

Cholera outbreak at a city hotel in Kenya, 2017: a retrospective cohort study

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ABSTRACT

Introduction: The Ministry of Health, Kenya (MOH) investigated a report on acute watery diarrhea (AWD) cases at a city hotel to confirm the cause, characterize, and identify associated factors. **Methods:** A suspected case of cholera was defined as AWD in any person aged >2 years at the hotel from August 31, 2017, to September 6, 2017. We took rectal swabs for laboratory confirmation and summarized the AWD data by person, place, and time. We defined a cohort of hotel staff with those who ate dinner on August 31, 2017, considered exposed and conducted a retrospective cohort study. We calculated attack rates (AR) and risk ratios (RR) with 95% confidence interval. Variables with $p < 0.1$ at bivariate analysis were entered into a multivariate model and those with $p < 0.05$ in the final model considered independently associated with the AWD. **Results:** *Vibrio cholerae* was isolated from seven (10.1%) out of 69 samples. Line listed 139 cases with a median age of 32 years (Range: 20–58 years) included 127 (91.4%) male and 127 (91.4%) guests. Index case was reported on August 31, 2017, cases peaked at 95 cases on September 3, 2017, and declined to three on September 6, 2017. A total of 30 (81.1%) of 37 hotel staff were exposed with 17 (56.7%) cases. Food specific ARs were: steamed spinach 78.6% and pineapples 26.3%. Spinach (RR: 3.0 (95%CI: 1.76-72.97)) was a risk factor while pineapples (RR: 0.4 (95%CI: 0.01-0.58)) was protective. **Conclusion:** This was a point source cholera outbreak likely due to eating contaminated spinach.

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Introduction

Cholera is an acute epidemic-prone diarrheal disease caused by the bacterium *Vibrio cholera* through a feco-oral transmission mainly by ingestion of contaminated water or food [1]. It has an incubation period ranging from 2 hours to 5 days with only 25% of those infected becoming symptomatic out of whom 20% develop severe disease with case fatality rates (CFR) of up to 50% without proper management [2]. Cholera is associated with poor water quality and sanitation practices. The World Health Organization (WHO) recommends a minimum of 0.2mg/liter free residual chlorine for safe drinking water, however, this can be increased to 5mg/liter during cholera outbreaks [3-5]. Cholera is an indicator of inequity and lack of social development and remains a global threat to public health [6].

It is estimated that about 1.3 billion people are at risk of cholera with 2.86 million cases (Range: 1.3 - 4.0 million cases) and 95,000 deaths (Range: 21,000 - 143,000 deaths) occurring in endemic countries globally every year [7-10]. Most of these cases occur in Asia, Latin America, Africa, and the Middle East countries affected by war, poverty, and natural disasters which promote crowding, poor sanitation, and limited access to safe water [8]. Africa contributes more than half of cholera cases reported to the WHO globally which is considered an underestimate due to the differences in modalities, completeness and case definitions among member states [2,11-14].

Cholera has been endemic in Kenya since it was first detected in 1971 with widespread outbreaks recorded in 1997-1999 and in 2007- 2010 [15]. This was followed by a significant decrease in reported cholera cases between 2011 and 2014, however, in 2015 cholera re-emerged and persisted in Kenya posing serious threat to public health [16]. In 2017, Kenya reported a total of 4,228 cases of cholera with 82 deaths (CFR: 1.9%) to the WHO [12]. On September 2, 2017, the Ministry of Health (MOH), Kenya was notified of cases of acute watery diarrhea (AWD) at a city hotel. We investigated to confirm the cause, characterize, and identify factors associated with the AWD.

Methods

Outbreak site

The AWD occurred at a three-star hotel and conference center located 13 kilometers from the city center. The hotel had a 200-bed capacity and offered private and corporate functions including outings, meetings, swimming, steam bath, weddings, parties, photo shoots, pool-side bar, sauna massage and picnics.

Investigation designs

We undertook the investigation in three phases. We conducted laboratory investigation to confirm the cause and a cross sectional study to characterize the outbreak. We did a retrospective cohort study to identify the factors associated with the outbreak. Lastly, food handlers' medical examination, water quality assessment and menu item traceability were performed to identify the source of the causative agent.

Outbreak population

The outbreak population constituted all persons who were at the city hotel from August 31, 2017, to September 6, 2017. The persons included patrons drawn from all the 47 administrative regions (counties) of the Republic of Kenya on an official activity, and the hotel members of staff. In the laboratory and cross-sectional investigation, we defined a suspected cholera case as any person aged >2 years who presented with AWD, abdominal pain, nausea or vomiting. A confirmed cholera case was any person from whose rectal swab sample *Vibrio cholera* had been isolated and a probable cholera case was any suspected case epidemiologically linked to a confirmed case. In the second phase of the investigation, all hotel staff members who were at the hotel on the evening of August 31, 2017, were included in a cohort. Any of these staff members who ate or drank at the hotel that evening was considered exposed while those who developed AWD between August 31, 2017, and September 6, 2017, were considered cases.

Data collection and analysis

We collected data on the number of people at the hotel during the time of the AWD from the hotel's boarding, duty roster and payment records using a

semi structured questionnaire. We took rectal swabs from the suspected cases to confirm the cause of the AWD and from the hotel staff members to assess for *Vibrio cholera* carriage. The swab samples were transported in Cary-Blair transport media to the National Public Health Laboratory Services (NPHLS) and plated on thiosulfate-citrate-bile salts agar (TCBS). The resultant colonies were evaluated using biochemical reactions and serotyped using commercial antisera. Colonies were also tested for antimicrobial susceptibility using disk diffusion method. Data were summarized using proportions.

We updated, consolidated, and cleaned the AWD line lists' data from the admitting health facilities using Microsoft Excel; and analyzed in Epi Info statistical software. The data were summarized in terms of person, place and time characteristics using means for continuous variables and proportions for categorical variables. The proportion (%) of cases and case fatality rate (CFR) were calculated. We also collected socio-demographic, clinical, exposure, and food hygiene factors data using a structured questionnaire in the cohort study and summarized using means, proportions, and attack rates (AR). We assigned socio-demographic factors, dinner on August 31, 2017, and hygiene practices as exposures and development of AWD as outcome and run a bivariate analysis. The exposure variables that had risk ratios (RR) with $p > 0.1$ with 95% confidence interval (95%CI) were reported as such while those with $p \leq 0.1$ on bivariate analysis were entered into a multivariate logistic regression through backward stepwise elimination method and RRs reported. The exposure variables whose RRs with 95%CI had $p \leq 0.05$ in the final model were considered independently associated with developing AWD and reported.

Two hundred (200) milliliters (ml) of water were collected using sterile bottle and transported to NPHLS at $< 8^{\circ}\text{C}$ to assess water quality. The water sample was filtered, and the filters placed in petri dishes containing MacConkey agar and Nutrient agar and incubated at 35°C for a period of 24 hours. Colonies were identified based on morphological characteristics and coliforms identified were counted. Water samples from the hotel's reservoir tank was also tested for residual chlorine using the color-wheel test kit and results quantified in terms of parts per million (ppm). We identified menu items which were consumed by the people at the hotel

during the AWD incident. For every menu item identified, supplier details were obtained from the hotel management. Using a standard checklist, data on sourcing, storage, processing, and transportation were obtained from the supplier. Where a menu item was a farm produce, we visited the source farm and collected additional data on farming practices.

Ethical considerations

This was a public health emergency that required immediate investigation and response, as such, could not go through the ethical review process due to time constraints. However, permission to investigate the suspected outbreak was granted by the Ministry of Health, county government, and hotel management. The objectives of the investigations were also explained to the participants and their verbal consent obtained.

Results

The city hotel received 526 people from August 31, 2017, through to September 6, 2017, including 429 (81.6%) male and 430 (81.8%) residents. Out of the 139 (26.4%) suspected cases, 127 (91.4%) were male and 127 (91.4%) were residents [Table 1](#). The mean age of the suspected cases was 34.8 years (SD: 10.2 years). The index cases included a resident and a non-resident member of staff who were reported on the night of August 31, 2017. The number of cases then rapidly increased peaking on the morning of September 3, 2017, with 87 cases before declining to two cases in the morning of September 6, 2017 [Figure 1](#). *Vibrio cholera* 01 serotype Ogawa was isolated from seven (10.1%) of the 69 rectal swab samples obtained from the suspected cases. All the isolates were sensitive to tetracycline and levofloxacin but resistant to amikacin. One case died (CFR: 0.7%) due to acute renal failure secondary to hypovolemic shock at one of the admitting hospitals.

Thirty-seven (37) hotel staff members were interviewed in the cohort study out of whom 19 (51.4%) were female, 21 (56.8%) had tertiary level of education and 13 (35.2%) were food handlers. The mean age of the staff members was 35.4 years (SD: 7.8 years). Out of the 13 hotel staff members who handled food, 10 (76.9%) reported washing hands before handling food while 6 (46.2%) used gloves to handle ready-to-eat foods. Nine (69.2%) had

undergone food handler's medical examination within the last six months preceding the outbreak. Thirty (81.1%) of the staff members took dinner at the hotel on August 31, 2017, out of whom 17 (AR: 56.7%) developed AWD [Table 2](#). None of the seven (AR: 0.0%) staff-members who never took dinner at the hotel on August 31, 2017, developed AWD. There was a higher likelihood of developing cholera among those who ate spinach (RR: 3.0 {95%CI: 1.76-72.97}) and cooked foods held at room temperature (RR: 6.8 {95%CI: 1.67-736.54}) than those who did not. Those who ate pineapples (RR: 0.4 {95%CI: 0.01-0.58}) were less likely to become cholera cases than those who did not.

Vibrio cholera O1 serotype Ogawa was isolated from one (2.7%) out of the 37 rectal swab samples taken from the hotel's members of staff. Onsite analysis of water samples found 0.02 ppm of residual chlorine while the microbiological analysis found 51-100 CFU/100ml coliforms. Spinach was supplied by a single subcontracted firm based in the city who delivered it directly from the farm while transporting in open vehicle. A visit to the spinach source farm found a peri-urban farm located on the northern part of the city where raw sewage was being used for irrigation and sewage sludge (night soil) for top dressing.

Discussion

This investigation confirmed a cholera outbreak due to *Vibrio cholera* O1 serotype Ogawa among people at a city hotel who presented with AWD. *Vibrio cholera* O1 serotype Ogawa is the cholera strain commonly isolated in cholera outbreaks in many African countries including Kenya [\[17-20\]](#). The male, residential guests and those aged between 25 - 35 years were the most affected during the outbreak. The most probable time of exposure was on the evening of August 31, 2017. The epidemic curve was consistent with a point source transmission indicative of a single common exposure. Having eaten dinner and specifically, steamed spinach was associated with being a case. Eating pineapples were protective in this outbreak.

Female sex has been shown to bear the biggest brunt of cholera outbreak because they are more likely to handle contaminated water, nurse the sick and clean sanitary facilities [\[21-25\]](#). This investigation,

however, presents a higher proportion of cases among the male than female. The high numbers of male than female at the hotel may explain this inconsistency. However, other cholera outbreak studies with similar findings attribute it to the outside households outbreak setting as men are more likely to eat away from home [\[26-30\]](#).

The proportion of cases was also higher among the residents than non-residents to the hotel. This could be explained by the likelihood of being exposed to the contaminated food being higher among the residents than the non-residents. The investigation also depicted a CFR within the WHO recommended <1% benchmark indicative of adequate clinical case management or quality of care [\[11,31\]](#). Low CFRs during cholera outbreaks have been associated with high quality of care due to qualified personnel, timely access to care, adequate rehydration, appropriate hygiene measures and patient compliance with the treatment plan [\[32,33\]](#). These may hold true in this outbreak which occurred in a high-end hotel with timely access to quality healthcare services within the city.

The point source distribution of cases in this investigation and absence of clustering of cases by places of origin focused the source of outbreak at the city hotel but the exact the likely source of the causative agent remained speculative. Detection of fecal coliforms from water samples from the hotel reservoir tanks and the isolation of *Vibrio cholera* from one of the food handlers suggest these as possible sources of the outbreak. However, this was unlikely as the infected food handler had been off duty the week preceding the outbreak and the epi curve did not depict a continuous common source transmission expected with contaminated water supply. Consumption of vegetables has been shown to be a risk factor for cholera outbreak with high prevalence of toxigenic *Vibrio cholera* demonstrated on vegetables from farms irrigated with waste water [\[11,34\]](#). In this investigation, eating spinach served on the evening of August 31, 2017, was the only menu item positively associated with the outbreak making it the likely vehicle of transmission. This may be attributed to poor farming practices observed at the source farms during the investigation, however, cabbages sourced from the same farm was not associated with being a case. This might have been due to inadequate cooking as the spinach was steamed while cabbage was stewed; contamination

by infected food handlers; or cross contamination during handling [35-38].

A positive association between eating cooked foods held at room temperature including ugali, spinach, beef stew, rice, cabbage, *githeri* and the development of cholera was also demonstrated in this study. This is consistent with other cholera outbreak investigations done in Port-au-Prince, Haiti, Harare, Zimbabwe, and Western Kenya [39-41]. This is likely due the food having been held at ambient temperatures during services which supports growth of *Vibrio cholera* [42]. Eating uncooked foods has been shown to be a risk factor for cholera as they harbour viable pathogens [39,43,44]. However, eating pineapples in this investigations was shown to be protective which may be due to its low pH which does not promote growth of *Vibrio cholera* [45,46]. Lack of hand washing after visiting the sanitary facilities and before eating have been shown to be positively associated with incidence of cholera [3,47,48]. This investigation, however, showed no association between hand washing and developing cholera. This could be due to a possibility of the food having been contaminated beforehand making hand washing ineffective.

Cholera is generally self-limiting with antibiotic therapy recommended in severe dehydration and comorbidities such as severe acute malnutrition and pregnancy [49]. Antibiotic prophylaxis can also be used among cholera contacts in enclosed settings such as prisons, camps, nurseries, orphanages, nursing homes, and ships [50]. Uncontrolled antibiotic prophylaxis in the general population in cholera endemic settings has been shown to drive antimicrobial resistance [36]. *Vibrio cholera* isolated in this investigation were sensitive to cholera first line antimicrobials agents. While this is a good sign, the use of antibiotics in cholera management needs to be closely monitored to reduce the likelihood of development of resistance.

Limitations

The cohort study in this investigation had a small sample size which may limit its power to bring out true associations. Failure to obtain food samples for further laboratory testing for possible pathogens made it difficult to pinpoint the exact culprit menu item.

Conclusion

This outbreak investigation revealed a point source cholera outbreak at a city hotel with consumption of spinach as a likely source of exposure. Eating food held at room temperature was a risk factor while eating pineapples was protective in the outbreak. Vegetables supplies especially those served raw or partially cooked should be sourced from farms with good farming practices. Ready-to-eat food items that are likely to support growth of *Vibrio cholera* should not be held at room temperature.

Implications for public health practice

Policies regulating food safety should consider the holistic farm-to-fork supply chain as opposed to the current focus on premises and food handlers.

What is known about this topic

- Cholera is acute diarrheal illness caused by *Vibrio cholera* through the feco-oral route and rapidly leads to dehydration, shock, and death if untreated
- Approximately 1.3 billion people are at risk of cholera with 3 - 5 million cases and 120,000 deaths occurring globally every year most of which occur in Sub Saharan Africa
- Cholera is an indicator of inequity and lack of social development and remains a global threat to public health

What this study adds

- This cholera outbreak demonstrated a higher proportion of male cases compared to female contrary to the female sex having been reported as the most vulnerable due to gender roles which could be attributed to out of household transmission
- Raw foods with low pH such as pineapples may be protective against cholera probably due to the low pH
- Handwashing before eating may not protect one against cholera if the food is contaminated beforehand

Competing interests

The authors declare no competing interests.

Authors' contributions

All the authors participated in the investigation protocol development. PN, AN, SW, AD, DL and RM collected data on food handlers' medical examination, water quality, traceability, retrospective cohort study and cross-sectional study under the guidance of EO and MO. All authors participated in data analysis and report writing. PN drafted the manuscript with input from all the authors. All the authors have read and approved the final version of the manuscript.

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Tables and figures

Table 1: Distribution of cases by sex and residential status during a cholera outbreak at a city hotel in Kenya, 2017

Table 2: Specific attack rates (AR) and risk ratios (RR) for August 31, 2017, dinner during a cholera outbreak at a city hotel in Kenya

Figure 1: Epidemic curve of cholera cases line listed between August 31, 2017, and September 6, 2017, at a city hotel in Kenya, 2017

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Table 1: Distribution of cases by sex and residential status during a cholera outbreak at a city hotel in Kenya, 2017

Group	Cases	Proportion
Sex		
Male	127	91.4
Female	12	8.6
Residential status		
Residents	127	91.4
Non-residents	12	8.0
Total	139	100.0

Table 2: Specific attack rates (AR) and risk ratios (RR) for August 31, 2017, dinner during a cholera outbreak at a city hotel in Kenya

Exposure factors	Ate				Never ate				RR	95% CI	P-Value
	Ill	Not Ill	Total	AR (%)	Ill	Not ill	Total	AR (%)			
Socio-demographic											
Being male	8	11	19	42.1	9	9	18	50.0	0.84	0.16-3.20	0.746
Having tertiary education and above	10	11	21	47.6	7	9	16	43.8	1.09	0.26-5.27	1.000
Working at the restaurant	8	5	13	61.5	9	15	24	37.5	1.64	0.54-13.63	0.188
Foods											
Supper of 31/8/2017	17	13	30	56.7	0	7	7	0.0	∞	-	-
Steamed spinach	11	3	14	78.6	6	17	23	26.1	3.01	1.76-72.97	0.003
Chicken stew	10	8	18	55.6	7	12	19	36.8	1.51	0.48-9.78	0.330
Githeri*	2	3	5	40.0	15	17	32	46.9	0.85	0.56-7.62	1.000
Ugali**	5	6	11	45.5	12	14	26	46.2	0.98	0.18-4.98	1.000
Beef stew	4	8	12	33.3	13	12	25	52.0	0.64	0.08-2.34	0.319
Pineapples	5	14	19	26.3	11	7	18	61.1	0.43	0.01-0.58	0.004
Banana	1	3	4	25.0	16	17	33	48.5	0.52	0.01-5.08	0.608
Watermelon	5	7	12	41.7	12	13	25	48.0	0.87	0.15-3.80	1.000
Boiled rice	8	10	18	44.4	9	10	19	47.4	0.94	0.20-3.90	1.000
Cabbage stew	3	4	7	42.9	14	16	30	46.7	0.92	0.11-6.09	1.000
Safety practices											
Ate cooked food served at room temp.	16	10	26	61.5	1	10	11	9.1	6.77	1.67-736.54	0.004
Drank tap water	5	6	11	45.5	12	7	19	63.2	0.72	0.08-2.81	0.454
Washed hands after toilet	13	14	27	48.1	4	6	10	40.0	1.20	0.256-8.27	0.725
Washed hands before eating	11	17	28	39.3	6	3	9	66.7	0.59	0.05-1.96	0.251
*A cereals meal made from maize mixed with legumes (commonly beans) together in a pot or cooker and boiled until soft											
**A type of porridge meal made from corn, millet, sorghum, or cassava flour cooked by boiling and kneading until it reaches a firm dough-like consistency											

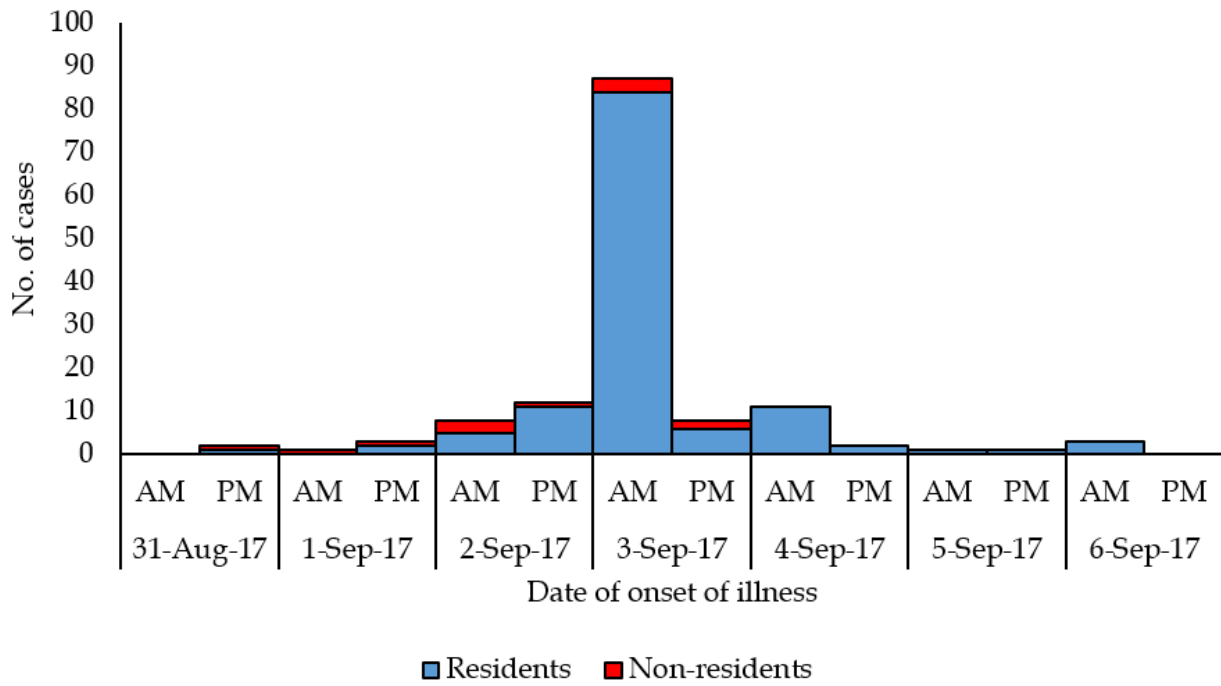


Figure 1: Epidemic curve of cholera cases line listed between August 31, 2017, and September 6, 2017, at a city hotel in Kenya, 2017