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Cholera Outbreak in a Fishing Village in Uganda: A Case Study

Participant Guide

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Cholera Outbreak in a Fishing Village in Uganda: A Case Study

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Abstract

In June 2015, the District Health Officer of Kasese District, southwestern Uganda reported an outbreak of cholera in a fishing village. Two fellows of the Uganda Public Health Fellowship Program – Field Epidemiology Track conducted an investigation to verify the existence of an outbreak, determine the mode of transmission, and recommend control measures. This case study describes that investigation, which teaches the steps in an outbreak investigation and the details in each step, what needs to be done in each step to achieve the objectives of the investigation, and what might be the common pitfalls during an outbreak investigation. This case study can be used to teach the fundamental principles of an outbreak investigation and use of Epi Info for outbreak analysis. The audience are field epidemiologists at various levels in different settings.

How to Use the Case Study

General instructions: Ideally, 1 or 2 instructors facilitate the case study for 8 to 15 participants in a classroom or conference room. After a brief introduction about the case study, the instructor asks a participant to read aloud a paragraph or two, going around the room and giving each participant a chance to read. After the participant has finished reading a question, the instructor directs all participants to perform calculations, construct graphs, or engage in a discussion of the answer. Sometimes, the instructor can split the class to play different roles, conduct calculations on different parts of a question, or take different sides in answering the question. As a result, participants enrich their learning experience.

Audience: FETP trainees (intermediate or advanced levels), public health or surveillance officers at national or subnational levels, Master of Public Health (MPH) students at schools of public health, and other public health officials interested in learning how to conduct outbreak investigations.

Prerequisites: Case study participants should have received lectures and training on fundamentals of biostatistics, fundamentals of epidemiology, outbreak investigation and Epi Info 7.

Materials needed:

- Flip charts, marker set: one per 8-10 participants
- Laptop computers with Microsoft Office Suite and Epi Info 7 pre-installed
- Projector, projection screen (or substitutes), and LASER pointer

Level of training and associated public health activity: Intermediate to Advanced

Time required: 2-3 hours

Language: English

Participant Guide

Goal of the Case Study: Case studies in applied epidemiology in general allow students to practice applying epidemiologic skills in the classroom to solve real-world public health problems. They are used as a vital component of an applied epidemiology curriculum, rather than as stand-alone tools. They are ideally suited to reinforcing principles and skills already covered in a lecture or in background reading. This particular case study is designed to provide a comprehensive overview of an outbreak investigation, including the steps involved in an investigation and the details in each step.

Learning Objectives - After completion of this case study, the participants should be able to:

1. Describe the steps in an outbreak investigation
2. Explain the details of how to verify the diagnosis and establish the existence of an outbreak
3. Construct a case definition, find cases, develop a line list, and conduct descriptive analysis
4. Choose a suitable analytic study design for an outbreak investigation
5. Recommend evidence-based control measures
6. Describe the types of communications and their targeted stakeholders

Introduction

On 20th June 2015, the Health Officer of Kasese District in southwestern Uganda reported a sharp increase in cholera cases in a village. More than 30 clinically diagnosed cases had occurred since 16th June. Twenty-seven samples were collected from these case-patients. Eight were positive for *Vibrio cholerae* by stool culture, and the other 19 were positive by a rapid diagnostic test, a dipstick immunochromatographic assay for qualitative detection of *V. cholerae* in stool specimens with a reported sensitivity of 99% and specificity of 97% [1]. He also noted that since March 2015, Kasese District had experienced an ongoing epidemic of cholera (serotype Inaba).

Cholera is an acute enteric infection characterized by an acute onset of profuse, painless watery stools which, if left untreated, can quickly lead to severe dehydration and death [2]. An estimated 1.4 to 4.3 million cases and 28,000 to 142,000 deaths from cholera occur worldwide every year [2]. The incidence of cholera reduces as communities develop and are able to access clean drinking water and food [2].

In 2008, WHO identified 51 countries as endemic for cholera, defined as cholera cases reported in at least 3 of the 5 most recent years [3]. Most of these 51 countries are in Sub-Saharan Africa, which have experienced continued cholera outbreaks since 2008 [3]. In Uganda, cholera outbreaks occur mainly along the western border with Democratic Republic of Congo, in the Karamoja Region to the north and in Kampala City slums [4].

Part 1

Outbreak detection and case finding

The outbreak was reported in Katwe Village, a fishing village in southwestern Uganda, on the shore of Lake Edward (Figure 1). The village has a population of 12,324 (including 6466 males and 5858 females). Most of the residents of the village are fishermen.

Figure 1. Katwe Village (-0.1438968, 29.880607), where a cholera outbreak occurred, June – July, 2015.

(Source: http://ian.macky.net/pat/map/ug/ug.html, public domain, accessed 20 Nov 2017)

Question 1. List the steps in an outbreak investigation.

Question 2. Before traveling to the field, what should the field epidemiologist do to prepare?

On 22 June, two PHFP-FET fellows travelled to the village to conduct an outbreak investigation to identify the mode of exposure for this outbreak, and to provide evidence-based recommendations for controlling this outbreak and preventing future outbreaks.

Question 3. Would you consider this an outbreak?

Question 4. Has the cholera diagnosis been confirmed for this outbreak?

The outbreak investigation team constructed a working case definition, developed a line list, conducted an active case search, and entered the data into the line list.

Question 5. What is a case definition?

Question 6. Construct a working case definition for this outbreak investigation.

Question 7. How should cases be found? What is a line list? What data should be included in the line list for this outbreak?

Part 2

Descriptive epidemiology and hypothesis generation

Descriptive epidemiologic analysis refers to the analysis of the line-list data by time, person, and place.

Descriptive epidemiology by time

Question 8. Use Epi Info and the data in the "Linelist" tab within the dataset "Katwe cholera dataset.xlsx" (Appendix 1) to construct an epidemic curve. Set 14th June 2015 as the start date and 8th July 2015 as the end date. What kind of exposure (e.g., point source, continuous common source, or propagated) caused this outbreak? Explain your answer.

Question 9. Estimate the time-point at which the exposure had occurred, using the epidemic curve. Note that cholera has a median incubation period of 3 days (range: a few hours to 5 days) [9].

Descriptive epidemiology by person

Question 10. Use Epi Info and the data in the "Linelist" tab within the dataset "Katwe cholera dataset.xlsx" to perform relevant calculations, and fill in the blanks in Tables 1 and 2. Interpret the findings.

Table 1. Attack rate of cholera by sex during a cholera outbreak in Katwe Village, southwestern Uganda, June – July 2015.

Sex	Population	Num. of cases	Attack Rate (/1000)
Male	6466		
Female	5858		
Total	**12324**		

Table 2. Percentages of total number of cholera cases by age group during a cholera outbreak in Katwe Village, southwestern Uganda, June – July 2015.

Age group (years)	Num. of cases	%
0-9		
10-19		
20-29		
30-39		
40-49		
50-59		
≥60		
Total	**59***	**100**

Question 11. Interpret the analysis results in Tables 1 and 2.

Question 12. Several months after the outbreak had ended, the investigators managed to obtain the age-specific population data (see Table 3). Use the population data to calculate the age-specific attack rates. What do you see differently compared with the percentages of total cases shown in Table 2?

Table 3. Percentages of total number of cholera cases by age group during a cholera outbreak in Katwe Village, southwestern Uganda, June – July 2015.

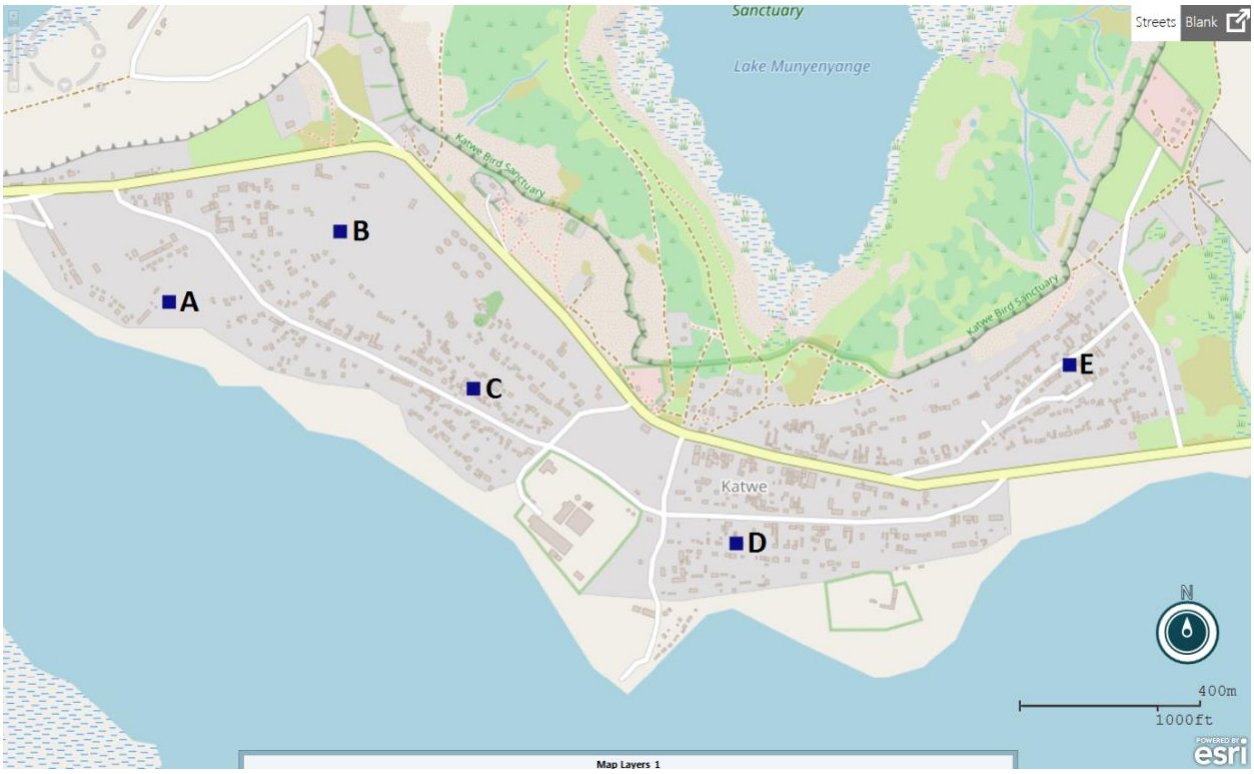
Age group (yrs)	Population	Num. of cases	%	Attack rate (/1000)
0-9	4157			
10-19	3159			
20-29	2025			
30-39	1236			
40-49	792			
50-59	460			
≥60	495			
Total	**12324**	**59***	**100**	**4.9#**

* Two case-patients had missing information on age. # Based on 61 cases.

Descriptive epidemiology by place

Katwe Village has 5 settlement areas: A, B., C, D, and E (Figure 3).

Figure 2. Map showing the locations of the settlements during a cholera outbreak in Katwe Village, southwestern Uganda, June – July 2015.



The team collected the data on the coordinates of the case-persons' residence to develop a spot map to show the distribution of the cases.

Question 13. Use Epi Info's "Create Maps" module and the coordinates data in the tab named "Linelist" to create a spot map on the locations of the cases. Interpret the results. In which settlement area did the exposure likely occur?

Question 14. Population data for each of the five settlement areas have been obtained from the administrators of the village (Table 4). Use the data in the "Linelist" tab to calculate the number of cases and attack rate by settlement area. Fill in the blanks in Table 4. Interpret the results.

Table 4. Attack rate of cholera by settlement area during a cholera outbreak in Katwe Village, southwestern Uganda, June – July 2015.

Settlement area	Population	Num. of cases	Attack rate (/1000)
D	2855		
C	1500		
E	2760		
B	2813		
A	2396		
Total	**12324**		

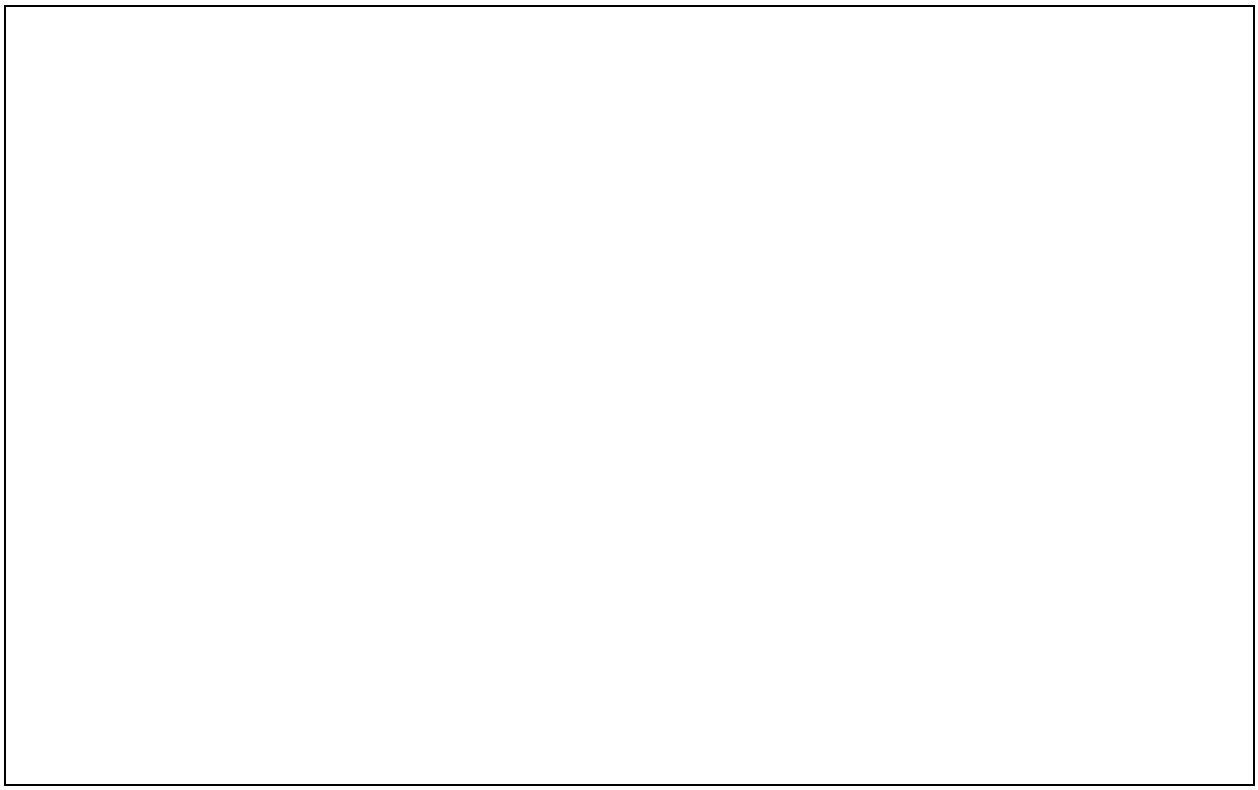
Hypothesis generation

The descriptive epidemiologic analyses indicated that, the exposure (whatever it was) occurred on 16th or 17th June in Settlement Area D, affected male and female residents equally, and affected all age groups. However, the exact nature of the exposure is still unknown.

Considering that cholera outbreaks are usually caused by contaminated water or food [2, 9, 11], the investigators conducted hypothesis-generating interviews of 10 case-persons regarding their potential food and water exposures. They found that:

- No large gathering had occurred in settlement D or anywhere in the entire village between 15th and 17th June that could explain this outbreak.
- Of the 10 case-persons interviewed, 9 usually collected water from the lakeshore Water Collection Site X, which was located in Settlement Area D.
- None of the 10 case-persons said they treated or boiled their drinking water.
- All 10 case persons always ate hot food.

Question 15. Based on the findings from the descriptive epidemiology analysis and the hypothesis-generating interviews, what is the working hypothesis on the mode of transmission?



Part 3

Analytic epidemiology study to test the hypothesis

After summarizing the results of the descriptive epidemiology analysis, the investigators formulated their hypothesis, and proceeded to conduct an analytic epidemiologic study to test their hypothesis.

Question 16. What are the common types of analytic epidemiologic studies? Of these, which is the most appropriate for this outbreak investigation?

Question 17. How would you select the cases and controls in this investigation? How many cases and controls should be selected? Justify your decisions.

At the time of the investigation, 32 suspected case-persons were available and willing to participate in the case-control study. They decided to select 128 controls (case-to-control ratio = 1:4) among asymptomatic villagers in the case-patient's neighbourhood (i.e. neighbourhood controls). Controls were individually matched to the cases by age.

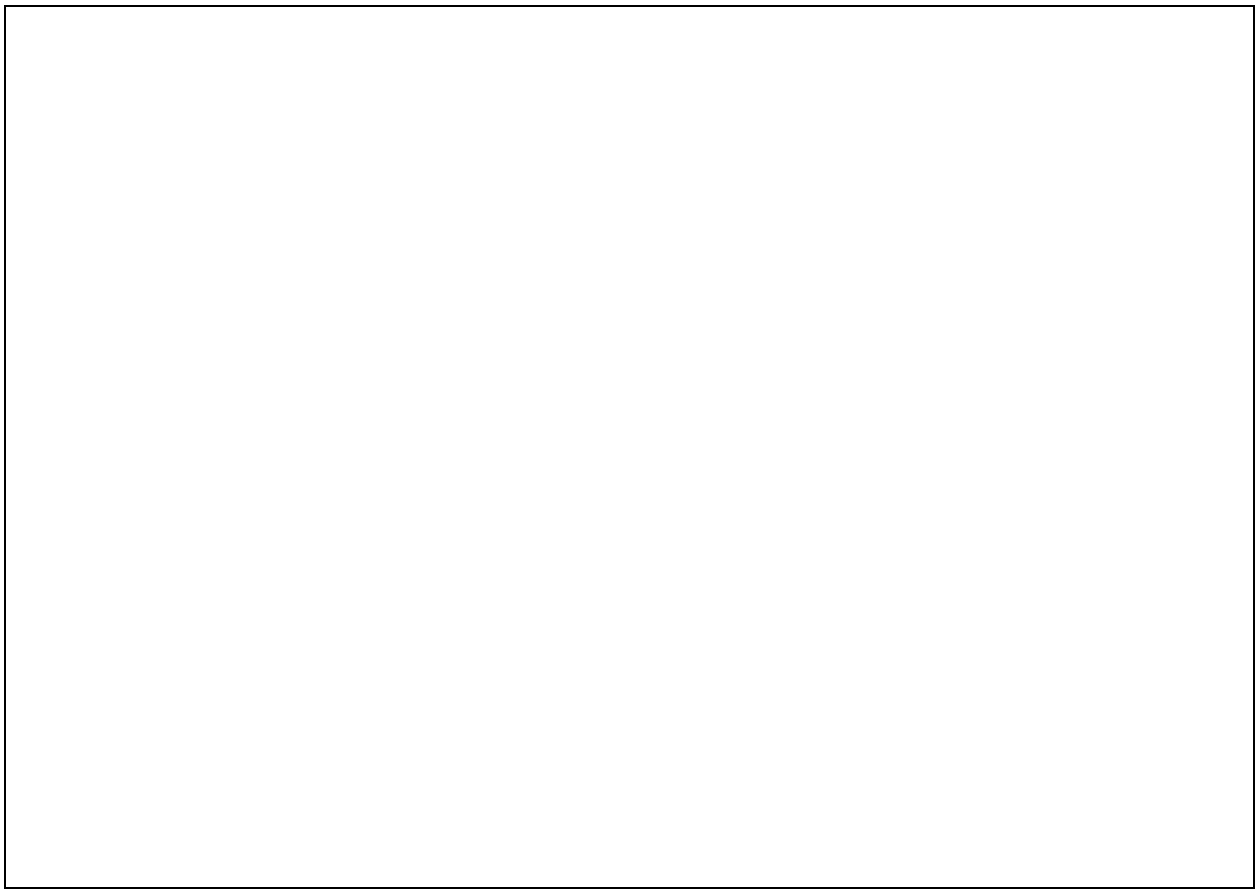
A standardized questionnaire was created to collect the information on where the residents usually collect their drinking water. Also, the investigators decided to include in the questionnaire some of the food items that emerged during the hypothesis-generating interviews even though this outbreak was unlikely to have been foodborne based on the descriptive epidemiologic analyses and hypothesis-generating interviews. They conducted face-to-face interviews of the case- and control-persons, with the help of members of the village health team.

Question 18. Use Epi Info and data in the "CaseCntlData" tab to assess the association between cholera and collecting water from Site X. Note: In this 1:4 matched case-control study the matching variable was "CaseCntlSet"; the variable denoting the case-control status was "Case1Cntl0" (1=Case, 0=Control); and the exposure variable was "H2O_SiteX_YN" (Y=usually collected water from Site X; N=otherwise). Fill in the blanks in Table 5. Interpret the results.

Table 5. Results of a case-control study on the mode of exposure during a cholera outbreak in Katwe Village, southwestern Uganda, June – July 2015.

Usual water-collection site	% Cases (n=32)	% Controls (n=128)	OR_{M-H} (95% CI)
Site X			
Elsewhere			

* No food items were significantly associated with the disease.



Part 4

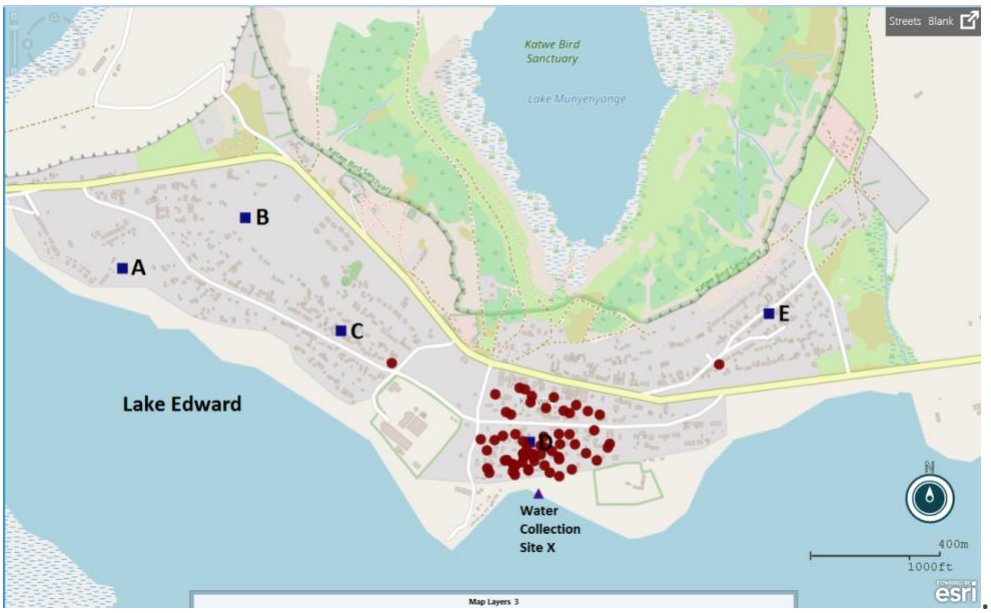
Environmental investigation and additional studies

At this point, the epidemiologic study had established a strong association between cholera onset and drinking water collected at Site X in Settlement Area D. However, it was still unclear how water contamination had occurred at Site X. To further understand how the water had been contaminated, the team conducted additional environmental and other investigations.

Question 19. What environmental investigations should be conducted?

The investigators conducted an environmental study on Water Collection Site X. This water collection site was on the shore of Lake Edward [Figure 5(a)]. A number of such water collection sites exist along the shore of Lake Edward. Residents of Katwe Village put rocks and fences around each water-collection site to protect people from crocodiles, hippopotamuses and other animals in water [Figure 5(b)]. These rocks and fences cause the water in the fenced areas to be stagnant.

Figure 3. Water Collection Site X used by residents in Settlement Area D during a cholera outbreak in Katwe Village, southwestern Uganda, June – July 2015



(a) Location of Water Collection Site X (shown as the triangle)

(b) Inside Water Collection Site X.

The investigators conducted a detailed interview of the primary case-person, a fisherman who had onset on 16th June, because descriptive epidemiologic analyses suggested that he might have caused this outbreak. He told the investigators that between 15th and 16th June he had spent two days and two nights fishing on the lake. On 16th June he developed cholera symptoms, and came ashore on the night of 16th June. After returning to the shore, he defecated "near" the fenced Water-Collection Site X. However, based on the epidemiologic evidence, he quite possibly had defecated *into* the fenced area.

Question 20. Should the investigators collect water from inside the Water Collection Site X and culture it for *V. cholerae*? Why or why not?

The investigators also investigated alternative water sources for the village. The village has a tap-water system. However, the system broke down eight months prior to this outbreak, forcing people to use lake water. Cleaner water was also available from a protected spring. However, the spring is several kilometres away, up on a hill. Once reaching there, one has to wait in a long line to get a Jerry-can of water. A commercial group collects water from the spring, transports it to the village, and sells it at 1000 Uganda Shillings (about $0.30) per Jerry-can. This price is not affordable for most of the villagers.

Question 21. What control and prevention measures should be implemented?

Before the investigation team arrived at the village, the local public health officials had already implemented the following immediate measures:

- Provision of chlorine tablets to the villagers to treat their drinking water
- Issuance of water boiling advisory to the villagers
- Advising the villagers to eat thoroughly cooked food and eat food while it is hot

Upon arrival at the village, the investigators advised the public health officials to also rigorously disinfect all patients' faeces to prevent further spread of cholera in the community.

After the investigation was completed, the investigators made the specific recommendations discussed above. These recommendations were implemented, with the assistance of the local government.

Question 22. How should one evaluate whether the control and prevention measures were effective?

Question 23. How should the findings be communicated? Who is the target audience?

Conclusion

[The conclusion is at the end of the Instructor's Guide and will be distributed separately.]

Background Reading

Fontaine RE, Goodman RA. Describing the findings: Descriptive epidemiology (Chapter 9). In: Gregg M. *Field Epidemiology*. 3rd ed., pp 156-198. New York: Oxford University Press, 2008.

Dicker RC. Analyzing and interpreting data (Chapter 10). In: Gregg M. *Field Epidemiology*. 3rd ed., pp 199-235. New York: Oxford University Press, 2008.

Goodman RA, Fontaine RE, Hadler JL, Vugia DJ. Developing interventions (Chapter 11). In: Gregg M. *Field Epidemiology*. 3rd ed., pp 236-248. New York: Oxford University Press, 2008.

Gregg MB. Communicate Epidemiology Findings (Chapter 12). In: Gregg M. *Field Epidemiology*. 3rd ed., pp 249-261. New York: Oxford University Press, 2008.

Dicker R, Coronado F, Koo D, Parrish RG. *Principles of Epidemiology in Public Health Practice, 3rd ed*. Lesson 6: Investigating an outbreak. Atlanta GA: US Department of Health and Human Services 2006. Pp.6-1 – 6-78. (http://www.cdc.gov/ophss/csels/dsepd/ss1978/ss1978.pdf. Accessed 22 Oct 2016)

Competing Interests

The authors declare no competing interest.

Author's Contributions

B-PZ supervised the study design, investigation and data analysis, and wrote the case study. GP and BK designed the study, analysed the data, and critically reviewed the case study. ARR participated in the study design, supervised the investigation, assisted with the data analysis, and critically reviewed the case study.

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References

1. Bioline. S. SD BIOLINE Cholera Ag O1/O139: SD Bioline; 2016 [22 Mar 2017]. Available from: http://www.standardia.com/en/home/product/Rapid_Diagnostic_Test/Cholera_Ag_O1-0139.html.

2. Organization WH. World Health Organisation. Cholera fact sheet 2015 [updated 19/10/2015; cited 2015 19/10/]. Available from: http://www.who.int/mediacentre/factsheets/fs107/en/.

3. Ali M, Lopez AL, You YA, Kim YE, Sah B, Maskery B, et al. The global burden of cholera. Bulletin of the World Health Organization. 2012; 90(3):209-18A. PubMed PMID: PMC3314202. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3314202/

4. Bwire G, Malimbo M, Maskery B, Kim YE, Mogasale V, Levin A. The burden of cholera in Uganda. PLoS Neglected Tropical Diseases. 2013;7(12):e2545. PubMed PMID: PMC3855006. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3855006/

5. LaMorte WW. Steps in the Investigation of a Disease Outbreak. Boston, MA: Boston University School of Public Health; 2016 [updated 5/3/2016; cited 2016 18 Oct 2016]. Available from: http://sphweb.bumc.bu.edu/otlt/MPH-Modules/PH/Outbreak/Outbreak_print.html.

6. Dicker R, Coronado F, Koo D, Parrish RG. Principles of Epidemiology in Public Health Practice. Atlanta GA: US Department of Health and Human Services. 2006.

7. Kasolo F, Roungou JB, Perry H. Technical guidelines for Integrated Disease Surveillance and Response in the African Region. Brazzaville, Republic of Congo and Atlanta, USA: WHO, CDC, Oct. 2010. Report No.

8. Fontaine R, Goodman R. Describing the findings: Descriptive epidemiology. In: Gregg MB, editor. Field Epidemiology. New York, NY: Oxford University Press, USA; 2008.

9. Heymann DL. Control of Communicable Diseases Manual. 20 ed: American Public Health Association; 2015.

10. Pande G, Kwesiga B, Bwire G, Kalyebi P, Ario A, Makumbi F, et al. Cholera outbreak caused by drinking contaminated water from a lakeshore water-collection site, Kasese District, southwestern Uganda, June - July 2015. (Manuscript in Submission)

11. CDC. CDC Health Information for International Travel 2014: The Yellow Book: Oxford University Press; 2013.

12. Gordis L. Epidemiology. Philadelphia, USA: Saunders Elsevier. 2009.

Appendix 1

Case study cholera Katwe fishing