0.2, 95% CI 0.03 0.87) was protective against cholera (Table 5).

Crab was the only food item that showed statistical significance in the multivariable analysis (multivariable mOR 3.29, 95% CI 1.03 10.56) (Table 3).

Other exposures

A larger proportion of case-patients than controls reported contact with a person with cholera in the 5 days before illness onset (17% vs. 9%), but this difference was not statistically significant (mOR 2.26, 95% CI 0.67-8.08). A similar percentage of case-patients and controls attended a funeral (15% vs. 13%) and a lower percentage of case-patients (17%) than controls (19%) reported attending a social gathering (wedding, church or mosque) in the 5 days before the case-patients' illness onset (Table 6).

Sanitation and hygiene

Most case-patients and controls had a pit latrine (84% vs. 86%). Only 3 (6%) case-patients and 3 (3%) controls reported open defecation. An equal percentage of case-patients and controls reported sharing a latrine with other households (62% vs. 65%). The median number of people sharing a latrine was 16 for case-patients (ranging from 2 to 100), and 15 for controls (ranging from 3 to 100). The median distance from the house to the latrine was 8 meters (range 0 to 150 meters) for case-patients and 10 meters for controls (range 0 to 150 meters). We observed soap for hand washing in the homes of 40 (83%) cases and 82 (98%) controls (Table 7).

Cholera knowledge

Case-patients received education on the causes and consequences of cholera during their hospitalization and were excluded from the analysis of cholera knowledge. When controls were asked about ways to prevent cholera, 79 (81%) mentioned washing your hands, 66 (67%) indicated drinking treated water, and 38 (39%) said eating properly heated food. When asked about ways to treat cholera; 86 (88%) controls mentioned going to a health facility immediately and 49 (50%) indicated drinking oral rehydration solution. ORS was observed in the home of 26 (27%) controls (Tables 8 – 11).

DISCUSSION

Demographics

The case and control groups were comparable with respect to age, gender and household size. Controls, however, appeared to be more educated than cases with 59% vs. 47%, respectively, reporting some secondary education. While not statistically significant, this finding aligns well with the higher proportion of controls reporting 'student' as their occupation. Level of education may impact understanding of health messages.

Water exposures

Drinking untreated/unsafe water was a statistically significant risk factor for cholera infection in the multivariate analysis. Both cases and controls had very high access to improved water sources, with public taps representing the most common type of improved water source, but we did not find residual chlorine in several spot checks of public taps. This finding suggests that either chlorine introduced into the water system at its origin in Guma Valley was not reaching some water points in the area we sampled, or that chlorination may not have been occurring. Consequently, improved water sources within eastern Freetown might not provide safe, treated drinking water. Further evaluation of a random sample of end points of the water distribution system should be conducted and repeated periodically to ensure appropriate water quality.

The lack of chlorine could make this and other improved water sources susceptible to contamination with *Vibrio cholerae*. Eastern Freetown has experienced significant population growth since the civil war. Overcrowding, competing priorities and limited resources have resulted in poor hygiene and sanitation conditions. These conditions combined with low chlorination rates create an environment highly vulnerable to cholera transmission. In this environment, point-of-use drinking water treatment represents the most effective short term strategy to ensure safe drinking water. Survey results indicated that 34% of control households had water treatment products, and 28% of case and 38% of control households had detectable chlorine residuals in stored drinking water. These findings suggest that at least part of the population has responded to water treatment recommendations. Programs to distribute water treatment products to households and efforts to chlorinate water collected from public sources should be continued and expanded.

In investigations of cholera outbreaks in other settings, sewage has entered networks of water pipes through cross contamination with sewer pipes or clandestine connections that allow surface contamination to enter water pipes. An evaluation of the integrity of water distribution networks and chlorination practices would be useful to identify and resolve potential

deficiencies. In the mid-long term, improvement and expansion of the water and sanitation infrastructure will help to prevent future epidemics of cholera and other waterborne diseases.

Food exposures

In the study, a wide range of food items were tested to see if they were associated with risk of cholera infection. Our data indicate that eating crab was a risk factor for cholera infection. Shellfish in marine environments are a natural reservoir for *V. cholerae* and have been implicated in investigations of previous cholera outbreaks, particularly shellfish that has not been adequately cooked or that has been cross-contaminated with raw shellfish during storage. Located along the Atlantic coast, the population of Freetown has easy access to shellfish. Cooking shellfish for at least 10 minutes will kill *V. cholerae*, and ensuring safe handling will prevent cross-contamination, making the food safe to eat.

Exposures to street-vended foods and drinks

In the bivariate analysis, our study found that consuming street-vended foods or drinks increased the risk of cholera. The multivariate analysis, however, suggested that the increased risk posed by street vendors was driven by drinking street-vended water.

Inadequate water and sanitation infrastructure in Freetown may serve as a barrier to the ability of street vendors to serve safe water with their food. Although our study was not designed to determine whether street vendors had the knowledge or supplies to practice sanitary food and drink preparation, this area deserves further exploration. Information, education and communication (IEC) campaigns focused on the importance of safe food handling practices and the importance of consuming water that has been treated with a chlorine product are core public health prevention activities.

Other exposures

Prior studies have noted contact with a cholera patient, funeral attendance or attending other gatherings conferred increased risk of infection. These exposures did not appear to result in increased risk of cholera infection within this population.

Knowledge, attitudes and practice

A small survey of knowledge, attitudes and practices (KAP) was nested into the case-control study. While the results of this survey were only applicable to the study population in eastern Freetown, this area was the most affected by the epidemic. To more accurately assess community knowledge, we only reported data on healthy controls, who had not likely received cholera prevention and treatment education at a health facility. A number of important trends emerged. First, a significant percentage of the healthy study population had heard cholera

messaging. The most common source of information was the radio, with friends listed as the second most common source. These findings suggest that people were hearing radio advertisements and talking with each other about the messages, expanding the reach of the social mobilization campaign. Handwashing, the importance of drinking treated water, and immediately seeking health care when diarrhea develops also appeared to be well retained messages. Given that health messaging had only been disseminated for a few weeks before our study, these findings indicate that knowledge and preventive messages were reaching the community.

Study participants understood the importance of soap in preventing cholera and we found that soap was universally available. A large gap, however, existed between the knowledge of ORS and water treatment products and the possession of these items. WASH interventions focused on improving the practice of point-of-use water treatment and ORS use might help to increase the availability of these prevention and treatment products.

LABORATORY SUPPORT

Laboratory services

The CDC team arrived in Sierra Leone with supplies to isolate and identify up to 200 *Vibrio cholerae*. This allotment included Cary Blair transport media, TCBS media, tryptic agar media, petri dishes, a micro pipetter and antisera for identification of *V. cholerae* serogroups O1 and O139, and serotypes Ogawa and Inaba. With the assistance of WHO, these supplies were delivered to the National Public Health Reference Laboratory in Lakka. Dr. Abdul Kamara at the public health laboratory used these supplies in conjunction with supplies provided by WHO and the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) to culture specimens collected throughout Sierra Leone.

The team also collected laboratory specimens as part of the case control study. Crystal Vc rapid diagnostic tests (RDTs) were performed on every specimen and two specimens were collected in Cary Blair transport media. One specimen was sent to the Central Public Health Reference Laboratory (CPHRL) for culture and a second specimen was sent to the CDC Enteric Diseases Laboratory in Atlanta for isolation, confirmation, antibiotic susceptibility testing and subtyping.

Results

Stool specimens were collected from 32 cases in Freetown; 30 were included in the final case-control analysis. Of these 30 specimens, 15 (50%) were positive for *V. cholerae* serogroup O1 by RDT. Culture at the CPHRL in Sierra Leone yielded 3 *V. cholerae* positives. Culture of all 30 specimens at the CDC Enteric Diseases Laboratory Branch, Atlanta, yielded 3 positive cultures, and PCR analysis of the specimens resulted in 13 with evidence of *V. cholerae* O1 El Tor infection (Table 12).

Testing of all 6 culture isolates showed *V. cholerae* serogroup O1, biotype El Tor, serotype Ogawa. Testing for antimicrobial susceptibilities showed sensitivity to doxycycline, tetracycline and ciprofloxacin, and resistance to sulfa-trimethoprim, furazolidone, sulfisoxazole, and streptomycin.

Pulsed-field gel electrophoresis (PFGE) testing at CDC showed that the two enzyme pattern has been seen 27 times before from seven countries in Africa and Asia. Note that multiple samples may have been collected from a single outbreak (Table 13).

Additionally, one sample from Freetown not included in the case-control study was PCR positive. The CDC laboratory received six stool swabs and seven mixed isolates from Bombali. All of the swab specimens were negative for *V. cholerae* by culture and PCR. Five isolates

showed PCR evidence of *V. cholerae* genes and one of those was viable and confirmed as *V. cholerae*.

Additional laboratory support

Dr. Molly Freeman, a microbiologist from the Enteric Disease Laboratory Branch (EDLB), traveled to Sierra Leone in the weeks following the return of the epidemiologic outbreak investigation team. In response to a Global Outbreak Alert and Response Network request, she worked with Dr. Marie Chattaway from the UK Health Protection Agency to assess sustainability and build microbiology laboratory capacity at the Sierra Leone Central Public Health Reference Laboratory (CPHRL). A full report of their activities can be found in the following report “Final Bacteriology Report, Overall assessment of establishing a cholera confirmation laboratory at CPHRL.” Coordination of CDC epidemiologic and laboratory services occurred prior to Dr. Freeman departure with a debriefing given by the outbreak investigation team. She communicated with members of the Epi-Aid team throughout her trip. Upon her return, Dr. Freeman provided a debriefing to representatives from the Enteric Disease Laboratory Branch, Waterborne Disease Prevention Branch, and Global Disease Detection. Dr. Freeman will provide ongoing technical support to the CPHRL on an ad hoc basis.

Cholera surveillance system evaluation in Bombali District, Sierra Leone

Surveillance system description

Public health importance

Intestinal infection with toxigenic *Vibrio cholerae* O1 causes acute, non-bloody watery diarrhea (typically referred to as 'rice water' stool) and in severe cases can rapidly lead to profound dehydration and death. The WHO publication Cholera Outbreak, Assessing the Outbreak Response and Improving Preparedness states that without adequate treatment, the mortality rate can be as high as 50%; however, with appropriate rehydration therapy the mortality rate should be less than 1%. In 2011, there were 589,854 cases and 7,781 deaths worldwide from *Vibrio cholerae* infections reported to the World Health Organization (WHO). Developing countries, specifically those in sub-Saharan Africa and Haiti, are disproportionately affected by cholera because of poor hygiene and sanitation, lack of safe water, lack of public health infrastructure, and inadequate access to medical care.

According to data reported to WHO, this 2012 cholera outbreak represented the largest ever reported in Sierra Leone. On 16 August, President Ernest Bai Koroma declared the epidemic an "emergency issue," paving the way for a more vigorous domestic and international response. As of 16 September, 18,508 cases and 271 deaths were reported, representing a case fatality ratio of 1.5%.

Bombali District experienced a significant upsurge in the number of cholera cases during late August/early September, placing significant stress upon the surveillance system. This evaluation sought to strengthen the ability of the system to detect and manage future outbreaks. Stakeholders for this evaluation included the Ministry of Health and Sanitation (MOHS), the Bombali District Health Management Team (DHMT), peripheral health units (PHUs), hospitals, clinical laboratories, medical professionals, the citizens of Sierra Leone, NGO partners and WHO.

Purpose and operation

The Bombali District cholera surveillance system served different purposes dependent on the incidence of disease

When disease is not known to be present, the system must:

- Rapidly detect cases to ensure appropriate control measures are taken

During periods of epidemic disease, the system must:

- Generate real time data at the national and district level to direct the deployment of limited resources
- Compile epidemic trends over time for future analysis and planning

This evaluation focused on the Bombali District surveillance system performance in preparation for and during epidemic disease. It intended to highlight the existing strengths and potential opportunities to enhance cholera surveillance. Lessons learned during an epidemic could also be applied to surveillance when disease is not known to be present.

Sierra Leone used the WHO case definitions for the surveillance of cholera.

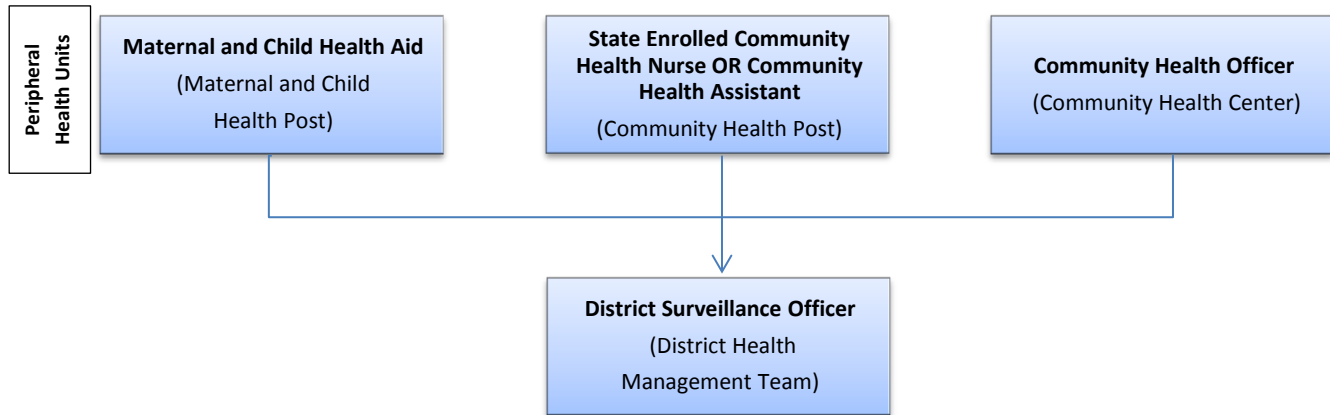
A case of cholera should be suspected when:

- in an area where the disease is not known to be present, a patient aged 5 years or more develops severe dehydration or dies from acute watery diarrhea;
- in an area where there is a cholera epidemic, a patient aged 5 years or more develops acute watery diarrhea, with or without vomiting.

A case of cholera is confirmed when *Vibrio cholerae* O1 or O139 is isolated from any patient with diarrhea.

A majority of persons infected with *Vibrio cholerae* had no clinical symptoms. Of those with cholera-associated diarrheal disease, some patients presented with mild, moderate or severe symptoms. A portion of patients did not seek out health care because of symptom severity, cultural norms, socio-economic status or distance to a health care facility. The entry point for patients who utilized the government health system was broadly known as a Peripheral Health Unit (PHU) and took multiple forms, dependent upon the size of the catchment area. In small villages, a Maternal and Child Health Aid was found at a Maternal and Child Health Post. In larger communities, a State Enrolled Community Health Nurse or Community Health Assistant was found at a Community Health Post. In 'chiefdom head-quarter towns,' a Community Health Officer (CHO) was found at a Community Health Center (CHC). There were multiple CHC's within larger metropolitan areas. Bombali District contained 99 PHUs.

Reporting flow of cholera surveillance



Information about a patient with diarrhea was collected by the PHU representative and reported to the Bombali District Surveillance Officer (DSO) as a case of diarrhea and vomiting (D&V). If the case shows sign of severe dehydration, a suspected cholera case was noted. The DSO initiated an outbreak investigation and traveled to the area of the suspected case to interview the patient and ensure that appropriate medical referrals had been made. If supplies were available, a cholera rapid diagnostic test (RDT) and stool collection were performed with samples sent to the regional and national reference laboratories.

There were 2 DSOs and 99 PHUs in Bombali District. A cell phone had been assigned to each PHU and a closed-user reporting system had been implemented. In this system, calls between the PHU and DSO incurred no charge to the user. Passive case finding occurred via this reporting system. Active case finding was performed by local community health motivators (e.g., community health workers) within each community. These motivators sought out community cholera cases and reported back to their respective PHUs.

Reporting hierarchy and timelines during different phases of a cholera outbreak are illustrated below.

- Routine Diarrhea and Vomiting reporting
 - Weekly reports from PHU → DSO → National surveillance system
- Initial suspect case of cholera case when *disease is not known to be present*
 - Immediate reporting to DSO for case investigation
- Routine reporting of suspect cholera cases during an epidemic
 - Daily reports from PHU → DSO → National surveillance system

Reported data included location, date seen, patient name, address, age, gender, date of onset and outcome. The information was transmitted verbally over the phone to the DSO, and the DSO documented cases onto a paper form. These data were entered into Excel by a second surveillance officer as time allowed.

Aggregated district surveillance data were reported daily to the national surveillance system over the telephone. Summary reports were compiled periodically for presentations to local leadership and partners. NGOs collaborating with the government to provide case management, WASH and social mobilization teams met daily with the District Health Medical Team to coordinate activities. Data were aggregated manually from the paper record for these meetings.

Resource requirement

To manage the cholera surveillance system, Bombali district had two dedicated District Surveillance Officers. The DSOs had access to computers with Microsoft Excel and intermittent internet access outside the DHMT. Mobile phones and air time for the closed-user group were provided by the UK based Medical Research Council. Funding for surveillance was shared between the MOHS, WHO and NGO partners.

Primarily, PHU staff served a clinical function and reported cases as part of their overall responsibilities.

Evaluation design

This evaluation focused on Bombali District in Sierra Leone with the approval of the District Medical Officer. It addressed issues related to cholera surveillance during an epidemic and preparations prior to an outbreak. Interviews were conducted with the Bombali District Surveillance officers, the CHO at Makeni Government Hospital (MGH), triage nurses at the Makeni Government Hospital Cholera Treatment Unit (CTU), ward nurse at the CTU, laboratory staff and a national surveillance officer. Line lists from 1 – 6 September 2012 for MGH, Bombali District and the national surveillance system were reviewed.

The evaluation was performed in collaboration with the Ministry of Health and Sanitation. A national surveillance officer played an integral role in evaluating and developing recommendations for the Bombali surveillance system. An effective and efficient cholera surveillance system offers many benefits since cholera surveillance data were used by the government and a variety of partners for national/international reporting, case management, social mobilization, WASH activities and research.

Surveillance system attributes and evaluation

Simplicity

The reporting system exhibited simplicity with each peripheral health unit, regardless of their catchment area size, reporting directly to the Bombali DSO. The data was verbally transferred over the telephone, and the PHU incurred no mobile charges because of the closed-user system, thereby lowering one barrier to reporting. The data was subsequently reported up to the national level.

The line list included a manageable number of elements, including – date, name, address, sex, occupation, date of onset, and outcome. These data, however, were recorded onto a paper form and inconsistently transferred into excel for data management. Summary frequencies and other statistics were manually compiled using the paper line list.

While a clear reporting contact had been established at each PHU, the route of data reporting could be inconsistent. For example, data for the PHU at Makeni General Hospital was collected using multiple mechanisms including:

1. A phone call from the Community Health Officer to the DSO (*includes* mild cases of suspected cholera)
2. A call from the DSO to the triage nurse in order to review the triage log (*includes* mild cases of suspected cholera)
3. A call from the DSO to the ward nurses in order to review the ward log (*does not include* mild cases of suspected cholera)
4. A visit by the DSO to review the triage log in person (*includes* mild cases of suspected cholera)

A call from the CHO represented the preferred reporting mechanism. Alternative pathways were sometimes utilized in lieu of the preferred pathway.

Conclusion: The closed-user reporting system provided an effective framework for consistent reporting. Actual reporting, however, was inconsistent due to the use of multiple reporting channels. Limiting the number of people reporting to the DSO would improve simplicity. The line list required appropriate data elements but paper forms made it difficult to aggregate these data. Data management could be further simplified by fully incorporating the use of Excel to organize and report data. District surveillance staff would benefit from additional data management training.

Flexibility

Reporting for cholera varied dependent upon the incidence of disease. At baseline, the district surveillance system was designed to detect cases of “Diarrhea and Vomiting.” When the suspected case definition for cholera in a non-epidemic setting (severe diarrhea with dehydration in a patient >5 years old) was met, additional investigation occurred. Cholera had been noted in many districts before its arrival in Bombali. After the first suspected cholera case was reported, the surveillance system quickly switched from weekly reporting of D&V to daily reporting of suspected cholera cases using the more sensitive WHO case definition.

As cases surged, a CTU was set up by the Finnish Red Cross. This introduced a new reporting entity since the NGO accepted responsibility for triage and treatment of all suspected cholera patients.

While the surveillance system accommodated the increased capacity requirements during the cholera outbreak, the district surveillance staff worked nonstop. The DSOs took daily calls from up to 99 PHUs, recorded the data, summarized the data, participated in national reporting and presented the data to partners.

Conclusion: The surveillance system effectively continued to report cases during the transition from weekly D&V cases to daily suspected cholera cases. The limited resources within the district surveillance office, however, were stretched. A plan for emergency surge capacity through temporary staff reassignments may prove beneficial. Including NGOs in emergency planning may facilitate their ability to report early and accurately.

Data Quality

Review of the Bombali District line list showed that data quality varied. Health facility based deaths were consistently reported; however, date of onset and outcome were frequently not reported.

Based on interviews with nurses at Makeni Hospital, only 4 of 14 had been formally trained on the WHO case definitions for cholera. Additionally, triage nurses used inconsistent criteria for cholera admissions. Acute diarrhea requires the presence of three loose stools in a 24-hour period. If a patient had fever, two loose bowel movements in 24 hours and “looked sick,” the patient might be admitted to the CTU rather than referred to the general medical ward. These patients who did not fit the case definition were incorrectly classified as cholera and reported to the district and national levels.

Data were reported to the DSO over the telephone and transcribed onto a paper form. When printed forms were not available, a table was manually created on white paper. Limited laboratory data were collected.

Conclusion: Some required data fields were inconsistently reported on the line list and application of the case definition can be variable. Consistent use of standardized forms and case definition training may be beneficial. Lab data is now being reported and needs to be systematically linked with the epidemiologic data.

Acceptability

All staff interviewed at the hospital supported the surveillance system. The sudden onset, severe consequences and simple reporting criteria made the cholera surveillance system acceptable to all users we interviewed.

In Bombali district, the WHO Cholera Command and Control Centre (C4) structure was implemented. There were daily meetings with local partners to coordinate case management, WASH and social mobilization activities based on surveillance data.

Given the timing of this evaluation during an epidemic, it was not possible to assess the acceptability of the surveillance system when disease was not known to be present.

Conclusion: High public health importance resulted in high acceptability of the system.

Sensitivity

The two case definitions for suspected cholera had varying sensitivity and specificity. Before an outbreak, a less sensitive and more specific definition was used to identify suspected cases. During an outbreak, when misdiagnosing cholera can rapidly lead to death, a more sensitive and less specific definition was used.

For Sierra Leone, a plan to systematically sample suspected cholera cases with either rapid diagnostic tests or culture had not been implemented. This made it difficult to evaluate surveillance system sensitivity because there was no laboratory standard for comparison.

It was important to recognize that as the outbreak waned and the proportion of non-cholera diarrhea increased, the broader WHO case definition remained very sensitive but lost significant specificity. Of nine cases interviewed for admission into the CDC's evaluation, a detailed history demonstrated that two had not experienced diarrhea, defined as three or more bowel movements over any 24-hour period. Of the remaining seven suspected cases, only three had positive cholera RDTs.

A second element of sensitivity examined the ability of the system to detect and report all suspected cholera cases that met the case definition. As previously noted, cholera presented with various levels of severity. Patient with mild, self-limited acute watery diarrhea might go undetected because they never presented to a health facility.

Conclusion: Sensitivity could not be credibly calculated in the existing system without the consistent application of a diagnostic gold standard. As laboratory capacity improves, systematic laboratory testing of all patients with any watery stool with RDT/culture (e.g., every 20th patient) might address this limitation. A chart review might provide insight into sensitivity/positive predictive value (PPV) relative to a well-accepted clinical definition.

Positive predictive value

As stated above, the positive predictive value could not be calculated without a diagnostic gold standard. The PPV was likely high during the peak of an epidemic when the majority of people seeking care have cholera. As the epidemic waned and non-cholera diarrhea patients were admitted to CTU, this may have artificially depressed the PPV of the surveillance system. Among samples collected during a waning epidemic, three of nine suspected cholera cases tested RDT positive, resulting in a 33% PPV.

Conclusion: A true PPV could not be calculated without systematically collecting laboratory data.

Representativeness

The MOHS deployed surveillance representatives into the smallest villages with their Maternal and Child Health Aids. These representatives gathered data on all reportable diseases, including cholera. During an epidemic, cholera case reporting should occur daily from all 99 PHUs in the district. This, however, rarely happened. Additionally, zero reporting was not performed consistently. In more remote areas, reporting proved difficult because of limited network coverage. A PHU representative might be unwilling to walk 3 km to report zero cases of cholera on a daily basis.

Passive surveillance occurred at health facilities. Poor roads and limited transport made it difficult for patients to travel to central facilities where they accessed care and could be counted.

Conclusion: The surveillance system possessed the potential to cover the vast majority of Sierra Leone, including the smallest villages. Limited cell coverage and lack of transportation made representative reporting difficult.

Timeliness

Data was largely gathered in a timely manner with daily reporting. Distant areas reported less frequently because of mobile phone coverage and transport issues. At later stages in the epidemic, a review of the line list suggested that PHUs with fewer cases reported every few days.

In Bombali district, laboratory testing occurred approximately 4 weeks after the first reported case. Antimicrobial sensitivity testing took additional weeks since samples were sent to the U.S. Recent training of national laboratory staff on *V. cholerae* culture techniques will improve this capacity. Creating stronger links between the surveillance team and the laboratory could provide additional benefits.

Conclusion: Reporting was timely and sufficient for management of resources. There existed reasonably effective daily reporting of cases. Laboratory and epidemiologic surveillance links could benefit from enhanced coordination. Prepositioning of laboratory supplies (RDTs, Cary Blair transport media) at the DHMT might also improve timeliness.

Stability

Resources for this epidemic response were drawn from existing public health staff. Their dedication and flexibility contributed to the success of this response.

Conclusion: Scaling of the surveillance system worked during this outbreak because of staff dedication. A standardized emergency plan to reallocate human and capital resources to support surveillance may benefit future outbreaks of cholera and other diseases.

Recommendations

Recommendations derived from this evaluation of the Bombali District Surveillance system can be grouped into four categories: training, planning, standardization and strengths

Training

- District Surveillance Officers may benefit from data management training in Excel in order to facilitate data collection, organization and reporting
- Clinical and surveillance staff at all levels may benefit from additional training on cholera case definitions
- Consider training members of the district hospital laboratory and the district surveillance office together on RDT and sample collection methodologies to facilitate epidemiologic and laboratory collaboration

Planning

- Consider creating an emergency plan that temporarily reassigns DHMT staff to assist with surveillance during an outbreak to increase surge capacity
- Consider incorporating NGO partners into the emergency plan during the early phase of an outbreak in order to increase the speed at which they can respond
- Consider building a small stockpile of RDTs and cholera transport media at the district level to facilitate more rapid confirmation of suspected cholera cases

Standardization

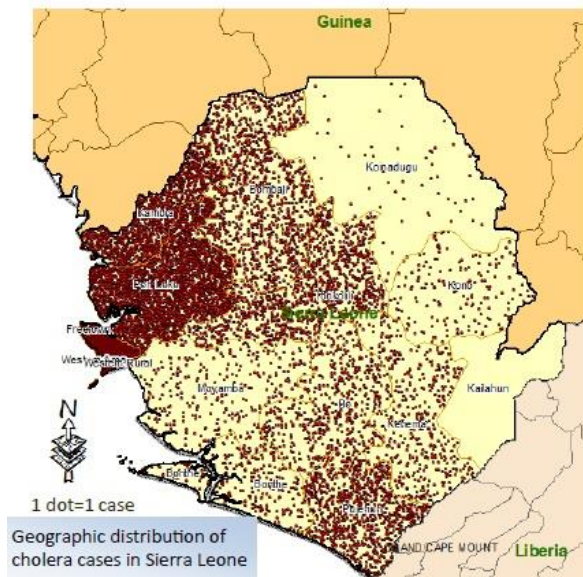
- Consider limiting the number of individuals reporting to the District Surveillance Officer, particularly at large health care facilities, to improve simplicity and data quality
- Consider increasing the availability and use of standardized reporting forms at all PHUs
- Consider initiating systematic laboratory surveillance using a standardized sample scheme during an outbreak to facilitate calculation of sensitivity and PPV

Strengths

- Continue to use and strengthen the closed-user network of cell phone reporting. Lessons learned in Bombali District can be applied across all districts in Sierra Leone.
- Continue to use multiple resources at the village level to gather surveillance data, including Maternal and Child Aids and Community Health Motivators
- Continue the strong coordination of activities with NGO partners that contribute to and utilize surveillance data

FIGURES & TABLES

Figure 1. Cholera case distribution as of 5 October 2012



Source: World Health Organization, Regional Office for Africa

Table 1. Demographic characteristics of cases and controls, Freetown, Sierra Leone, September 2012.

	Cases (n/N)	Controls (n/N)
Age, median (range)	23 (5–50)	25 (6–77)
Median household size (range)	7 (2–27)	7 (1–24)
No. ppl under roof, median (range)	10 (3–70)	9.5 (2–35)
Female sex (%)	24/49 (49%)	56/98 (57%)
Some secondary school (%)	21/45 (47%)	53/90 (59%)
<i>Occupation</i>		
Student	15 (35%)	46 (53%)
Farmer	2 (5%)	2 (2%)
Trader	13 (30%)	26 (30%)
Teacher	8 (19%)	1 (1%)
Unemployed	4 (9%)	10 (11%)
Other	1 (2%)	2 (2%)
Missing	12	11

Table 2. Water sources and water treatment among cases and controls, Freetown Sierra Leone, September 2012.

	Cases	Controls	mOR (95% CI)
Access to improved water sources	47/49(96%)	94/98 (96%)	1.0 (0.1–13.1)
Reported drinking untreated/unsafe water	30/42(71%)	41/96(43%)	4.8 (1.9–14.8)
Reported treating drinking water at home	18/47 (38%)	47/96 (49%)	--
Boiling	3/18 (6%)	6/47 (13%)	--
Chlorination	15/18 (94%)	36/47 (77%)	--
Water treatment product present at home	--	33/98 (34%)	
Chlorine residuals found in stored drinking water	11/37 (30%)	30/76 (40%)	0.7 (0.3–2.0)

Table 3. Conditional multivariable logistic regression analysis of risk factors associated with cholera infection, Freetown Sierra Leone, September 2012

Characteristic	mOR	95% CI
Crab*	3.29	(1.03–10.56)
Okra	0.49	(0.13–1.81)
Hot rice	0.04	(0.002–1.238)
Vended water*	9.37	(2.01–43.72)
Unsafe water*	3.43	(1.07–11.04)
Secondary education	0.47	(0.113–1.91)

*Statistically significant at $p < 0.05$

Table 4. Univariable exposure among cases and controls to street vended food or drinks in the 5 days before the case-patient's illness onset, cholera investigation, Freetown Sierra Leone, September 2012.

	Cases n=49 (%)	Controls n=98 (%)	mOR (95% CI)
Consumed food or beverages from a street vendor	42 (86%)	50 (51%)	5.4 (2.1–16.4)
Water	38 (78%)	36 (37%)	6.4 (2.5–19.0)
Pop drinks	20 (41%)	16 (16%)	2.3 (0.7–8.7)
Rice	28 (57%)	29 (30%)	1.1 (0.39–3.4)
Grand soup	15 (31%)	15 (15%)	1.6 (0.56–4.6)
Ginger beer	17 (35%)	20 (20%)	1.0 (0.3–3.1)
Sliced fruit	4 (8%)	9 (9%)	0.9 (0.2–4.2)

Table 5. Univariable food exposures among cases and controls in the 5 days before the case-patient's illness onset, cholera investigation, Freetown Sierra Leone, September 2012.

	Cases n=49		Controls n=98		mOR	95% CI
Beans	32	65%	64	65%	1.00	(0.47 – 2.17)
Beef	22	45%	45	46%	0.96	(0.44 – 2.05)
Beni (seed)	10	20%	31	32%	0.58	(0.24 – 1.33)
Bitter leaves	10	20%	14	14%	1.55	(0.56 – 4.27)
Cassava	29	59%	66	67%	0.66	(0.28 – 1.54)
Cassava leaf	37	76%	81	83%	0.64	(0.25 – 1.65)
Chicken	28	57%	52	53%	1.18	(0.56 – 2.55)
Canda (cow hide)	22	45%	47	48%	0.89	(0.42 – 1.84)
Crabs	21	43%	25	26%	2.18	(0.98 – 5.03)
Crain Crain	32	65%	70	71%	0.81	(0.34 – 1.92)
Cucumbers	24	49%	44	45%	1.17	(0.57 – 2.39)
Cold, left over ebe	1	2%	3	3%	0.67	(0.01 – 8.30)
Fresh, hot ebe	9	18%	15	15%	1.36	(0.47 – 3.86)
Cold then reheated ebe	0	0%	1	1%	2.00	(0.00 – 38.0)
Alcohol the 5 days before illness	7	14%	7	7%	2.02	(0.57 – 7.41)
Fish	48	98%	97	99%	0.50	(0.01 – 39.3)
Cold left over foofoo	10	20%	12	12%	1.77	(0.65 – 4.81)
Fresh, hot foofoo	25	51%	60	61%	0.73	(0.35 – 1.52)
Cold and then reheated foofoo	1	2%	9	9%	0.22	(0.01 – 1.60)
Ginger beer	21	43%	37	38%	1.27	(0.56 – 2.84)
Goat	10	20%	17	17%	1.32	(0.41 – 4.25)
Grand Soup	20	41%	41	42%	1.04	(0.51 – 2.10)
Lime	24	49%	38	39%	1.73	(0.78 – 3.95)
Milk	27	55%	70	71%	0.47	(0.21 – 1.05)
Mangoes	12	24%	18	18%	1.41	(0.57 – 3.40)
Okra	20	41%	58	59%	0.46	(0.19 – 1.06)
Omoli (Water and fermented sugar)	6	12%	1	1%	12.00	(1.46 – 552)
Plantain	15	31%	32	33%	0.88	(0.38 – 2.02)
Plum	16	33%	42	43%	0.63	(0.28 – 1.40)
Pop Drinks	23	47%	46	47%	1.00	(0.46 – 2.11)
Pork	4	8%	5	5%	1.60	(0.32 – 7.43)
Potato	29	59%	70	71%	0.56	(0.25 – 1.22)
Potato leaf	41	84%	94	96%	0.20	(0.03 – 0.87)
Poyo	6	12%	2	2%	6.00	(1.07 – 60.8)
Cold, reheated rice	20	41%	31	32%	1.45	(0.67 – 3.13)
Fresh, hot rice	45	92%	96	98%	0.13	(0.00 – 1.26)

Cold and then reheated rice	23	47%	71	72%	0.34	(0.15 – 0.75)
Sugar Cane	4	8%	9	9%	0.88	(0.19 – 3.37)
Sour-Sour	13	27%	25	26%	1.05	(0.45 – 2.43)
Bean soup	22	45%	53	54%	0.70	(0.33 – 1.46)
Ground nut soup	32	65%	77	79%	0.50	(0.20 – 1.22)
Boiled Okra Soup	17	35%	39	40%	0.78	(0.33 – 1.79)
Palm oil soup	23	47%	60	61%	0.57	(0.26 – 1.19)
Pepper soup	18	37%	46	47%	0.64	(0.29 – 1.40)
Tea	33	67%	68	69%	0.91	(0.41 – 2.07)
Tola (seed, heated and pounded)	20	41%	26	27%	2.00	(0.87 – 4.71)
Tomatoes	10	20%	33	34%	0.53	(0.22 – 1.22)

Table 6. Other exposures among cases and controls, cholera investigation, Freetown Sierra Leone, September 2012.

	Cases n=48	Controls n=98	mOR (95% CI)
Contact with a person with cholera	8 (17%)	8 (9%)	2.26 (0.7–8.1)
Attended a funeral	7 (15%)	13 (13%)	1.1 (0.3–3.2)
Attended a social gathering	8 (17%)	18 (19%)	0.8 (0.3–2.2)

Table 7. Sanitation practices among cases and controls, cholera investigation, Freetown Sierra Leone, September 2012.

	Cases n=49	Controls n=98
Pit latrine	41 (84%)	84 (86%)
Modern flush toilet	3 (6%)	8 (8%)
Pour flush toilet	1 (2%)	4 (4%)
Bucket	0 (0%)	1 (1%)
Open	3 (6%)	3 (3%)
Shared a latrine with other households	29/47 (62%)	62/96 (65%)
Soap observed in home	40 (83%)	91 (93%)

Table 8. Responses by cases and controls to “How can you prevent cholera?” cholera investigation, Freetown Sierra Leone, September 2012.

	Cases n=49	Controls n=98
Drink treated water	40 (82%)	66 (67%)
Wash your hands	39 (80%)	79 (81%)
Eat properly heated food	20 (41%)	38 (39%)
Disinfect house with chlorine	4 (8%)	4 (4%)
Take an antibiotic pill	3 (6%)	8 (8%)
Cholera cannot be prevented	0 (0%)	1 (1%)
Don't know	6 (12%)	8 (8%)

Table 9. Responses by cases and controls to “What should you do if you have cholera?” cholera investigation, Freetown Sierra Leone, September 2012.

	Cases n=48	Controls n=96
Go to a health facility	44 (90%)	86 (88%)
Drink ORS	31 (63%)	49 (50%)
Take an antibiotic	1 (2%)	7 (7%)
Go to a traditional healer	0 (0%)	2 (2%)
Cholera cannot be treated	0 (0%)	0 (0%)
Don't know	3 (6%)	5 (5%)

Table 10. Responses by cases and controls to “How do you get cholera?” cholera investigation, Freetown Sierra Leone, September 2012.

	Cases n=48	Controls n=96
By drinking contaminated water	35 (71%)	69 (70%)
By eating contaminated food	33 (67%)	73 (74%)
By not washing hands	13 (27%)	29 (30%)
From a dirty environment	9 (18%)	28 (29%)
Flies and insects	5 (10%)	29 (30%)
Burial preparation	0 (0%)	2 (2%)
From the air	1 (2%)	16 (16%)
Caring for people that are ill with cholera	0 (0%)	4 (4%)
Shaking hands	0 (0%)	1 (1%)
Don't know	12 (24%)	14 (14%)

Table 11. Responses by cases and controls to “What do you remember most about the messages you’ve received?” cholera investigation, Freetown Sierra Leone, September 2012.

	Cases n=49 (%)	Controls n=98 (%)
Treat your water	-	44 (45%)
Wash your hands using soap and safe water	32 (65%)	70 (71%)
Drink ORS or SSS if you have diarrhea	23 (47%)	20 (20%)
Use latrines or bury feces	2 (4%)	8 (8%)
Go to a clinic immediately if you have severe watery diarrhea/cholera	10 (20%)	16 (16%)
Don't defecate in an open field, in/near a body of water	4 (8%)	10 (10%)
Cook food well	11 (22%)	23 (23%)
Don't know	3 (6%)	5 (5%)

Table 12. Laboratory testing results, Sierra Leone, September 2012 n=32

Sample Number	Gender	Age	Collection area	RDT	Sierra Leone Culture	CDC Culture	CDC PCR analysis
Freetown 124	M	19	Wellington	Neg	Neg	Neg	Neg
Freetown 125	M	20	Wellington	Pos - O1	Pos - O1	Neg	Pos
Freetown 126	M	24	Wellington	Pos - O1	Pos - O1	Neg	Pos
Freetown 129	M	35	Wellington	Neg	Neg	Neg	Neg
Freetown 130	M	26	Wellington	Neg	Neg	Neg	Neg
Freetown 133	M	27	Wellington	Neg	NT	Neg	Neg
Freetown 134	F	8	Wellington	Pos - O1	NT	Neg	Pos
Freetown 135	F	13	Wellington	Pos - O1	NT	Pos	Pos
Freetown 136	M	19	Wellington	Pos - O1	NT	Neg	Pos
Freetown 137	M	23	Wellington	Neg	NT	Neg	Neg
Freetown 138	M	38	Wellington	Pos - O1	NT	Neg	Pos
Freetown 140	F	23	Wellington	Neg	NT	Neg	Neg
Freetown 141	F	50	Wellington	Neg	NT	Neg	Neg
Freetown 142	F	21	Wellington	Pos - O1	NT	Pos	Pos
Freetown 143	F	20	Wellington	Pos - O1	NT	Neg	Pos
Freetown 144	F	45	Wellington	Pos - O1	NT	Pos	Pos
Freetown 145	F	15	Kuntoloh	Pos - O1	NT	Neg	Neg
Freetown 148	F	34	Wellington	Neg	Neg	Neg	Neg
Freetown 149	F	35	Wellington	Neg	Neg	Neg	Neg
Freetown 150	M	49	Wellington	Neg	Neg	Neg	Neg
Freetown 151	M	26	Wellington	Neg	Neg	Neg	Neg
Freetown 152	M	6	Kuntoloh	Pos - O1	Neg	Neg	Pos
Freetown 154	F	18	Kuntoloh	Pos - O1	Neg	Neg	Pos
Freetown 157	M	40	Wellington	Neg	Neg	Neg	Neg
Freetown 158	F	23	Wellington	Neg	Neg	Neg	Neg
Freetown 164	M	33	Wellington	Pos - O1	Neg	Neg	Pos
Freetown 166	F	25	Wellington	Pos - O1	Neg	Neg	Neg
Freetown 167	M	28	Wellington	Pos - O1	Pos - O1	Neg	Pos
Freetown 168	F	47	Kuntoloh	Neg	Neg	Neg	Neg
Freetown 171	F	24	Wellington	Neg	Neg	Neg	Neg
Not included in analysis							
Freetown 103	M	34	Military 34	Pos - O1	Neg	Neg	Neg
Freetown 128	M	39	Wellington	Pos - O1	Pos - O1	Neg	Pos

Sample Number	Gender	Age	Collection area	RDT	Sierra Leone Culture	CDC Culture	CDC PCR analysis
Bombali 101	F	8	Makeni	Neg	Neg	Neg	Neg
Bombali 103	M	55	Makeni	Pos - O1	Neg	Neg	Neg
Bombali 104	M	35	Makeni	Neg	Neg	Neg	Neg
Bombali 108	M	30	Makeni	Pos - O1	Neg	Neg	Neg
Bombali 109	F	6	Makeni	Pos - O1	Neg	Neg	Neg
Bombali 110	F	27	Makeni	Neg	Neg	Neg	Neg
Bombali isolate 1				NT	NT	Neg	Neg
Bombali isolate 2				NT	NT	Neg	Pos
Bombali isolate 3				NT	NT	Neg	Pos
Bombali isolate 4				NT	NT	Pos	Pos
Bombali isolate 5				NT	NT	Neg	Pos
Bombali isolate 6				NT	NT	Neg	Neg
Bombali isolate 7				NT	NT	Neg	Pos

NT=not tested

Table 13. Occurrence of Pulsed-field gel electrophoresis *Vibrio cholerae* two-enzyme pattern from Sierra Leone, September 2012

Source Country	Occurrence
Angola	11
Kenya	8
Tanzania	2
Togo	2
Bangladesh	2
Guinea-Bissau	1
India	1

APPENDIX – Questionnaires

Risk Factor Case-Control Study ENGLISH CASE QUESTIONNAIRE

Elicit answers from [name of case].

- IF CASE-PATIENT IS AN ADULT—Read the text below and proceed to Q.1.
- IF CASE-PATIENT IS 5 –15 YEARS OLD—Ask to speak with the parent or guardian, read the parent/guardian the text below, and proceed to Q1
- IF CASE-PATIENT < 5 YEARS OLD—Thank them for their time, note on log sheet, and end interview.

We are working with the Ministry of Health and Sanitation in Sierra Leone to investigate the ongoing cholera outbreak. We are only collecting information necessary to better understand the cholera outbreak. Your responses to our questions will have no direct impact on you or your family but instead will help us better understand this outbreak and how to prevent cholera from spreading. You and your family are free to choose whether or not to participate in this investigation. You are also free to say no to any part of this investigation. There is no penalty if you or your family do not want to participate, and this will not affect the medical care you receive. Even if you agree to participate, you may change your mind at any time.

We are wondering if you would be willing to answer some questions. It will take about 30 minutes of your time.
 Yes → GO TO Q1
 No → Thank them, note on log sheet, and end interview.

Q #	Question
A. RESPONDENT INFORMATION	
1	What is your relationship to the person with cholera? (CIRCLE ONE) 1. Patient 2. Spouse 3. Parent 4. Sibling 88. Other (<i>specify</i>) _____
B. CASE PATIENT VERIFICATION	
2	Since June 23rd, have you (the patient) been sick with acute watery diarrhea? 1. Yes → go to Q3 0. No → End Questionnaire 99. Don't know → End Questionnaire
3	Since June 23rd, was anyone else in your (the patient's) house sick with cholera (i.e. acute watery diarrhea) before you (the patient) (or your family member)? 1. Yes → End Questionnaire 0. No → go to Q4 99. Don't know → End Questionnaire
4	On the day you were most ill, how many stools did you have in a 24 hour period? (DO NOT READ, CIRCLE ONE) 1. Less than 3 stools/day → End Questionnaire 2. Equal or more than 3 stools/day → go to Q5
5	Have you received IV fluids (drip) during your admission? (<i>CHECK IF PATIENT HAS/HAD AN I.V.</i>) 1. Yes → go to Q6 0. No → End Questionnaire
6	Date of first watery diarrhea (dd/mm/yyyy): ____/____/2012

7	In the 5 days before you had diarrhea, did you travel outside Freetown for the entire 5 days? 1. Yes 0. No 99. Don't know <i>If yes → End Questionnaire</i> <i>If no → go to Q8</i>
8	Date admitted to hospital (dd/mm/yyyy): ____/____/2012
9	How long did it take you to reach the health facility? _____ hours _____ minutes
10	Have you had any of the following additional symptoms during your diarrheal illness? (Read each symptom and record response) ____ Vomiting ____ Fever ____ Leg cramps ____ Nausea ____ Loss of consciousness ____ Other _____
C. CASE IDENTIFYING INFORMATION	
11	Patient first name: _____ Last name: _____
12	Age: _____ (years)
13	Sex 1. Male 2. Female
14	What was the patient's place of residence in the 5 days before illness began? 1. Patient's address _____ 2. Phone: _____ 3. Area/section: _____ 4. Get directions: _____
15	How many people live in your (the patient's) household (eat from the same pot)? _____ (number of persons, including patient) 99. Don't know
16	How many people live under your (the patient's) roof (your house)? _____ (number of persons, including patient) 99. Don't know
17	How many people live in your (the patient's) compound? _____ (number of persons, including patient) 2. Not applicable 99. Don't know
18	What was the last year of school you (the patient) completed?(CIRCLE ONE) 1. None 2. Some primary school 3. Completed primary school 4. Some secondary school 5. Completed secondary school 6. Any trade school/university (tertiary level) 88. Other (specify) _____

19	What do you (the patient) do for a living?(<i>CIRCLE ONE</i>) 1. Student 2. Child (not in school) 3. Farmer 4. Fisherman 5. Trader 6. Maid 7. Street food vendor 8. Teacher 9. Unemployed 10. Health Care Worker 88. Other(specify) _____			
20	Does your (the patient's) household own any of the following items? (<i>ANSWER EACH QUESTION, CHECK ALL THAT APPLY</i>)			
		1. Yes	0. No	99. Don't know
	Radio	☐	☐	☐
	Motorcycle	☐	☐	☐
	Car	☐	☐	☐
	Electricity	☐	☐	☐
	Mobile telephone	☐	☐	☐
	Television	☐	☐	☐

D. EXPOSURES	
21	In the 5 days before you had diarrhea, were you in contact with anyone with cholera (acute watery diarrhea)? 1. Yes 0. No 99. Don't know
22	In the 5 days before you had diarrhea, did you go to a funeral? 1. Yes 0. No 99. Don't know <i>If yes, go to Q23</i> <i>If no, skip to Q26</i>
23	<i>If YES, Did you help prepare the body?</i> 1. Yes 0. No 99. Don't know
24	<i>If YES, Did you eat any food or drink at the funeral?</i> 1. Yes 0. No 99. Don't know
25	<i>If YES, Did this person die from cholera (acute watery diarrhea)?</i> 1. Yes 0. No 99. Don't know
26	In the 5 days before you had diarrhea, did you go to any wedding or social gathering (church, mosque etc)? 1. Yes 0. No 99. Don't know <i>If yes, go to Q27</i> <i>If no, skip to Q28 (section E)</i>
27	<i>If YES, Did you eat any food or drink at the gathering?</i> 1. Yes 0. No 99. Don't know

E. WATER EXPOSURES

28	In the 5 days before you had diarrhea, what water sources did you drink from (Probe: while at home, at work, at school, away from home)? (DO NOT READ, CIRCLE ALL THAT APPLY) 1. Piped into dwelling/plot 2. Public tap (tap water) 3. Open well 4. Covered well 5. Borehole/handpump 6. Spring 7. River or stream 8. Lake or pond 9. Rainwater 10. Bottled water 11. Packet water (Brand _____) 12. Local water bags 88. Other (specify) _____ 99. Don't know
29	In the 5 days before you had diarrhea, did you drink any untreated/unsafe water? 1. Yes 0. No 99. Don't know <i>If YES, go to Q.30</i> <i>If NO, skip to Q.31</i>
30	<i>If YES, from what source?</i> (DO NOT READ, CIRCLE ALL THAT APPLY) 1. Piped into dwelling/plot 2. Public tap (tap water) 3. Open well 4. Covered well 5. Borehole/handpump 6. Spring 7. River or stream 8. Lake or pond 9. Rainwater 10. Bottled water 11. Packet water (Brand _____) 12. Local water bag 88. Other (specify) _____ 99. Don't know
31	In the 5 days before you had diarrhea, did you or your family do anything to make your drinking water safe at home? 1. Yes 0. No 99. Don't know <i>If yes, go to Q32</i> <i>If no, skip to Q35 (section F)</i>

32	<i>If YES, what have you been doing to make your drinking water safe at home? (DO NOT READ, CIRCLE ALL THAT APPLY)</i> 1. Boiling 2. Chlorination product (Klorin/Aquatab) 3. Filter (specify type _____) 88. Other (specify) _____ 99. Don't know
33	In the 5 days before you had diarrhea, how often did you or your family make your drinking water safe at home? 1. Daily 2. Every 2-3 days 3. Once in the five days 88. Other (specify) _____ 99. Don't know:

F: FOOD EXPOSURES

35. Category 1: Food staples

In the 5 days before you had diarrhea, did you eat any of the following food items? (ANSWER EACH QUESTION)

	1. Yes	0. No	99. Don't know
Cassava	☐	☐	☐
Plantains	☐	☐	☐
Potato	☐	☐	☐
Foofoo			
Did you eat any freshly made, hot foofoo ?	☐	☐	☐
Did you eat cold leftover foofoo ?	☐	☐	☐
Did you eat cold leftover foofoo that was reheated ?	☐	☐	☐
Ebe (porridge, cassava, yam and potatoes)			
Did you eat any freshly made, hot ebe ?	☐	☐	☐
Did you eat cold leftover ebe ?	☐	☐	☐
Did you eat cold leftover ebe that was reheated ?	☐	☐	☐
Rice			
Did you eat any freshly made, hot rice ?	☐	☐	☐
Did you eat cold leftover rice ?	☐	☐	☐
Did you eat cold leftover rice that was reheated ?	☐	☐	☐

36. Category 2: Meat, Fish and Dairy

In the 5 days before you had diarrhea, did you eat any of the following food items? (ANSWER EACH QUESTION)

	1. Yes	0. No	99. Don't know
Chicken	☐	☐	☐
Pork	☐	☐	☐
Goat	☐	☐	☐
Beef (cow meat)	☐	☐	☐
Canda (cow hide)	☐	☐	☐
Fish	☐	☐	☐
<i>If YES, was it cooked?</i>	☐	☐	☐
<i>If YES, was it smoked?</i>	☐	☐	☐
Crabs	☐	☐	☐
<i>If YES, was it cooked?</i>	☐	☐	☐
Milk	☐	☐	☐
<i>If YES, was it cow milk?</i>	☐	☐	☐
<i>If YES, was it powdered milk?</i>	☐	☐	☐

37. Category 3: Soups

In the 5 days before you had diarrhea, did you eat any of the following food items? (ANSWER EACH QUESTION)

	1. Yes	0. No	99. Don't know
Ground nut soup	☐	☐	☐
Boiled okra soup	☐	☐	☐
Pepper soup	☐	☐	☐
Palm oil soup	☐	☐	☐
Bean soup	☐	☐	☐

38. Category 4: Vegetables and leaves

In the 5 days before you had diarrhea, did you eat any of the following food items? (ANSWER EACH QUESTION)

	1. Yes	0. No	99. Don't know
Grand soup	☐	☐	☐
Sour-sour (cooked sour leaves)	☐	☐	☐
Beni (seed)	☐	☐	☐
Tola (seed, heated and pounded)	☐	☐	☐
Crain crain	☐	☐	☐
Potato leaves	☐	☐	☐
Cassava leaves	☐	☐	☐
Bitter leaves	☐	☐	☐
Beans	☐	☐	☐
Okra	☐	☐	☐
Cucumbers	☐	☐	☐
Sugarcane	☐	☐	☐

39. Category 5: Fruits

In the 5 days before you had diarrhea, did you eat any of the following food items? (ANSWER EACH QUESTION)

	1. Yes	0. No	99. Don't know
Plums	☐	☐	☐
Mangoes	☐	☐	☐
Tomatoes	☐	☐	☐
Limes	☐	☐	☐

40. Category 6: Drinks and alcohol

In the 5 days before you had diarrhea, did you eat any of the following food items? (ANSWER EACH QUESTION)

	1. Yes	0. No	99. Don't know
Pop drinks	☐	☐	☐
Ginger beer	☐	☐	☐
Omoli (water and fermented sugar)	☐	☐	☐
Poyo (Palm wine)	☐	☐	☐
Tea	☐	☐	☐
Any alcohol in the 5 days before you became ill with watery diarrhea	☐	☐	☐

41 In the 5 days before you had diarrhea, did you eat any food, drinks or water purchased from a street vendor?
 1. YES (specify where: _____)
 0. No
 99. Don't know

If YES, did you eat any of the following at a street vendor? _____

	1. Yes	0. No	99. Don't know
Pop drinks	☐	☐	☐
Water	☐	☐	☐
Ginger beer	☐	☐	☐
Grand Soup	☐	☐	☐
Rice	☐	☐	☐
Any Soup	☐	☐	☐
Sliced fruit	☐	☐	☐
Other: (please specify: _____)			

If YES, between _____ and _____ how often did you eat at a street vendor?

1. More than once a day
2. Once a day
3. 2-3 times a week
4. Once in the 5 days
88. Other (specify _____)
99. Don't know

G. KNOWLEDGE, ATTITUDES AND PRACTICES	
42	Before you came to the health facility, did you receive any information about cholera? 1. Yes 0. No 99. Don't know <i>If yes, go to Q43</i> <i>If no, skip to Q46</i>
43	<i>If YES, how did you receive that information? (Do not read, CIRCLE ALL THAT APPLY)</i> 1. Radio 2. Television 3. SMS 4. Newspaper 5. Flyer/brochure/poster 6. Community meeting 7. Hospital staff 8. Community health worker 9. Friend 10. Family member 88. Other (specify _____) 99. Don't know

44	<i>If YES, when did you receive information about cholera?</i> 1. 1 week ago 2. 2-3 weeks ago 3. 1 month ago 4. More than 1 month ago 88. Other (specify) _____ 99. Don't know
45	<i>If YES, how often have you received education about cholera?</i> 1. Daily 2. 2-3 days per week 3. Once per week 4. Once per 2 weeks 5. Once per month 88. Other (specify) _____ 99. Don't know
46	Have you received any health education from this health facility during this admission? 1. Yes 0. No 99. Don't know <i>If yes, go to Q47</i> <i>If no, skip to Q48</i>
47	<i>If YES, on what topics? (Do not read, CIRCLE ALL THAT APPLY)</i> 1. How you can prevent yourself from getting cholera 2. How cholera is spread 3. Water treatment 4. Hand hygiene 88. Other (specify) 99. Don't know
48	What do you remember most about the messages you've received (this includes messages both before and after you were admitted)? (Do not read, circle all that apply) 1. Wash your hands using soap and safe water 2. Drink ORS of SSS if you have diarrhea 3. Use latrines or bury feces 4. Go to a clinic immediately If you have severe watery diarrhea/cholera 5. Don't defecate in an open field, in/near a body of water 6. Cook food well, keep it covered, eat it hot and peel fruits and vegetables 88. Other (specify) 99. Don't know
49	How do you get cholera? (Do not read, circle ALL THAT APPLY) 1. By drinking contaminated water 2. By eating contaminated food 3. Burial preparation 4. By not washing hands 5. Caring for people that are ill with cholera 6. From the air 7. Flies and insects 8. Shaking hands 9. From a dirty environment 88. Other (specify) _____ 99. Don't know

50	Can you tell me the symptoms of cholera? (Do not read, circle ALL THAT APPLY) 1. Watery diarrhea 3. Bloody diarrhea 4. Vomiting 5. Fever 6. Dehydration 7. Poor appetite 8. Fatigue 9. Cough 88. Other(specify) _____ 99. Don't know
51	Please name ways to prevent cholera (DO NOT READ, CIRCLE ALL THAT APPLY) 1. Wash your hands 2. Drink treated water 3. Eat properly heated food 4. Disinfect house with chlorine 5. Take an antibiotic pill 6. Cholera cannot be prevented 88. Other (specify) _____ 99. Don't know
52	What should you do with the body of someone that died of cholera? (DO NOT READ, CIRCLE ALL THAT APPLY) 1. Immediately bury the body 2. Wash hands with soap and safe water after handling the body 88. Other (specify) _____ 99. Don't know
53	What should you do if you have cholera (DO NOT READ, CIRCLE ALL THAT APPLY) 1. Drink oral rehydration solution 2. Go to a health facility 3. Go to a traditional healer 4. Take an antibiotic 5. Cholera cannot be treated 88. Other (specify) _____ 99. Don't know
57	Since June 23rd, did you receive any products for the prevention or treatment of cholera before you were admitted to the CTU? 1. Yes 0. No 99. Don't know <i>If yes, go to Q58</i> <i>If no, skip to Q62</i>
58	If YES, what products? (Do not read, CIRCLE ALL THAT APPLY) 1. Chlorine products 2. ORS 3. Soap 88. Other (specify) _____ 99. Don't know
59	If YES, who did you receive these products from? (Do not read, CIRCLE ALL THAT APPLY) 1. Community health worker 2. Health facility 3. NGO 88. Other (specify) _____ 99. Don't know

60	If YES, how often have you received these products? 1. Daily 2. 2-3 days per week 3. Once per week 4. Once per 2 weeks 5. Once per month 88. Other (specify) 99. Do not know															
61	If YES, were these products free? 1. Yes 0. No 99. Don't know															
62	Do you know what ORS is? 1. Yes 0. No 99. Don't know <i>If yes, go to Q63</i> <i>If no, skip to Q67</i>															
63	Do you know where to get ORS? 1. Yes 0. No 99. Don't know <i>If yes, go to Q64</i> <i>If no, skip to Q65</i>															
64	If YES, where do you get it? 1. Pharmacy 2. Community health worker 3. Health facility 88. Other (specify _____) 99. Don't know															
65	Do you know how to prepare ORS? 1. Yes 0. No 99. Don't know <i>If yes, go to Q66</i> <i>If no, skip to Q67</i>															
66	If YES, how do you prepare it? <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 5px;"> <tr> <th style="width: 25%;"></th> <th style="width: 10%;">1. Yes</th> <th style="width: 10%;">0. No</th> <th style="width: 10%;">99. Don't know</th> <th style="width: 45%;">Quantity used (<i>estimate amount</i>)</th> </tr> <tr> <td>ORS Sachet</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> <td style="text-align: center;"><i>(number of sachets)</i></td> </tr> <tr> <td>Water</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> <td style="text-align: center;"><i>(estimate in liters)</i></td> </tr> </table>		1. Yes	0. No	99. Don't know	Quantity used (<i>estimate amount</i>)	ORS Sachet	☐	☐	☐	<i>(number of sachets)</i>	Water	☐	☐	☐	<i>(estimate in liters)</i>
	1. Yes	0. No	99. Don't know	Quantity used (<i>estimate amount</i>)												
ORS Sachet	☐	☐	☐	<i>(number of sachets)</i>												
Water	☐	☐	☐	<i>(estimate in liters)</i>												
67	When do you usually wash your hands with soap? (<i>Do not read. Check all that are mentioned. If the response is, "When they are dirty," probe to determine when hands become dirty.</i>) 1. Before preparing food or cooking 2. Before eating 3. Before feeding children 4. After cleaning/changing baby 5. After contact with a sick person 6. After using the toilet 7. Do not wash hands with soap 88. Other (specify) _____ 99. Don't know															

Thank you for your participation!

THIS SECTION IS TO BE FILLED OUT BY THE PERSON PERFORMING THE WATER TESTING **AT THE PATIENT'S HOUSE**

H. HOUSEHOLD OBSERVATIONS	
House GPS coordinates N: _____ W: _____	
68	<i>What type of roofing does this household have (CIRCLE ONE)?</i> 1. Thatch 2. Metal/iron sheet 3. Tile/asbestos sheets 4. Wood 5. Cement 88. Other: _____
69	<i>What type of flooring does this household have (CIRCLE ONE)?</i> 1. Mud 2. Metal/iron sheet 3. Wood 4. Cement 5. Tile/linoleum 88. Other: _____
70	<i>What type of material is used for the walls (CIRCLE ONE)?</i> 1. Mud 2. Metal 3. Wood 4. Cement/plaster 5. Bricks/blocks/stones 88. Other: _____
71	"Can you please show me where your drinking water is stored at home?" 1. Drinking water stored 0. No drinking water stored
72	<i>What type of drinking storage container is it?(CIRCLE ONE)</i> 1. Bucket 2. Jerry can (plastic container with narrow mouth) 3. Clay pot 4. Drum (wide mouth) 5. Plastic drinking water bottle 88. Other _____
73	Observation: <i>Does the storage container have (circle):</i> 1. Tap Yes No 2. Cover Yes No
74	Can you please show me how you obtain water from the storage container? <i>Make observation on how water is obtained from the storage container</i> 1. Pours water out 2. Uses a tap 3. Uses a cup (or similar utensil) and dips in the water 88. Other (specify) _____
75	<i>Test chlorine in drinking water (CIRCLE ONE)</i> 1. Positive for chlorine 0. Negative for chlorine

76	“Do you have any products used to make your drinking water safe at home?” 1. Yes 0. No <i>If yes, go to Q77</i> <i>If no, skip to Q78</i>
77	If YES, could you please show it to me? 1. Has 0. Doesn't have Make a note of product name: _____
78	Is there ORS in house? 1. Yes 0. No <i>If yes, go to Q79</i> <i>If no, skip to Q80</i>
79	If YES, could you please show it to me? 1. Has 0. Doesn't have
80	Is there soap for hand-washing in the house? 1. Yes 0. No <i>If yes, go to Q81</i> <i>If no, skip to Q21</i>
81	If YES, could you please show it to me? 1. Has 0. Doesn't have
82	Can you show me how you wash your hands? (RECORD ALL OBSERVATIONS THAT APPLY) 1. Uses soap 2. Makes lather 3. Use towel to dry 4. Air dry 5. Wipe hands on clothes 6. Uses only water (No soap) 0. Not able to demonstrate
83	<i>Observations:</i> Is there a pitcher or cup to pour water for washing hands? 1. Yes 0. No If inside, is there a basin for catching water? 1. Yes 0. No
84	“Can you show me where you most often defecate?” (CIRCLE ALL THAT APPLY) 1. Flush toilet 2. Pour flush toilet/latrine 3. Pit latrine 4. Bucket latrine (where feces are manually removed) 5. Hole in the ground 6. Open defecation (no facilities, bush, or field) 88. Other (specify) _____
85	<i>How far away is the latrine/defecation area from the house (ESTIMATE DISTANCE)</i> _____ metres
86	Do you share your latrine with other houses? 1. Yes 0. No 99. Don't know
87	“How many people share the latrine?” (RECORD NUMBER OF PERSONS) _____ (no. of persons)

88	"Today, where did you collect your drinking water for the household?" (DO NOT READ, CIRCLE ALL THAT APPLY) 1. Piped into dwelling/plot 2. Public tap (tap water) 3. Open well 4. Covered well 5. Borehole/handpump 6. Spring 7. River or stream 8. Lake or pond 9. Rainwater 10. Bottled water 11. Packet water 12. Local water bags 88. Other (specify) _____ 99. Don't know
89	Water Source GPS coordinates N _____ W: _____

Thank you very much for your participation.

Risk Factor Case-Control Study ENGLISH CONTROL QUESTIONNAIRE

Elicit answers from [name of case].

- IF CASE-PATIENT IS AN ADULT—Read the text below and proceed to Q.1.
- IF CASE-PATIENT IS 5 –15 YEARS OLD—Ask to speak with the parent or guardian, read the parent/guardian the text below, and proceed to Q1
- IF CASE-PATIENT < 5 YEARS OLD—Thank them for their time, note on log sheet, and end interview.

We are working with the Ministry of Health and Sanitation in Sierra Leone to investigate the ongoing cholera outbreak. We are only collecting information necessary to better understand the cholera outbreak. Your responses to our questions will have no direct impact on you or your family but instead will help us better understand this outbreak and how to prevent cholera from spreading. You and your family are free to choose whether or not to participate in this investigation. You are also free to say no to any part of this investigation. There is no penalty if you or your family do not want to participate, and this will not affect the medical care you receive. Even if you agree to participate, you may change your mind at any time.

We are wondering if you would be willing to answer some questions. It will take about 30 minutes of your time.
 Yes → GO TO Q1
 No → Thank them, note on log sheet, and end interview.

Q #	Question
A. RESPONDENT INFORMATION	
1	Who is the respondent? (CIRCLE ONE) 1. Self 2. Parent 3. Sibling 88. Other (specify) _____
B. CONTROL PATIENT VERIFICATION	
2	Since June 23rd, have you been sick with acute watery diarrhea? 1. Yes → End questionnaire 0. No → Go to Q3 99. Don't know → End Questionnaire
3	Since June 23rd, was anyone else in your house sick with cholera (i.e. acute watery diarrhea)? 1. Yes → End Questionnaire 0. No → go to Q4 99. Don't know → End Questionnaire
4	Between _____ and _____, did you travel outside Freetown for the entire 5 days? 1. Yes 0. No 99. Don't know If yes → End Questionnaire If no → go to Q5
C. CONTROL IDENTIFYING INFORMATION	
5	Respondent first name: _____ Last name: _____
6	Age: _____ (years)
7	Sex 1. Male 2. Female

8	Between _____ and _____, what was the respondent's place of residence?			
	1. Respondent's address _____			
	2. Phone: _____			
	3. Area/section: _____			
	4. Get directions: _____			
9	How many people live in your household (eat from the same pot)? _____ (number of persons, including patient) 99. Don't know			
10	How many people live under your roof (your house)? _____ (number of persons, including patient) 99. Don't know			
17	How many people live in your compound? _____ (number of persons, including patient) 2. Not applicable 99. Don't know			
18	What was the last year of school you completed?(CIRCLE ONE)			
	1. None			
	2. Some primary school			
	3. Completed primary school			
	4. Some secondary school			
	5. Completed secondary school			
	6. Any trade school/university (tertiary level)			
	88. Other (specify) _____			
19	What do you do for a living?(CIRCLE ONE)			
	1. Student			
	2. Child (not in school)			
	3. Farmer			
	4. Fisherman			
	5. Trader			
	6. Maid			
	7. Street food vendor			
	8. Teacher			
	9. Unemployed			
	10. Health Care Worker			
	88. Other (specify) _____			
20	Does your household own any of the following items? (ANSWER EACH QUESTION, CHECK ALL THAT APPLY)			
		1. Yes	0. No	99. Don't know
	Radio	☐	☐	☐
	Motorcycle	☐	☐	☐
	Car	☐	☐	☐
	Electricity	☐	☐	☐
	Mobile telephone	☐	☐	☐
	Television	☐	☐	☐

D. EXPOSURES			
21	Between _____ and _____, were you in contact with anyone with cholera (acute watery diarrhea)?		
	1. Yes 0. No 99. Don't know		

22	Between _____ and _____, did you go to a funeral? 1. Yes 0. No 99. Don't know <i>If yes, go to Q23</i> <i>If no, skip to Q26</i>
23	<i>If YES, Did you help prepare the body?</i> 1. Yes 0. No 99. Don't know
24	<i>If YES, Did you eat any food or drink at the funeral?</i> 1. Yes 0. No 99. Don't know
25	<i>If YES, Did this person die from cholera (acute watery diarrhea)?</i> 1. Yes 0. No 99. Don't know
26	Between _____ and _____, did you go to any wedding or social gathering (church, mosque etc)? 1. Yes 0. No 99. Don't know <i>If yes, go to Q27</i> <i>If no, skip to Q28 (section E)</i>
27	<i>If YES, Did you eat any food or drink at the gathering?</i> 1. Yes 0. No 99. Don't know

E. WATER EXPOSURES	
29	Between _____ and _____, what water sources did you drink from (Probe, while at home, at work, at school, away from home)? <i>(DO NOT READ, CIRCLE ALL THAT APPLY)</i> 1. Piped into dwelling/plot 2. Public tap (tap water) 3. Open well 4. Covered well 5. Borehole/handpump 6. Spring 7. River or stream 8. Lake or pond 9. Rainwater 10. Bottled water 11. Packet water (Brand _____) 12. Local water bags 88. Other (specify) _____ 99. Don't know
30	Between _____ and _____, did you drink any untreated/unsafe water? 1. Yes 0. No 99. Don't know <i>If YES, go to Q.31</i> <i>If NO, skip to Q.32</i>

31	<i>If YES, from what source?</i> <i>(DO NOT READ, CIRCLE ALL THAT APPLY)</i> 1. Piped into dwelling/plot 2. Public tap (tap water) 3. Open well 4. Covered well 5. Borehole/handpump 6. Spring 7. River or stream 8. Lake or pond 9. Rainwater 10. Bottled water 11. Packet water (Brand _____) 12. Local water bags 88. Other (specify) _____ 99. Don't know
32	Between _____ and _____, did you do anything to make your drinking water safe at home? 1. Yes 0. No 99. Don't know <i>If yes, go to Q33</i> <i>If no, skip to Q35 (section F)</i>
33	<i>If YES, what have you been doing to make your drinking water safe at home? (DO NOT READ, CIRCLE ALL THAT APPLY)</i> 1. Boiling 2. Chlorination product (Klorin/Aquatab) 3. Filter (specify type _____) 88. Other (specify) _____ 99. Don't know
34	If YES, between _____ and _____, how often do you make your drinking water safe at home? 1. Daily 2. Every 2-3 days 3. Once in the five days 88. Other (specify) _____ 99. Don't know

F: FOOD EXPOSURES

35. Category 1: Food staples

Between _____ and _____, did you eat any of the following food items? (ANSWER EACH QUESTION)			
	1. Yes	0. No	99. Don't know
Cassava	☐	☐	☐
Plantains	☐	☐	☐
Potato	☐	☐	☐
Foofoo			
Did you eat any freshly made, hot foofoo ?	☐	☐	☐
Did you eat cold leftover foofoo ?	☐	☐	☐
Did you eat cold leftover foofoo that was reheated ?	☐	☐	☐
Ebe (porridge, cassava, yam and potatoes)			
Did you eat any freshly made, hot ebe ?	☐	☐	☐
Did you eat cold leftover ebe ?	☐	☐	☐
Did you eat cold leftover ebe that was reheated ?	☐	☐	☐
Rice			
Did you eat any freshly made, hot rice ?	☐	☐	☐
Did you eat cold leftover rice ?	☐	☐	☐
Did you eat cold leftover rice that was reheated ?	☐	☐	☐

36. Category 2: Meat, Fish and Dairy

Between _____ and _____, did you eat any of the following food items? (ANSWER EACH QUESTION)			
	1. Yes	0. No	99. Don't know
Chicken	☐	☐	☐
Pork	☐	☐	☐
Goat	☐	☐	☐
Beef (cow meat)	☐	☐	☐
Canda (cow hide)	☐	☐	☐
Fish	☐	☐	☐
<i>If YES, was it cooked?</i>	☐	☐	☐
<i>If YES, was it smoked?</i>	☐	☐	☐
Crabs	☐	☐	☐
<i>If YES, was it cooked?</i>	☐	☐	☐
Milk	☐	☐	☐
<i>If YES, was it cow milk?</i>	☐	☐	☐
<i>If YES, was it powdered milk?</i>	☐	☐	☐

37. Category 3: Soups

Between _____ and _____, did you eat any of the following food items? (ANSWER EACH QUESTION)			
	1. Yes	0. No	99. Don't know
Ground nut soup	☐	☐	☐
Boiled okra soup	☐	☐	☐
Pepper soup	☐	☐	☐
Palm oil soup	☐	☐	☐
Bean soup	☐	☐	☐

38. Category 4: Vegetables and leaves

Between _____ and _____, did you eat any of the following food items? (ANSWER EACH QUESTION)			
	1. Yes	0. No	99. Don't know
Grand soup	☐	☐	☐
Sour-sour (cooked sour leaves)	☐	☐	☐
Beni (seed)	☐	☐	☐
Tola (seed, heated and pounded)	☐	☐	☐
Crain crain	☐	☐	☐
Potato leaves	☐	☐	☐
Cassava leaves	☐	☐	☐
Bitter leaves	☐	☐	☐
Beans	☐	☐	☐
Okra	☐	☐	☐
Cucumbers	☐	☐	☐
Sugarcane	☐	☐	☐

39. Category 5: Fruits

	Between _____ and _____, did you eat any of the following food items? (ANSWER EACH QUESTION)			
		1. Yes	0. No	99. Don't know
	Plums	☐	☐	☐
	Mangoes	☐	☐	☐
	Limes	☐	☐	☐
	Tomatoes	☐	☐	☐

40. Category 6: Drinks and alcohol

	Between _____ and _____, did you eat any of the following food items? (ANSWER EACH QUESTION)			
		1. Yes	0. No	99. Don't know
	Pop drinks	☐	☐	☐
	Ginger beer	☐	☐	☐
	Omoli (water and fermented sugar)	☐	☐	☐
	Poyo (Palm wine)	☐	☐	☐
	Tea	☐	☐	☐
	Between _____ and _____, did you drink any alcohol?	☐	☐	☐

41 Between _____ and _____, did you eat any food or drinks purchased from a street vendor?

1. YES (specify where: _____)

0. No

99. Don't know

If YES, did you eat any of the following at a street vendor? _____

	1. Yes	0. No	99. Don't know
Pop drinks	☐	☐	☐
Water	☐	☐	☐
Ginger beer	☐	☐	☐
Grand Soup	☐	☐	☐
Rice	☐	☐	☐
Any Soup	☐	☐	☐
Sliced fruit	☐	☐	☐
Other: (please specify: _____)			

If YES, between _____ and _____ how often did you eat at a street vendor?

1. More than once a day

2. Once a day

3. 2-3 times a week

4. Once in the 5 days

88. Other (specify _____)

99. Don't know

G. KNOWLEDGE, ATTITUDES AND PRACTICES

42 Have you received any information about cholera?

1. Yes 0. No 99. Don't know

If yes, go to Q43

If no, skip to Q46

43	<i>If YES, how did you receive that information? (Do not read, CIRCLE ALL THAT APPLY)</i> 1. Radio 2. Television 3. SMS 4. Newspaper 5. Flyer/brochure/poster 6. Community meeting 7. Hospital staff 8. Community health worker 9. Friend 10. Family member 88. Other (specify) _____ 99. Don't know
44	<i>If YES, when did you receive information about cholera?</i> 1. 1 week ago 2. 2-3 weeks ago 3. 1 month ago 4. More than 1 month ago 88. Other (specify) _____ 99. Don't know
45	<i>If YES, how often have you received education about cholera?</i> 1. Daily 2. 2-3 days per week 3. Once per week 4. Once per 2 weeks 5. Once per month 88. Other (specify) _____ 99. Don't know
46	<i>What do you remember most about the messages you've received? (Do not read, circle all that apply)</i> 1. Treat water before drinking and using 2. Wash your hands using soap and safe water 3. Drink ORS of SSS if you have diarrhea 4. Use latrines or bury feces 5. Go to a clinic immediately If you have severe watery diarrhea/cholera 6. Don't defecate in an open field, in/near a body of water 7. Cook food well, keep it covered, eat it hot and peel fruits and vegetables 88. Other (specify) 99. Don't know
47	<i>How do you get cholera? (Do not read, circle ALL THAT APPLY)</i> 1. By drinking contaminated water 2. By eating contaminated food 3. Burial preparation 4. By not washing hands 5. Caring for people that are ill with cholera 6. From the air 7. Flies and insects 8. Shaking hands 9. From a dirty environment 88. Other (specify) _____ 99. Don't know

48	Can you tell me the symptoms of cholera? (DO NOT READ, CIRCLE ALL THAT APPLY) 1. Watery diarrhea 3. Bloody diarrhea 4. Vomiting 5. Fever 6. Dehydration 7. Poor appetite 8. Fatigue 9. Cough 88. Other(specify) _____ 99. Don't know
49	Please name ways to prevent cholera (DO NOT READ, CIRCLE ALL THAT APPLY) 1. Wash your hands 2. Drink treated water 3. Eat properly heated food 4. Disinfect house with chlorine 5. Take an antibiotic pill 6. Cholera cannot be prevented 88. Other (specify) _____ 99. Don't know
50	What should you do with the body of someone that died of cholera? (DO NOT READ, CIRCLE ALL THAT APPLY) 1. Immediately bury the body 2. Wash hands with soap and safe water after handling the body 88. Other (specify) 99. Don't know
51	What should you do if you have cholera (DO NOT READ, CIRCLE ALL THAT APPLY) 1. Drink oral rehydration solution 2. Go to a health facility 3. Go to a traditional healer 4. Take an antibiotic 5. Cholera cannot be treated 88. Other (specify) _____ 99. Don't know
52	If you have cholera, do you think it is necessary to go to a health facility? 1. Yes 0. No 99. Don't know
53	Is cholera treatment free? 1. Yes 0. No 99. Don't know
54	How long does it take you to travel to the nearest health facility or cholera treatment center?
55	Since June 23rd, have you received any products for the prevention or treatment of cholera? 1. Yes 0. No 99. Don't know <i>If yes, go to Q56</i> <i>If no, skip to Q61</i>
56	If YES, what products? (Do not read, CIRCLE ALL THAT APPLY) 1. Chlorine products 2. ORS 3. Soap 88. Other (specify) _____ 99. Don't know

57	If YES, who did you receive these products from? <i>(Do not read, CIRCLE ALL THAT APPLY)</i> 1. Community health worker 2. Health facility 3. NGO 88. Don't know 99. Other																		
58	If YES, how often have you received these products? 1. Daily 2. 2-3 days per week 3. Once per week 4. Once per 2 weeks 5. Once per month 6. Other 7. Do not know																		
59	If YES, were these products free? Yes 0. No 99. Don't know																		
61	Do you know what ORS is? 1. Yes 0. No 99. Don't know <i>If yes, go to Q62</i> <i>If no, skip to Q66</i>																		
62	Do you know where to get ORS? 1. Yes 0. No 99. Don't know <i>If yes, go to Q63</i> <i>If no, skip to Q64</i>																		
63	If YES, where do you get it? 1. Pharmacy 2. Community health worker 3. Health facility 88. Other (specify _____) 99. Don't know																		
64	Do you know how to prepare ORS? 1. Yes 0. No 99. Don't know <i>If yes, go to Q65</i> <i>If no, skip to Q66</i>																		
65	If YES, how do you prepare it? <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 25%;"></th> <th style="width: 10%;">1. Yes</th> <th style="width: 10%;">0. No</th> <th style="width: 10%;">99. Don't know</th> <th style="width: 45%;">Quantity used <i>(estimate amount)</i></th> </tr> </thead> <tbody> <tr> <td>ORS Sachet</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> <td style="text-align: center;"><i>(number of sachets)</i></td> </tr> <tr> <td>Water</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> <td style="text-align: center;"><i>(estimate in liters)</i></td> </tr> </tbody> </table>					1. Yes	0. No	99. Don't know	Quantity used <i>(estimate amount)</i>	ORS Sachet	☐	☐	☐	<i>(number of sachets)</i>	Water	☐	☐	☐	<i>(estimate in liters)</i>
	1. Yes	0. No	99. Don't know	Quantity used <i>(estimate amount)</i>															
ORS Sachet	☐	☐	☐	<i>(number of sachets)</i>															
Water	☐	☐	☐	<i>(estimate in liters)</i>															
66	When do you usually wash your hands with soap? <i>(Do not read. Check all that are mentioned. If the response is, "When they are dirty," probe to determine when hands become dirty.)</i> 1. Before preparing food or cooking 2. Before eating 3. Before feeding children 4. After cleaning/changing baby 5. After contact with a sick person 6. After using the toilet 7. Do not wash hands with soap 88. Other (specify) _____ 99. Don't know																		

Thank you for your participation!

THIS SECTION IS TO BE FILLED OUT BY THE PERSON PERFORMING THE WATER TESTING AT THE PATIENT'S HOUSE

H. HOUSEHOLD OBSERVATIONS	
House GPS coordinates N: _____ W: _____	
67	What type of roofing does this household have (CIRCLE ONE)? 1. Thatch 2. Metal/iron sheet 3. Tile/asbestos sheets 4. Wood 5. Cement 88. Other: _____
68	What type of flooring does this household have (CIRCLE ONE)? 1. Mud 2. Metal/iron sheet 3. Wood 4. Cement 5. Tile/linoleum 88. Other: _____
69	What type of material is used for the walls (CIRCLE ONE)? 1. Mud 2. Metal 3. Wood 4. Cement/plaster 5. Bricks/blocks/stones 88. Other: _____
70	"Can you please show me where your drinking water is stored at home?" 1. Drinking water stored 0. No drinking water stored
71	What type of drinking storage container is it?(CIRCLE ONE) 1. Bucket 2. Jerry can (plastic container with narrow mouth) 3. Clay pot 4. Drum (wide mouth) 5. Plastic drinking water bottle 88. Other _____
72	Observation: Does the storage container have (circle): 1. Tap Yes No 2. Cover Yes No
73	Can you please show me how you obtain water from the storage container? Make observation on how water is obtained from the storage container 1. Pours water out 2. Uses a tap 3. Uses a cup (or similar utensil) and dips in the water 88. Other (specify) _____
74	Test chlorine in drinking water (CIRCLE ONE) 1. Positive for chlorine 0. Negative for chlorine

75	“Do you have any products used to make your drinking water safe at home?” 1. Yes 0. No <i>If yes, go to Q76</i> <i>If no, skip to Q77</i>
76	If YES, could you please show it to me? 1. Has 0. Doesn't have Make a note of product name: _____
77	Is there ORS in house? 1. Yes 0. No <i>If yes, go to Q81</i> <i>If no, skip to Q82</i>
78	If YES, could you please show it to me? 1. Has 0. Doesn't have
79	Is there soap for hand-washing in the house? 1. Yes 0. No <i>If yes, go to Q80</i> <i>If no, skip to Q81</i>
80	If YES, could you please show it to me? 1. Has 0. Doesn't have
81	Can you show me how you wash your hands? (RECORD ALL OBSERVATIONS THAT APPLY) 1. Uses soap 2. Makes lather 3. Use towel to dry 4. Air dry 5. Wipe hands on clothes 6. Uses only water (No soap) 0. Not able to demonstrate
82	<i>Observation:</i> Is there a pitcher of cup to pour water for hand-washing? 1. Yes 0. No If inside, is there a basin for catching water? 1.Yes 0. No
83	“Can you show me where you most often defecate?” (CIRCLE ALL THAT APPLY) 1. Flush toilet 2. Pour flush toilet/latrine 3. Pit latrine 4. Bucket latrine (where feces are manually removed) 5. Hole in the ground 6. Open defecation (no facilities, bush, or field) 88. Other _____
84	<i>How far away is the latrine/defecation area from the house (ESTIMATE DISTANCE)</i> _____ metres
85	Do you share your latrine with other houses? 1. Yes 0. No 99. Don't know
86	“How many people share the latrine?” (RECORD NUMBER OF PERSONS) _____ (no. of persons)

87	"Today, where did you collect your drinking water for the household?" <i>(DO NOT READ, CIRCLE ALL THAT APPLY)</i> 1. Piped into dwelling/plot 2. Public tap (tap water) 3. Open well 4. Covered well 5. Borehole/handpump 6. Spring 7. River or stream 8. Lake or pond 9. Rainwater 10. Bottled water 11. Packet water 12. Local water bag 88. Other (specify) _____ 99. Don't know
88	Water Source GPS coordinates N _____ W: _____

Thank you very much for your participation.