OUTBREAK REPORT

Descriptive characterization of the cholera outbreak In Lusaka District, 2016

P Kabwe[1, 2], L Moonde[1,2], A Gama[2], F Hadunka[1,2], N Sinyange[1,2], E Kateule[1,2], A Inambao[1,2], M Mwamba[5], G Zulu[5], R Kumar[3,4]

1. Zambia Field Epidemiology Training Program, Lusaka, Zambia;
2. Ministry of Health, Lusaka, Zambia;
3. ASPPH/CDC Allan Rosenfied Global Health Fellow,
4. US Centers for Disease Control and Prevention, Lusaka, Zambia,
5. Lusaka District Medical office

Correspondence: Patrick Kabwe (sumechanda@yahoo.com)

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On February 5, 2016, the Zambian Ministry of Health was notified of cholera cases in the western part of Lusaka district, which spread rapidly to peri-urban areas in the northern and eastern part of the city in the subsequent weeks. We conducted a descriptive analysis of the cholera outbreak.

We conducted a retrospective analysis of the line list, obtained through the district surveillance officer. Cholera case definitions were modified integrated disease surveillance response (IDSR) manual. Attack rates (ARs) and case fatality rates (CFRs) were calculated. Population projections from the Central Statistics Office 2010 census were used to generate the ARs. We interviewed confirmed case-patients using a standard questionnaire to get exposure information. Data from laboratory and environmental assessment records were extracted for analysis.

A total of 1,054 cases were reported from 5th February - 31st May 2016 with an overall AR of 45.2 cases/100,000 population and overall CFR of 1.9%. The median age of case-patients was 22 (IQR: 7-32) years and the age-specific CFR was highest among case-patients <5 years (6%). Of those interviewed (n=44), boreholes (64%) were the most common water sources and hand washing with soap was not routinely practiced. About 32% (n=44) of the cases did not treat drinking water, 36% used chlorine, and 27% boiled their drinking water. The circulating strain was *Vibrio cholerae* serogroup 01 Ogawa, biotype El Tor, and was 100% sensitive to ciprofloxacin and chloramphenicol. *Vibrio cholerae* was isolated from 59 water and five food samples

Poor sanitation, inadequate access to clean water, and contaminated foods, were possible contributors to the outbreak. There is need to sensitize the communities on personal hygiene and improve water access.

Introduction

Cholera is an acute intestinal diarrheal disease characterized by profuse watery diarrhea, vomiting, and rapid dehydration. In the absence of adequate treatment, the mortality rate is high; in vulnerable groups and high-risk areas, mortality rates of up to

7.5% have been reported [1]. Modern cholera outbreaks are caused by *Vibrio cholerae* 01 Inaba El Tor and O1 Ogawa biotype El Tor strains [2, 3]. Currently, African countries account for the highest proportion of cholera cases reported worldwide [3].

Table 1 Distribution of Cholera Cases and laboratory results in Lusaka District Feb-May 2016 (N=1,054)

Characteristic	Number (%)
Female	502 (48)
Male	552 (52)
Median age (yrs)	22 (IQR: 7-32)
Age groups (yrs)	
<5	140 (13)
5 – 15	237 (23)
16 – 29	328 (31)
30 – 59	292 (28)
60+	47 (5)
Unknown[1]	10 (1)
Place of residence	
Kanyama	336 (32)
Bauleni	301 (29)
Mandevu	147 (14)
Matero	126 (12)
Munali	66 (6)
Chawama	49 (5)
Kabwata	29 (3)
Laboratory findings (% positivity)	
Stool culture (n=45)	20 (44)
Rapid diagnostic tests (n =125)	90 (72)

[1]Three of the twenty deaths were among individuals with unknown age

Lusaka district has a population of approximately 2.3 million, and has 33 health facilities. Lusaka district is densely populated (100 person per square kilometer) with a large portion of the population living in peri-urban areas, where overcrowding and poor water and sanitation are prevalent, thus increasing the risk of waterborne diseases such as typhoid and cholera [4, 5].

Most cholera outbreaks occur in the western part of Lusaka city, which is a low-income densely populated area with several compounds clustered together. It has insufficient coverage of drainage networks, resulting in flooding during the rainy seasons. The lack of clean water and sanitation facilities are major challenges affecting the communities in this part of the city [5, 6]. Cholera was last recorded in Lusaka during the 2010/2011 rainy season from January to April [4]. An analysis of available rainfall and cholera outbreak data in Lusaka shows a strong association between rainfall and cholera outbreaks [4].

Outbreak

On 5th February 2016, the Lusaka District Medical Office received notification that four members of a single family presented with diarrhea and vomiting at Kanyama public clinic in western Lusaka after the burial of a family member who died of similar symptoms. Rectal swabs collected from all the four patients examined at the Kanyama public clinic yielded *vibrio cholerae* .at the reference laboratory. The Lusaka District Medical Office opened a Cholera Treatment Center (CTC) at Kanyama public clinic was opened on 7th February. As more cases arose, a second CTC was opened at Matero Referral public clinic in the northern part of Lusaka on 8th March 2016, and a third CTC was opened at Bauleni public clinic in the eastern part of

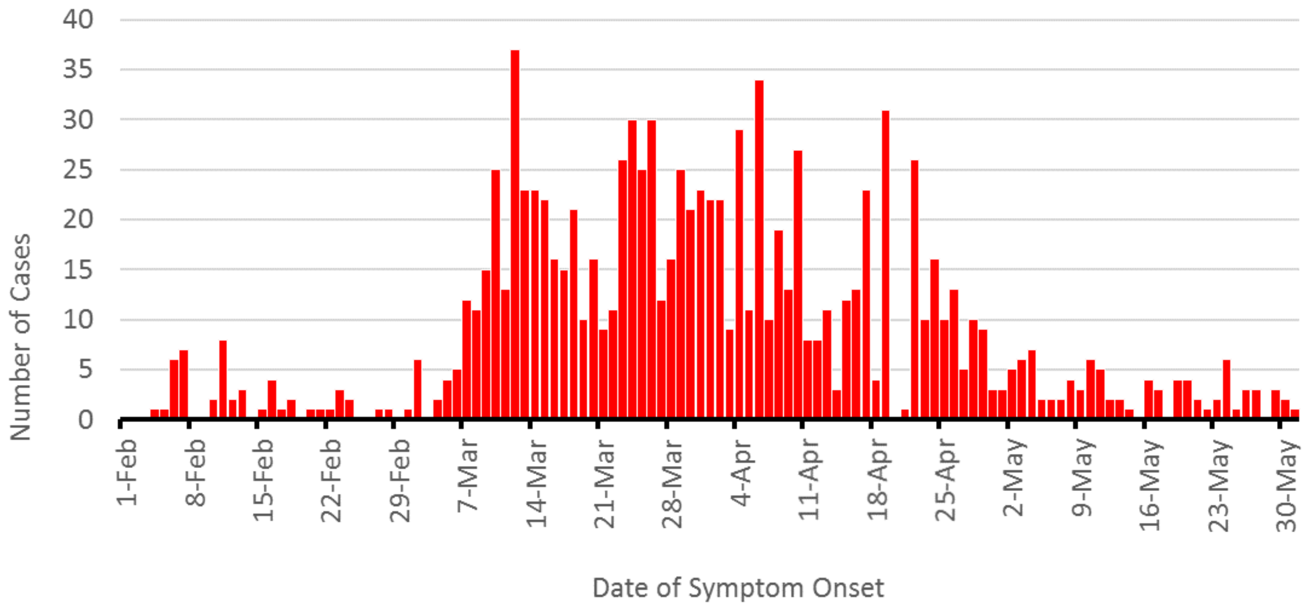

Figure 1 Cholera Epidemic curve, Lusaka District Feb-May 2016 (N=1,054)

Lusaka on 9th March 2016. Each CTCs was staffed with qualified health personnel 24 hours every day. Standard treatment guidelines were observed by the staff according to the World Health Organization (WHO) cholera treatment guidelines [8].

On 8th February the Lusaka District Medical Office informed the Zambian Ministry of Health (MoH) of the cholera outbreak. A team comprising of MoH epidemiologists, Field Epidemiology Training Program (FETP) residents, environmental health officers, laboratory personnel, and a WHO surveillance officer was sent to verify the outbreak, determine its magnitude, identify the source, and to implement control and preventive measures.

Methods

We conducted a retrospective analysis of cholera cases in Lusaka district. After modifying the case definition in the National Technical Guidelines of the Integrated Diseases Surveillance and Response (IDSR) [7], investigators defined a suspected cholera case-patient as any resident of Lusaka district with acute watery diarrhea, with or without vomiting, from 2nd February– 31st May 2016. A confirmed cholera case-patient was defined as a suspected case in which *vibrio cholerae* O1 or O139 has been isolated through culture or, a case-patient epidemiologically linked to a confirmed case. Screening of suspected cases was done using the rapid cholera diagnostic test (SD Bioline-

44FK30, Standard diagnostic Inc). Cultures with the characteristic appearance of *vibrio cholerae* were confirmed by biochemical and serological tests using polyvalent O1 and mono-specific Ogawa and Inaba antisera. Susceptibility to antimicrobial agents was determined by the Kirby–Bauer disk diffusion method and interpreted as recommended by the National Committee for Clinical Laboratory Standards [16, 17] with commercial antimicrobial discs.

Table 2 Age-Specific Attack Rates and Case Fatality Rates of Cholera Cases, Lusaka District Feb-May 2016 (N=1054)

Age Groups	Population[1]	Cases	Deaths[2]	Attack Rate per 100,000	Case Fatality Rate (%)
<5	419,436	140	8	33	5.7
5-15	640,805	237	3	40	1.3
16-29	706,726	328	2	46	0.6
30-59	625,946	292	2	47	0.7
60+	52,377	47	2	90	4.2

[1]Age-specific population estimated based on age percentages in greater Lusaka. [2]Ten of the 20 deaths were brought in dead and ten died in a facility with dehydration as cause of death

Data Collection

Active case-finding was conducted by the district surveillance officers, and all cases from the three CTCs were entered in a line list. During active case-finding, cholera information, education and communication (IEC) materials were distributed to the communities. Data on age, sex, place of residence, and onset of symptoms were extracted from the line lists obtained from the three CTCs. Data including the type of test conducted, results of the test, and sensitivity patterns were extracted from records at Kanyama clinic laboratory and the national reference laboratory at University Teaching Hospital (UTH).

Environmental Assessment

We reviewed records from the environmental health department at Kanyama public clinic. Food samples had been collected from unlicensed street vendors, public markets and privately owned supermarkets in Lusaka district. Water samples were collected from water kiosks run by the Lusaka Water and Sewerage Company (LWSC), as well as selected shallow wells, boreholes, and a stream within the affected communities. Analysis of water and food samples for possible contamination with *vibrio cholerae* was conducted at the UTH Food and Drug Laboratory.

Interviews of Confirmed Patients

Laboratory-confirmed case-patients and epidemiologically-linked patients selected by convenience sampling were interviewed using a structured questionnaire. We collected demographic information, information on travel to cholera-confirmed areas (during the five day period prior to symptom onset), and food exposures (during the five day period prior to symptom onset). In addition, we collected information on drinking water sources (ie: shallow wells, boreholes, and tap water), as well as personal hygiene practices (e.g. the presence of soap in the households, treatment of household water for drinking, washing of hands after toilet use, and storage of water). Data was also collected on perceived availability of water, and cost of water provided by LWSC.

Table 3 Residents specific Attack Rates and Case Fatality Rates of Cholera Cases, Lusaka District Feb-May 2016 (N=10541)

Residence	population	Cases	Deaths	Attack rate per 100,000	Case Fatality Rate (%)
Kanyama	366,170	336	5	185	1.5
Bauleni	132,531	301	2	227	0.7
Chawama	174,080	49	3	28	6.1
Mandevu	375,035	147	6	39	4.1
Munali	279,658	66	2	23	3.0
Matero	295,415	126	2	43	1.6
Kabwata	181,497	29	0	16	0.0
TOTAL	**2,330,200**	**1054**	**20**	**45**	**1.9**

Data Analysis

Epidemic curves were constructed from the line list based on reported date of symptom onset. We computed the attack rate (AR) using reported cases, and Central Statistics Office population projections from the 2010 census for each of the seven administrative constituencies in Lusaka district [9]. Case-fatality rate (CFR), and age-specific CFRs were calculated using cases with complete clinical information on age, sex, residence, and outcome. The numerator for the age-specific CFR was the number of deaths in the specific age group, and the denominator was the number of cases in the age-specific groups with complete clinical information. Data analysis was conducted using Epi Info version 3.5.3.

Results

Epidemic Progression

The index case was an 18-month-old female residing in the western part of Lusaka city who presented with diarrhea and vomiting on 2nd February 2016 and later died before being taken to the health facility. In total, we identified 1,054 cases that met the case definition for suspected, confirmed or epidemiologically liked cases in Lusaka district from 2nd February through to 31st May 2016. The highest absolute numbers of cholera cases were reported from Kanyama and Bauleni compounds (Table 1). The overall cholera AR in Lusaka district was 45.2/100,000 population. The median age of case-patients was 22 years (IQR: 7-32) and 54% of the cases were 5-29 years old; 48% were female (Table 1). The epidemic curve showed multiple peaks suggestive of a propagated cholera outbreak (Figure 1). The most pronounced peaks were seen on March 22nd and 19th April, respectively. By the end of May 2016, only two cases were reported.

The overall CFR was 1.9%, with 20 deaths among the 1,054 cases (Table 2). Of the 20 deaths observed in the study, 10 arrived to the health facility already deceased, and 10 died at the health facility. The age-specific CFR was highest among children <5 years (5.7 %), followed by the 60+ age group (4.2%). The AR was highest (90/100,000) in 60+ age group (small population denominator) and lowest (33.4/100,000) in <5 age group (Table 2).

Table 4 Environmental Samples Collected from Lusaka District Feb - May 2016

Water Source	Number of samples collected	# (%) of samples with *Vibrio cholerae*
Treated tap water	172	6 (3.5)
Shallow wells	91	48 (53)
Borehole	50	5 (10)
Stream	1	0 (0)
Total	**314**	**59 (19)**
Food sources		
Street Vendors	23	2
Public Markets	25	3 (12)
Supermarket (Kanyama)	3	0 (0)
Household Foods	0	0 (0)
Total	**51**	**5 (10)**
Total samples	**365**	**64 (17.5)**

Table 3 details the AR and CFR by location, with the highest AR in Bauleni with 227 cases per 100,000 residents, followed by Kanyama at 185 cases per 100,000 residents. All other locations had fewer than 50 cases per 100,000 population; however, the CFR was highest in the areas with fewer cases, with a CFR of 6.1% in Chawama (49 cases), 4.1% in Mandevu (147 cases), and 3.0% in Munali (66 cases).

Laboratory testing

A total of 170 stool specimens were tested. Rapid cholera diagnostic test (RDT) was done on 125 stool specimens, of which 90 (72.0%) were positive. Culture was done on 45 stool specimens, of which 20 (44.4%) were positive (Table 1). Laboratory analyses showed that the circulating strain was *Vibrio Cholerae* sero-group 01 Ogawa, biotype *El* Tor, and was sensitive to both ciprofloxacin and chloramphenicol. It's worth noting that only two antibiotics (ciprofloxacin and chloramphenicol) where tested for antibiotic susceptibility due to non-availability of reagents for the other recommended antibiotics for cholera treatment.

A total of 314 water samples from shallow wells, boreholes, stream and tap water were analyzed, of which 59 (18.8%) yielded *Vibrio cholerae.* Five out of 51 (9.8 %) food samples from street vendors and markets were contaminated with *vibrio cholerae* (Table 4).

Confirmed Case-Patient Interviews

A total of 44 case-patients were interviewed using the structured questionnaire. The median age of the interviewed case-patients was 20 years (IQR 5-15) and 57% were female (Table 5). Of the patients interviewed, 64% drank from boreholes, 27% from shallow wells, and 9% from community water kiosks operated by LWSC (Table 4). The majority of cases reported washing hands after using the toilet (87%) and washing hands before handling food (84%), but only 23% reported washing hands before drinking water.

Table 5 Self-reported characteristics of selected confirmed cholera cases in Lusaka District, February 2016 (N=44)

Characteristic	Categories	Number (%)
Sex	Female	25 (57)
	Male	19 (43)
Age (median = 20)	<5	9 (21)
	5-15	7 (16)
	16-29	11 (25)
	30-59	15 (34)
	60+	0 (0)
Education	No education	8 (18)
	Primary	15 (34)
	Secondary	10 (23)
	Tertiary	1 (2)
Water sources in the last 5 days prior to symptom onset	Borehole	28 (64)
	Shallow well	12 (27)
	Water kiosks	4 (9)
Hand washing practices	Running water with soap	10 (23)
	Stagnant water with soap	6 (14)
	Running water only	21 (48)
	Stagnant water only	7 (16)
	Before handling food	37 (84)
	Before handling drinking water	10 (23)
	After visiting the toilet	39 (87)
	After handling baby's nappies	9 (21)
Type of toilet	Modern flush toilet	4 (9)
	Pit latrine	40 (91)
Waste disposal	Burning	3 (7)
	Refuse pit	33 (75)
	Burying	4 (9)
	Dumping	4 (9)
Foods consumed 5 days prior to symptom onset	Nshima hot	40 (91)
	Nshima cold	4 (9)
	Vegetables hot	39 (89)
	Vegetables cold	2 (5)
	Rice hot	2 (5)
	Rice cold	0 (0)
	Beef hot	17 (39)
	Beef cold	1 (2)
	Sausage hot	0 (0)
	Sausage cold	0 (0)
	Munkoyo cold	11 (25)
	Munkoyo hot	0 (0)
Treatment of drinking water	Boiled	12 (27)
	Boiled and chlorinated	2 (6)
	Chlorinated	16 (36)
	Did not treat	14 (32)

Each person in the community had to pay approximately $0.05 to access 20 liters of water at the water kiosks every day. Hand washing with soap was reported by 23% of the interviewees, whereas 48% reported washing hands without soap. The majority (91%) had pit latrines in their households, and waste disposal was commonly done in refuse pits (75%). Drinking water was treated with chlorine for 36% of interviewees, boiled by 27%, both boiled and chlorinated by 6%, and not treated by 32% of the cases.

Discussion

After five years without reported cholera cases in Lusaka district, an outbreak occurred at the beginning of February 2016 with 1,054 cases of cholera reported by the end of May 2016. This outbreak had a CFR of 1.9%, which was slightly lower than the CFR of 2.1% in the 2010-11 and the CFR of 4.5% in the 2004 Zambian outbreaks [10]. The World Health Organization (WHO) recommends that cholera CFRs should not exceed 1% if cases are properly treated, yet most cholera outbreaks worldwide continue to have CFRs that exceed this threshold [11,12]. Correct case management by qualified staff, availability of rehydration fluids, and good coordination are associated with low CFRs, whereas poor access to health facilities and lack of knowledge (on prevention and transmission of cholera) has been blamed for higher CFRs in other outbreaks [12,13,14]. In an outbreak in Guinea Bissau, for example, those who died were six times more likely not to have sought care in a health center [13]. In the current outbreak in Lusaka district, ten of the 20 deaths (50%) had died before they reached the CTC. The ten that died in the facility due to severe dehydration, representing a CFR of less than 1%. This may indicate adequate provision of standard treatment (rehydration and antibiotic therapy) to case-patients admitted to the CTCs.

The epidemiological curve could have indicated a propagated spread of the cholera outbreak, suggestive of a common source, however no links could be established among different compounds in Lusaka where the cases where coming from. There was a possibility that cholera cases from different areas had their own source of the outbreak. There was thus need to design and conduct a study which could have helped better understand how the outbreak affected different compounds in the same time period.

The importance of sanitation and access to clean water to prevent future cholera outbreaks cannot be overemphasized. The current cholera epidemic in Lusaka occurred in the western, Northern and eastern peri-urban sections of the city where there is poor sanitation and a lack of access to clean and safe water. Several studies have documented the association of poor sanitation and lack of safe water to outbreaks of cholera in the aforementioned areas of Lusaka district [1, 4, 5, 6, 10]. The poor access to clean water was evidenced by the use of water sources which were contaminated with *Vibrio cholerae*. With flooding that occurs in the rainy season, fecal contamination increases the risk of cholera outbreaks. Given that most households in the affected communities live on less than $1 per day, many residents are unable to afford the fee to access the treated water from LWSC kiosks, and might be forced to use water from contaminated shallow wells [15]. Testing shallow wells for fecal contamination during rainy season, and providing safe drinking water for free when contamination is likely, could prevent future cholera outbreaks.

Similarly, the presence of *Vibrio cholerae* in selected food samples posed a risk to the public. These foods were being sold to the unsuspecting public, and could have contributed to the spread of the cholera outbreak. A study done in Lusaka to determine risk factors associated with cholera outbreaks found that consuming street-vended foods was significantly associated with increased risk of being infected with cholera [10]. These contaminated foods could have thus contributed to the progression of the outbreak. There is need to conduct more analytic studies to determine the safety of street-vended foods during cholera outbreaks.

Our findings also showed that hand washing with soap was not a routine activity among interviewed patients. Handwashing, if done correctly, has a protective effect in the prevention of cholera [1]. Thus there is a need to sensitize the communities on the importance and significance of handwashing with soap.

Additionally, the proportion of children <5 years with cholera is a cause for concern. It should be noted that the current IDSR case definition for cholera does not capture children <5 years diarrhea due to the commonality of diarrhea among this group. In countries endemic for cholera, a review of the case definition is usually recommended to include cases below the age of five years because children have the highest risk of death [14]. In this outbreak, children under 5 years old, and seniors over 60 years had the highest case fatality rates, suggesting that they should be prioritized for future preventative interventions.

Finally, the 2016 cholera outbreak started late, compared with the normal seasonal pattern of cholera in the country [4, 6]. The first case in Lusaka was declared in early February 2016 and ended in late May. In contrast, prior outbreaks began in mid-October (start of the rain season) and ended by late April (end of the rain season), coinciding with the usual rainy season [4, 6]. In 2016, however, there was a delay in the rains starting in most parts of the country, probably due to the El Nino effect, and this could have contributed to the late start of the cholera epidemic. The 2016 outbreak indicates a need to closely observe weather patterns in Zambia, in order to help anticipate cholera outbreaks and allocate necessary resources for surveillance and treatment.

One of the limitations of this study was the lack of inclusion of controls for the examination of risk factors. Previous studies conducted in Zambia to determine risk factors and triggers for cholera outbreaks have shown strong associations between consumption of street vended foods and cholera outbreaks. Furthermore these studies also highlighted the protective effect of consuming dried sardines (kapenta in local language) and handwashing with soap [1]. However, the risk/protective factors for this cholera epidemic are poorly understood thus far. As such, there is need to conduct an analytical study to help understand the factors that triggered the current epidemic.

In addition, the investigation relied on records from CTC, and cases that did not present at the health centers may have been missed. In addition, the 10 cases that died before arriving at the health facility were diagnosed based on clinical symptoms reported by the caregivers, because no stool samples were collected for laboratory confirmation. Another limitation was that convenient sampling was used in the selection of confirmed cases for interviews as well as in the selection of environmental samples for laboratory investigations. There was also lack of a standard methodology on the steps taken to process the environmental samples.

In spite of these limitations, this study is informative in describing the most current outbreak of cholera in Zambia and has highlighted the importance of surveillance, prompt treatment, and safe water sources for the prevention of future cholera-related fatalities.

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