ORIGINAL ARTICLE

Successful Multi-partner Response to a Cholera Outbreak in Lusaka, Zambia 2016: A Case Control Study

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ABSTRACT

Background: A Cholera outbreak was reported in Lusaka District between February and May 2016, with 1,079 cases and 20 deaths recorded in the per-urban areas. Bauleni catchment area alone reported 441 (40.9%) case patients with case fatality rate of 4 (0.9%). Bauleni clinic was one of the three established cholera treatment centres (CTC) and other two being Kanyama and Matero Health Centres. Ministry of Health engaged partners that conducted a multi-intervention response to the outbreak. This study is aimed at identifying factors associated with the outbreak.

Materials and methods: We conducted a case-control study, at the ratio 1:3, to identify risk factors associated with cholera outbreak. We identified cases of cholera through the cholera register at Bauleni health centre and randomly selected population based controls being residents of Bauleni Township without watery diarrhoea. The standard case definition for suspected cholera case was any person of any age with profuse, effortless watery diarrhoea (three or more stools in 24 hours), with or without vomiting. A confirmed cholera case was defined as any person suspected to have cholera with a positive laboratory result. Univariate and multivariate analysis was performed using Epi-Info version 3.5.4 and Stata version 11.2.

Results: On the Cholera Treatment Centre surveillance case-patients register, out of 441 cases, 241 (54.6%) cases were male while 200 (45.4 %%) cases were female, with an attack rate of 14.8/1,000 population and 4 (0.9%) fatalities. The study participants, who included 49 case-patients and 151 controls, had mean-age of 31 years [range, 29-34 years]. Positive Vibrio in stool cholera was associated with drinking inadequately treated borehole water [Adjusted OR=0.79; 95% CI (0.10-6.04), p>0.05]. This odds ratio was adjusted for level education and gender to control and account for any confounding. Though this finding was not statistically significant at p>0.05, the laboratory result was biologically significant as vibrio cholerae was isolated in the borehole water. Drinking treated water was protective [Adjusted OR 0.13; 95% CI (0.05-0.31, p<0.05].

Conclusion: Improving methods that promote safe drinking water are likely to be effective measures in averting future cholera outbreaks in this setting.

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INTRODUCTION

Cholera is an acute infectious illness with profuse watery diarrhoea caused by toxigenic Vibrio cholera serogroup

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O1 or O139. Vibrio cholera is a curved Gram-negative comma-shaped bacterium that belongs to the family Vibrionaceae and shares common characteristics with the family Enterobacteriaceae.[1]

Cholera disease caused by Vibrio cholera continues to be a global threat to public health and a key indicator of inadequate social development. Cholera infection is now largely confined to developing countries in the tropics and subtropics. It is endemic in Africa, parts of Asia, the Middle East, and South and Central America. In endemic areas, outbreaks usually occur when war or civil unrest disrupts public sanitation services. Natural disasters like earthquakes, tsunami, volcanic eruptions, landslides and floods also contribute to outbreaks by disrupting the normal balance of nature.[2] Cholera epidemics continue to cause major morbidity and mortality globally, and recent large outbreaks in Haiti, Zimbabwe, and Sierra Leone show the urgent need for improved control measures to save lives and reduce human suffering.[3,4]

The organism normally lives in aquatic environments along the coast. People acquire its infection by consuming contaminated water, seafood, or other foods. Once infected, persons excrete the bacteria in stool thus perpetuating infection transmission through the faeco-oral route by contamination of water or food. Thus, the infection can spread rapidly, particularly in areas where human waste is untreated.

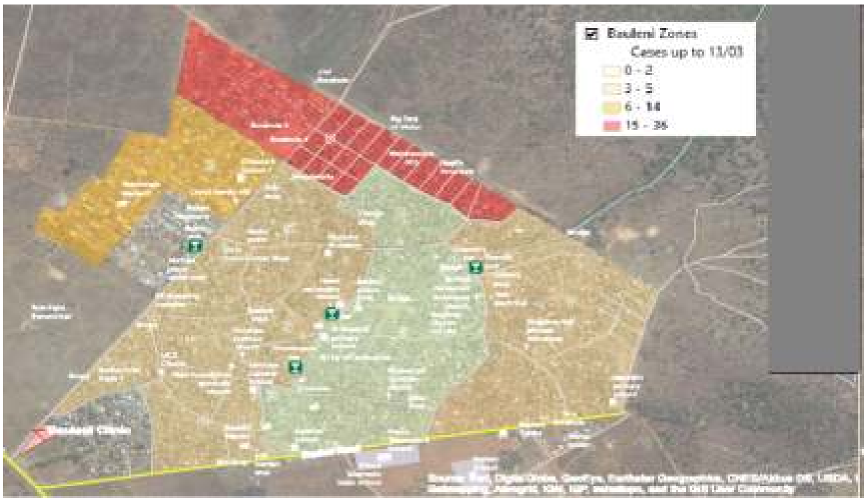
The short incubation period of cholera disease of two hours to five days facilitates the potentially fast spreading pattern of outbreaks resulting in hypovolemic shock and death if rehydration of the affected persons is delayed. Transmission is closely linked to inadequate environmental management. The disease is a key indicator of lack of social development. Risk factors for cholera outbreaks include poor access to safe drinking water, contaminated food, inadequate sanitation and inadequate personal hygiene.[5,6]

In Zambia, there has been no confirmed cholera epidemic since the year 2011 when the country previously experienced continuous outbreak from the year 2003. The current cholera epidemic affected Lusaka, Southern, Central, Copperbelt and Northern provinces with high cholera cases recorded in Kanyama and Bauleni townships of Lusaka City in Lusaka province. As part of the larger evaluation of the cholera epidemic in Lusaka, we conducted a study in Bauleni, to assess the risk factors associated with the epidemic

Borehole 5, located in the zones 8 and 9 with most clustering of cholera cases (figure 1), was suspected to be unsafe and was closed, in week 10. The health workers observed overflowing sewage which flooded the water reticulation system, whose water sample laboratory results yielded vibrio cholerae organism. Amongst the multiple water and sanitation related cholera control interventions, oral cholera vaccine (OCV) vaccination, as a complementary intervention, was conducted with a view of reducing transmission and eventual control of the outbreak.

This study documents a successful implementation of a multi-partner response to a cholera outbreak including determining associated risk factors. The lessons learnt will significantly contribute to future key cholera preventive and control measures.

Figure: Bauleni Township: Distribution of cholera cases as of 13 March 2016



METHODS

Study area

The study was conducted in Bauleni Compound which is situated about 7 km from the central business district of Lusaka City and has an estimated population of 29,843. The area has a health centre servicing the population.

Study design

We conducted a case-control study in the township using the entire area population and based on the sample size formula for comparing proportions with exposure among cases and controls as embedded in the 'stalcal' utility feature of epi-info statistical software, we used a confidence level of 95%, power of 80%, expected exposure frequency in cases of 50%, case to control ratio of 1:3, with a minimum sample of 50 cases and 150 healthy controls matched by neighbourhood were recruited. Additionally, the study reviewed the public health reports to assess the preventive interventions being implemented.

The standard case definition for a suspected cholera case was any person of any age with profuse, effortless watery diarrhoea (three or more stools in 24 hours), with or without vomiting. A confirmed cholera case was defined as any person suspected to have cholera with a positive laboratory result. A standard case definition for the case was applied and a control was defined, *a priori*, as a person living in the neighbourhood with case-patient but did not meet the characteristics of the standard case definition. A control therefore was a person, in Bauleni, who did not have acute watery stool during the same period. Cholera treatment centre data was based on cholera cases derived from patients' information on the case-patients line-listing register provided by Bauleni Health Centre. Controls were randomly selected from neighbourhood community by the epidemiological surveillance team members.

Data analysis

Double data entry was done in Epi-info software version 3.5.4, with error trapping mechanism embedded, in the data entry screen, to prevent outliers and data cleaning preceded analysis.

We performed descriptive analysis of the outbreak data by person, place and time for the all line-listed cholera cases including determining attack rate to describe the entire outbreak and document the disease trend utilising an epidemic curve (Figure 2).

Univariate analysis, for the case control data, was expressed as frequency distribution and percentages for demographic characterization of study participants (Table 1). Additionally, analytical epidemiology was conducted utilizing logistic regression for multivariate analysis to calculate the adjusted odds ratios to control and account for any confounding (Table 2).

RESULTS

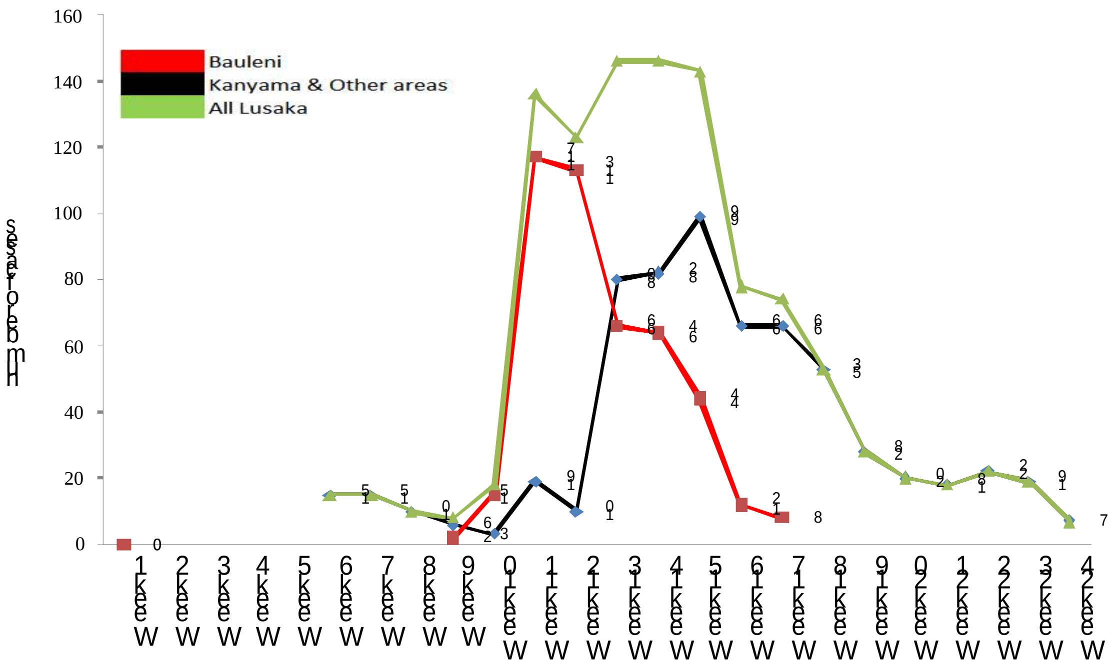
Descriptive epidemiology

Study participants

While the cholera outbreak in Lusaka was first reported in Kanyama area on 5 February 2016 of week 6, the first case of cholera in Bauleni was recorded in week 9 on 22 February 2016 and continued until week 17 with the last case recorded on 24th April 2016. On the overall, 1,079 cholera cases and 20 deaths were reported in the peri-urban areas of Lusaka District (including Bauleni). A total of 441 case-patients were recorded with 4 deaths representing case fatality rate (CFR) of 0.9% in Bauleni area alone. The peak of the outbreak was in week 10, in Bauleni, with 117 cases reported that week (Figure 2). The laboratory confirmation reviewed *Vibrio Cholerae Ogawa* as the causative agent. Laboratory results from borehole water sample collected from boreholes 5 in zones 8 and 9, of Bauleni, which had shown most clustering of case-patients had *vibrio cholerae* isolated. The epidemic curve in Figure 2 describes the trend of the outbreak.

Of the 441 case-patients on the CTC register at Bauleni Health Centre, we enrolled 49 cases in the case-control study. For all case-patients documented in the CTC register, the youngest case-patient was aged 11 months while the oldest was 84 years of age. The attack rate for the Bauleni area outbreak was 14.8 per 1,000 population.

Figure 2: Cholera Outbreak Epi-curve in Bauleni and Kanyama & Other Areas of Lusaka District, 2016.



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Inspection of Premises

During implementing the cholera control programme interventions, the Department of Public Health under Lusaka City Council inspected a total number of 826 premises comprising of hotels/lodges, butcheries, restaurants, markets, schools and other public places of Lusaka District. The inspections were carried out in line with the Public Health Act Cap 295, Food and Drugs Act Cap 303 and the Occupational Health and Safety Act Cap 313 of the Laws of Zambia. Out of 826, a total of 334 were closed whilst 376 were warned and 116 were found to be satisfactory. The inspections focused on presence of running water, treatment of drinking water, hygiene and adequacy of toilet facilities, subscription to waste management, medical certification of food handlers and general cleaning of surroundings. The premises that did not heed to the public health conditions were closed and taken for prosecution.

State of Environment and Sanitation

The majority of houses in the cholera affected community (Bauleni) are not built according to the legal standards as stipulated in the Public Health Act (Building Regulations) and the Urban and Regional planning Act of the Laws of Zambia. There is uncollected garbage which encourages infestation of house flies and rodents. Generally, the hygiene standards in the affected communities are poor. The common types of conservancy sanitation are pit latrines which are used in Zones 3,4,5,6 and 7 and on the average 4 to 8 households on a plot size of 10 by 15 m^2 share one latrine toilet. The storm water drainage system is blocked in some areas causing overflows in the homes during the rainy season. Major sources of water supply are communal boreholes and shallow wells. The physical inspection in the community revealed that the distance between the pit latrines and shallow wells in most households was 5 - 10 metres and this increased the chance of ground water contamination with faecal excrements.

In Zones 8 and 9, there are portable toilets which use septic tanks for the households. On average, persons in these zones share 1 toilet to about 1-3 households. Zones 8 and 9 do not have storm water draining system. Sewage was observed overflowing around boreholes 4 and 5, which supply zones 8 and 9, causing water contamination.

Bacteriologic investigation

Twenty two (22) water samples were submitted for analysis to the University of Zambia, School of Veterinary Laboratory and Zambia Bureau of Standards laboratory. Twelve (12) water sample results tested positive for *Vibrio cholerae.*

Socio-demographic characteristics of study participants

There were 49 cases 151 controls. The mean age for both cases and controls was 31 years (range, 29 to 34 years of age). A total of 22 (44.9%) cases and 61 (44.4%) controls were male. There was significant association between gender and low educational level with likelihood of contracting cholera infection (Table 1).

Table 1: Demographic characterisation of study participants

Characteristic	Cases [n/ (%)] (*N*=49)	Controls [n/(%)] (*N*=151)	*p*-value
Sex			
Male	22 / (44.9%)	61/ (40.4%)	<0.001
Age			
0-20	21 / (24.5%)	28 / (18.8%)	0.585
21-30	15 / (30.6%)	45 / (30.2%)	
31-40	9 / (18.4%)	44 / (29.5%)	
41-50	10 / (20.4%)	20 / (13.4%)	
51-60	2 / (4.1%)	9 / (6.0%)	
>60	1 / (2.0%)	3 / (2.0%)	
Marital status			
Single	17 / (34.7%)	74 / (49.1%)	0.073
married	22 / (44.9%)	59 / (39.1%)	
Divorced	7 / (14.3%)	7 / (4.6%)	
Widowed	3 / (6.1%)	11 / (7.3%)	
Educational level			
Uneducated	7 / (14.3%)	47 / (31.3%)	0.001
Primary	21 / (42.9%)	80 / (53.3%)	
Secondary	9 / (18.4%)	9 / (6.0%)	
Tertiary	12 / (24.5%)	14 / (9.3%)	

Table 2: Analysis of select potential risk factors of cholera infection

Risk factor	Cases (N=49)	Controls (N=151)	Crude OR* (95% CI)	*p*-value	*Adjusted* OR (95% CI)	*p-value*
Drinking treated water	18 (36.7%)	123 (81.4%)	0.13 (0.06-0.28)	<0.001	0.12 (0.05-0.31)	<0.001
Drinking borehole water	46 (93.9%)	146 (96.7%)	0.52 (0.09-3.52)	0.383	0.79 (0.10-6.04)	0.823
Contact with patient	15 (30.6%)	17 (11.3%)	3.47 (1.44-8.13)	0.001	5.20 (1.74-15.58)	0.003
Access to toilet facility	35 (71.4%)	136 (90.1%)	0.27 (0.11-0.68)	0.001	0.72 (0.23-2.32)	0.584
Hand washing with soap	20 (40.8%)	139 (90.1%)	0.06 (0.02-0.14)	<0.001	0.06 (0.02-0.17)	<0.001
Hand washing before eating	46 (93.8%)	149 (98.7%)	0.21 (0.02-1.87)	0.062	0.54 (0.05-6.22)	0.625
Knowledge on cholera	30 (61.2%)	89 (58.9%)	1.10 (0.54-2.27)	0.777	0.92 (0.38-2.25)	0.856

A.1. OR=odds ratio

In the multivariate analysis, the risk factors for cholera infection were as follows: contact with cholera case-patients; drinking treated water; and hand washing with use of soap and running water were significantly associated with cholera infection, [*Adjusted OR* = 5.20; 95% (CI 1.74-15.58, *p*=0.003)], [*Adjusted OR*=0.12; 95% CI (0.05-0.31, *p*<0.001)], and [*Adjusted OR*=0.06; 95% CI (0.02-0.17, *p*=0.001)] respectively.

The population had a protective effect for using water collected from borehole; access to a household toilet; and having knowledge on how cholera spreads [*AOR*=0.79; 95% CI (0.10-0.31, *p*=0.823)], [AOR=0.72; 95% CI (0.23-2.32, *p*=0.584], *AOR*=0.92; 95% CI (0.38-2.25, *p*=0.856)]. However these findings were not statistically significant.

DISCUSSION

The outbreak of cholera in Bauleni Township, which took place between weeks 9 and 17 of 2016, was one of the epi-centres in Lusaka District. Cholera disease had not been reported in Zambia for the previous 6 years. An epidemiologic investigation conducted in Bauleni demonstrated an overall attack rate of 1.5%, with a case fatality rate of 0.9%. Notably, the deaths occurred towards the end of the outbreak, and interviews with clinicians revealed that the deaths of affected case-patients resulted from coinfection(s).

The descriptive epidemiology from case-control study shows that there were 22 (44.9%) males amongst case-patients and 61 (40.4%) amongst the controls at *p*<0.001. There was significant association between gender and low educational with the likelihood of contracting cholera infection (Table 1).

The adjusted odds ratios indicated that treatment of drinking water; washing hands with soap and running water had assisted in averting cholera infection as these factors showed a protective effect. Therefore, these factors were not associated with presence of cholera infection. Having contact with a diarrhoea case [*Adjusted OR* = 5.20; 95% (CI 1.74-15.58)], was a risk factor.. On the other hand, access to borehole water [*Adjusted OR*=0.79; 95% CI (0.10-0.31, *p*=0.823)]; condition of toilet facility [*Adjusted* OR=0.72; 95% CI (0.23-2.32, *p*=0.584]; knowledge on how cholera spreads [*Adjusted OR*=0.92; 95% CI (0.38-2.25, *p*=0.856)] were protective factors though these findings were not statistically significant (Table 2). The foregoing is evidence that availability of effective preventive and control measures alone is not adequate. There is need for populations to observe best personal hygiene practices which are critical in averting cholera occurrence.

While known good cholera preventive and control interventions such as access to household toilet; handwashing before eating and having knowledge on how cholera spreads showed protective effect, this study showed that they were not statistically significant. There is need to advocate for good practices to be observed by communities.

Additionally, during this cholera outbreak, apart from the implementation of well-known effective cholera interventions, Zambia benefitted from a single largest Oral Cholera Vaccine deployment from the global vaccine stockpile. By week 11, Bauleni begun experiencing a decline in cholera cases and this outcome was further enhanced with the introduction of the Oral Cholera Vaccine, a complementary intervention.

Further, the findings of the study in Bauleni revealed a replica of what happened in London in 1854 during a cholera outbreak. Similar to the findings of John Snow, the source of contaminated water which resulted into cholera outbreak in Bauleni was borehole 5 and this borehole was closed on 13 March 2016 in week 11, 2016.[7] This coincided with the decline in cholera cases following the closure of the borehole (Figure 2).

CONCLUSION

The study findings revealed that, mere presence of preventive and control intervention alone without good personal hygiene practices is adequate. There is need to advocate for practices that prevent cholera transmission.

The cholera was controlled in eight (8) weeks. There were several factors that may have contributed to its termination of the cholera outbreak which included cutting-off of supply of contaminated water source(s) and implementation of OCV vaccination.

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