High Mortality in a Cholera Outbreak in Western Kenya after Post-Election Violence in 2008

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Abstract. In 2008, a cholera outbreak with unusually high mortality occurred in western Kenya during civil unrest after disputed presidential elections. Through active case finding, we found a 200% increase in fatal cases and a 37% increase in surviving cases over passively reported cases; the case-fatality ratio increased from 5.5% to 11.4%. In conditional logistic regression of a matched case-control study of fatal versus non-fatal cholera infection, home antibiotic treatment (odds ratio [OR] 0.049; 95% CI: <0.001–0.43), hospitalization (OR, 0.066; 95% CI, 0.001–0.54), treatment in government-operated health facilities (OR, 0.15; 95% CI, 0.015–0.73), and receiving education about cholera by health workers (OR, 0.19; 95% CI, 0.018–0.96) were protective against death. Among 13 hospitalized fatal cases, chart review showed inadequate intravenous and oral hydration and substantial staff and supply shortages at the time of admission. Cholera mortality was under-reported and very high, in part because of factors exacerbated by widespread post-election violence.

INTRODUCTION

Although cholera incidence has decreased in Asia and Latin America during the past decade, the incidence in sub-Saharan Africa has remained relatively unchanged. Two thirds of reported cholera outbreaks from 1995 to 2005 occurred in Africa. Moreover, cholera mortality remains disproportionately high in Africa. In Asia, the reported case-fatality ratio (CFR) has been <1% since 2002. Although the annual cholera CFR has decreased in Africa, it has never dropped below 1.5% and was 2.7% in 2006. From 2000 to 2005, eight African countries registered CFRs >5%. This high mortality highlights deficiencies in access to care and case management in much of Africa, given decades of evidence that cholera when treated promptly and appropriately should.

In early 2008, a cholera outbreak spread through 10 districts in Nyanza Province in western Kenya along Lake Victoria. By April 15, 2008, the Kenya Ministry of Health (MOH) reported 790 cholera cases and 53 deaths (CFR, 6.7%). This CFR was startling considering that the average CFR for cholera cases reported to WHO from Kenya from 2000 to 2007 was already excessive at 3.8% (Kenya MOH, unpublished data). It was also twice as high as that observed in other recent cholera outbreaks in Africa. The peak number of cases occurred in the months after the contentious Kenyan presidential election of December 27, 2008, when disputed results triggered a several month-long period of protest, violence, public transportation disruptions, and work stoppages throughout Kenya, during which >1,000 people were killed and 350,000 were displaced from their homes. We undertook a study of the 2008 Kenya cholera outbreak to more precisely characterize the mortality burden and associated risk and protective factors.

MATERIALS AND METHODS

Case finding. We used the WHO/Kenya MOH definition of a suspected cholera case in an outbreak setting—watery diarrhea (at least three bowel movements in 24 hours) of sudden onset in a person ≥5 years of age. Cholera cases were identified by obtaining line-lists compiled by the District MOH for the three districts that reported the most cases in Nyanza Province: Kisumu East, Migori, and Rongo (Figure 1). In all sub-locations—the lowest administrative unit with ~10–15 villages—in those three districts with reported cholera deaths, additional cases and deaths were sought. Active case finding started by interviewing the administrative head of the sub-location, the sub-chief, about cholera cases in his sub-location. Next, in villages where cases occurred, a similar interview was held with the administrative head of the village, the village elder. Last, all households of cases from the District MOH line list and additional cases identified by sub-chiefs and village elders were visited. In turn, the families of these cases were asked if they knew any other suspect cases in the area. All persons interviewed were asked to identify both surviving and fatal cases of cholera-like illness. For each suspected cholera case identified through active case finding, the District MOH line list was searched based on the person’s name, age, and village to assess if the case had been reported previously.

Case-control study. In April 2008, an age-matched case-control study was conducted in the same three districts with active case finding. A case was defined as a person with an illness meeting the suspected cholera case definition, between February 1, 2008 and April 15, 2008, who died. Controls were defined as persons with an illness meeting the suspected cholera case definition in the same time period who survived. We matched controls to cases using the following age groups: 5–14, 15–34, 35–49, and ≥50 years. For each sampled case, two controls were sought from the same village, or sub-location if not enough in the village, by simple random sampling among all age-group matched surviving cholera cases identified through both the district MOH line-list and through active case finding.

The target sample size was 31 cases and 62 controls. This was based on the sample size needed to confirm an odds ratio (OR) of 4.0 with a P < 0.05 and 80% power for the independent variable “not seeking medical care within the initial 48 hours of a cholera illness,” where 57% of cases did not seek care during the initial 48 hours, which was based on preliminary data from cholera cases in this outbreak. Data were collected by health workers who underwent a 2-day training. A structured, pre-tested questionnaire was used to ask about

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symptoms and potential risk factors for dying. Interviewers administered the questionnaire to a knowledgeable proxy for all cases and controls. The proxy was most often the mother or primary caretaker in the family. Chronic illnesses were defined as cancer, tuberculosis, and HIV/AIDS. Socioeconomic status was assessed by surrogate measures, including house characteristics and ownership of TV, radio, and bicycle. The determination of residual free chlorine in stored household drinking water was done using a colorimetric test kit (Chlorine DPD #1 Rapid; Lamotte Company, Chestertown, MD). We conducted medical record reviews in facilities where cholera cases died. The hospital administrative officer in hospitals and the nursing or clinical officer-in-charge in health facilities were asked to quantify any staff and supply shortages during the post-election violence.

We performed bivariate analysis using conditional logistic regression to compare proportions. Medians were compared using the Wilcoxon rank sum test. For multivariable analysis, conditional logistic regression was done using the forward selection procedure, starting with the most significant variable from bivariate analysis (version 9.2; SAS Institute, Cary, NC). All terms with $P < 0.10$ from bivariate analysis were entered into the model. Combinations of significant variables were entered into the model until the best-fitted, parsimonious model was determined. The exact test was used to calculate ORs and 95% confidence intervals (CIs). Interaction was tested for all variables in the final model by including and evaluating product terms for significance ($P < 0.05$). Because a number of enrolled persons reported bloody diarrhea, which is not usually associated with cholera, we reran the final model excluding cases and controls with bloody diarrhea.

All participating individuals gave verbal consent. This study was deemed part of an acute public health response in an outbreak setting by the Kenya MOH and CDC and thus did not receive formal review and approval by Ethical Review Committees.

RESULTS

Case finding. Ten (48%) of 21 districts in Nyanza Province reported cholera cases. At the Kenya Medical Research Institute/CDC laboratory, *Vibrio cholerae* O1, serotype Inaba, susceptible to tetracycline, was isolated from stools from 19 (61%) of 31 patients during the outbreak period. More cholera isolates were identified in hospital laboratories in Nyanza Province, although stool culture was not performed on most suspected cases. Of all reported cases in Nyanza Province, 546 (69%) occurred in the three districts where this study took place (Figures 1 and 2).

In all three districts with active case finding, cases and deaths were identified that had not been reported to the District MOH (Table 1). A greater proportion of unreported fatal cases than surviving cases were detected. We found 46% more cholera cases through active case finding over those on the District MOH line-lists; however, 200% more fatal cases were found through active case finding compared with 37% more surviving cases ($P < 0.001$). When comparing the CFRs of cases identified by active surveillance (not on District MOH line-list) versus passive (on District MOH line-list) in each of the sub-locations, the ratios of CFRs varied from 2.6 to 38.3 (mean = 4.3; 95% CI, 2.4–7.7, for all sub-locations; Table 1). The overall CFR (for all cases identified by any method) decreased monthly as the outbreak progressed: 16.7% in January, 11.3% in February, 6.7% in March, and 2.8% in April.

Case-control study. We enrolled 31 cases and 55 controls; for 7 cases, only 1 surviving, matched cholera control could be found. We enrolled 12 cases from Kisumu East district, 13 from Migori district, and 6 from Rongo district. Cases and controls had equal age and sex distribution (Table 2). Controls had more reported fever, bloody diarrhea, and weakness than cases, whereas cases had more vomiting (Table 2).

The median duration from diarrhea onset to death among cases was 1 day, with 55% reporting diarrhea for < 2 days before dying. Nineteen (61%) deaths occurred in health facilities, 2 (7%) en route to hospital and 10 (32%) at home. Of the 19 deaths at health facilities, 15 (79%) occurred among admitted patients. We were able to locate information on 13 (87%) of hospitalized case-patients in eight facilities. The median time from admission to death was 18 hours (range, 6–96 hours). Level of consciousness was not noted in the charts, although most patients were described as “weak-looking” on admission. Of the 12 with a diagnosis written in the chart, only 6 (50%) listed “cholera.” Ten (77%) of 13 patients had intravenous fluids prescribed during the hospital course, but only 6 had documentation that intravenous fluids were given. The median amount of intravenous fluid (normal saline without potassium, Hartmann solution, or Darrow solution) given was 3.75 L (range, 1.5–6 L). Only two patients had documentation...
of receiving oral rehydration treatment (ORT) in the hospital, and three received doxycycline. Shortages of hospital staff during the time of admission of the case-patient were reported in seven (88%) facilities. Compared with optimal pre-election staffing numbers, at the time of case-patient admission, hospital administrators reported a 49% deficit in nurses, 46% deficit in clinical officers, and 33% deficit in medical officers. Five (62%) facilities reported having reduced or no supply of intravenous fluids and cannulae, and three (37%) had shortages of ORT supplies.

Factors that were protective against dying in bivariate analysis were the following: having heard about cholera before becoming ill, having soap in the household before cholera illness, being treated in a government health facility, having been educated about cholera before becoming ill, having been educated about cholera by a health worker, and being admitted to hospital overnight (Table 3). Of note, fewer cases than controls had residual free chlorine in their stored household drinking water, but this did not quite reach statistical significance. Factors not associated with cholera mortality included sex, educational level, having other cholera cases in the home, household crowding, duration of transport and transport fare to the nearest admitting facility, and socioeconomic status. Of note, only 4 (4.7%) of the 86 cholera patients reported ORT use at home (2 oral rehydration solution [ORS], 2 homemade sugar-salt solution).

In multivariable analysis, home treatment with antibiotics, hospital admission, seeking care in government-run facilities, and being educated about cholera by a health worker were protective against death (Table 4). No significant interaction between variables was found. On rerunning the final model without 1 case and 11 controls with bloody diarrhea, the point estimates were similar, although the CIs were wider, so that only admission was statistically significant (Table 4).

**DISCUSSION**

In early 2008, a large outbreak of cholera with unusually high mortality occurred in western Kenya. The CFR among cases reported to the Kenya MOH of 6.7%, which is already high, likely underestimated the actual CFR because of disproportionate under-reporting of cholera deaths. Through active case finding in selected sub-locations, we found the CFR increased from 5.5% to 11.4%, which is more than three times the average CFR observed among reported cases in Kenya from 2000 to 2005. Moreover, the CFR was much higher than the average CFR reported in several cholera outbreaks in Kenya in 2005 (2.5%) and another large outbreak in Nyanza Province in 1997 (4%). During recent cholera outbreaks in other African countries, reported CFRs also were lower: Guinea-Bissau (3.4%), Zambia (3.5%), Nigeria (6.1%), Madagascar (5.9%), and Tanzania (2.1%), and Zimbabwe (2.9%).

Reporting of cholera cases almost always depends on passive health facility-based surveillance and likely results in a significant underestimation of cases in most cholera outbreaks in Africa. Many cholera patients without severe illness do not seek care from health facilities. Moreover, access to health facilities in rural African settings is often poor because of obstacles of distance, lack of transport, and cost. In this out-

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**Table 1**

Comparison of case-fatality ratios (CFRs) between cholera patients line-listed by the District Ministry of Health (MOH) and those identified through active case-finding in selected sub-locations, Nyanza Province, January–April, 2008

<table>
<thead>
<tr>
<th>District</th>
<th>No. of sub-locations with active case finding (% total sublocations in district)</th>
<th>Cases</th>
<th>Deaths (CFR)</th>
<th>Ratio of CFR active case finding to line-listed cases (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>District MOH line-listed</td>
<td>Active case findinga</td>
<td>Total</td>
<td>District MOH line-listed</td>
</tr>
<tr>
<td>Kisumu East</td>
<td>6 (11%)</td>
<td>83</td>
<td>58</td>
<td>141</td>
</tr>
<tr>
<td>Migori</td>
<td>11 (17%)</td>
<td>119</td>
<td>58</td>
<td>177</td>
</tr>
<tr>
<td>Rongo</td>
<td>3 (6%)</td>
<td>69</td>
<td>9</td>
<td>78</td>
</tr>
<tr>
<td>Total 3 districts</td>
<td>20 (12%)</td>
<td>271</td>
<td>125</td>
<td>396</td>
</tr>
</tbody>
</table>

*a Cases and deaths only found through active case finding. If someone was found on both the District MOH line-list and through active case finding, they appear in column for district MOH line-listed.
break, and perhaps in others in rural Africa, cholera deaths and the CFR were also underestimated by passive facility-based surveillance. Severely ill cholera patients also face the same limitations of access to care, which can lead to undercounting. Additionally, for fatal cases, because of the rapidity of onset of profuse diarrhea and vomiting with cholera, such patients might die before accessing health facilities.5,9,20 In this study, the majority of fatal cases died < 2 days from illness onset. Although under-reporting of cholera cases and deaths likely occurs during normal times in Africa, the phenomenon is likely worsened during periods of civil unrest, which have been the background for many recent cholera outbreaks in Africa, including those in Zimbabwe and the Democratic Republic of Congo.1,4,18 An alternative explanation for our finding more unreported fatal than surviving cases with active case finding is that people might have recalled cholera deaths more than surviving cases because of recall bias, leading to a falsely high estimation of the CFR.

The post-election violence that enveloped Kenya in early 2008 undoubtedly contributed to the high mortality rate. After a disputed presidential election on December 27, 2007, the country erupted into widespread violence and civil disruption. Nyanza Province experienced lack of public transportation, multiple work stoppage “mass action” days, and impromptu roadblocks on rural roads, greatly complicating access to health facilities. Moreover, many staff in health facilities in Nyanza Province who had left their posts to go to their home areas to vote and to celebrate Christmas were unable to return. Health facility staff of rival ethnic backgrounds also fled their posts in Nyanza Province out of concern for their personal safety. Health facilities experienced shortages in critical supplies during the months after the election, including those used for oral and intravenous rehydration. Staff and supply shortages were most acute in January and February during the height of post-election violence, but persisted into March and April, when the number of reported cholera cases peaked. This was confirmed by our review of hospitalized fatal cases, where shortages in both staffing and rehydration supplies were consistently reported. A limitation of our case-control study is that we did not directly ask participants if post-election violence affected their ability to seek health care for their illness.

We found that seeking care at a government health facility and being admitted at any facility were protective against death. Seeking care outside the home was also shown to be protective for death in cholera outbreaks in Peru and Guinea-Bissau.20 Because patients treated at health facilities were more likely to be reported on the District MOH line-list, it is possible that the associations between protection against cholera death and clinic visitation and admission were confounded by the fact that more controls than cases were on the District MOH line-list. Both protective factors remained significant, however, after stratifying by the source of line-listing (data not shown).

**Table 2**

<table>
<thead>
<tr>
<th>Characteristics of cases and controls in the case-control study of risk factors for cholera death, Nyanza Province, Kenya, January–April 2008</th>
<th>Cases</th>
<th>Controls</th>
<th>P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number</td>
<td>31</td>
<td>55</td>
<td>-</td>
</tr>
<tr>
<td>Age [median years (range)]</td>
<td>35 (7–90)</td>
<td>34 (5–72)</td>
<td>-</td>
</tr>
<tr>
<td>Female [N (%)]</td>
<td>14 (45)</td>
<td>35 (63)</td>
<td>0.083</td>
</tr>
<tr>
<td>Clinical presentation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diarrhea duration in days (median)</td>
<td>1</td>
<td>3</td>
<td>0.001</td>
</tr>
<tr>
<td>Maximum number bowel movements per day (median)</td>
<td>6</td>
<td>6</td>
<td>0.58</td>
</tr>
<tr>
<td>Bloody diarrhea</td>
<td>1 (3)</td>
<td>11 (20)</td>
<td>0.015</td>
</tr>
<tr>
<td>Vomiting</td>
<td>28 (90)</td>
<td>41 (75)</td>
<td>0.056</td>
</tr>
<tr>
<td>Fever</td>
<td>2 (6)</td>
<td>12 (22)</td>
<td>0.069</td>
</tr>
<tr>
<td>Weakness</td>
<td>8 (26)</td>
<td>31 (56)</td>
<td>0.0038</td>
</tr>
<tr>
<td>Body pain</td>
<td>3 (10)</td>
<td>10 (18)</td>
<td>0.27</td>
</tr>
<tr>
<td>Headache</td>
<td>3 (10)</td>
<td>10 (18)</td>
<td>0.27</td>
</tr>
<tr>
<td>Anorexia</td>
<td>5 (16)</td>
<td>16 (29)</td>
<td>0.13</td>
</tr>
<tr>
<td>Altered level of consciousness</td>
<td>8 (26)</td>
<td>16 (29)</td>
<td>0.89</td>
</tr>
</tbody>
</table>

* Proportions compared by Cochran-Mantel-Haenszel test, stratified for matched case-control groups. Medians compared by Wilcoxon rank-sum test.

**Table 3**

<table>
<thead>
<tr>
<th>Factors associated with cholera death in the case-control study at P ≤ 0.10 (bivariate analysis, conditional logistic regression model, exact test), Nyanza Province, Kenya, January–April 2008</th>
<th>Cases (%)</th>
<th>Controls (%)</th>
<th>Odds ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heard about cholera before illness</td>
<td>26 (83.9)</td>
<td>54 (98.2)</td>
<td>0.10</td>
<td>0.002–0.89</td>
</tr>
<tr>
<td>Soap for hand washing observed in home</td>
<td>21 (67.7)</td>
<td>47 (85.5)</td>
<td>0.19</td>
<td>0.02–0.98</td>
</tr>
<tr>
<td>Treated in government facility</td>
<td>15 (48.4)</td>
<td>43 (74.1)</td>
<td>0.24</td>
<td>0.07–0.76</td>
</tr>
<tr>
<td>Protected water source for drinking water*</td>
<td>7 (22.6)</td>
<td>21 (38.2)</td>
<td>0.23</td>
<td>0.02–1.65</td>
</tr>
<tr>
<td>Safe stool disposal (latrine, dug pit, or toilet)</td>
<td>21 (67.7)</td>
<td>47 (85.4)</td>
<td>0.28</td>
<td>0.05–5.19</td>
</tr>
<tr>
<td>Educated on cholera before illness (any source)</td>
<td>14 (45.2)</td>
<td>40 (72.7)</td>
<td>0.29</td>
<td>0.08–0.88</td>
</tr>
<tr>
<td>Educated on cholera by health workers</td>
<td>9 (29.0)</td>
<td>32 (58.2)</td>
<td>0.30</td>
<td>0.08–0.88</td>
</tr>
<tr>
<td>Home treatment with antibiotics†</td>
<td>5 (16.1)</td>
<td>19 (34.5)</td>
<td>0.34</td>
<td>0.08–1.10</td>
</tr>
<tr>
<td>Admitted overnight</td>
<td>15 (48.4)</td>
<td>41 (74.5)</td>
<td>0.34</td>
<td>0.10–0.96</td>
</tr>
<tr>
<td>Stored water in narrow-mouthed container</td>
<td>13 (41.9)</td>
<td>36 (65.5)</td>
<td>0.38</td>
<td>0.13–1.04</td>
</tr>
<tr>
<td>Chlorine absent in home water</td>
<td>23 (74.2)</td>
<td>28 (50.9)</td>
<td>2.83</td>
<td>0.86–10.8</td>
</tr>
<tr>
<td>Chronic medical condition (cancer, TB, HIV)</td>
<td>6 (19.4)</td>
<td>3 (5.5)</td>
<td>8.22</td>
<td>0.90–39.4</td>
</tr>
<tr>
<td>Not working at time of illness onset</td>
<td>5 (16.1)</td>
<td>1 (1.8)</td>
<td>9.10</td>
<td>1.00–43.4</td>
</tr>
</tbody>
</table>

* Protected water sources were considered protected wells, rainwater, and tap water.
† Most persons did not know antibiotic names.
Although seeking care at a health facility was protective against death, we also found that those who did reach health facilities were often mismanaged, which is suggested by the relatively long duration between admission and death (i.e., median, 18 hours), adequate time to have rehydrated a patient. Even in extreme situations such as the Goma refugee camp during the 1994 Rwandan crisis, the cholera CFR can be <1% with proper case management in facilities. Last, in Africa, the value of ORT in preventing deaths associated with dehydration diarrhea has been long established. In our chart review, intravenous fluids were not given to all patients, and those who did receive them did not receive the proper fluids or enough to replenish the massive electrolyte and volume depletion caused by cholera, which can be ≥10% body weight. Few patients received ORT at home or in health facilities. This inadequate management of cholera cases might have been exacerbated because of the reduced staffing and supplies during the post-election violence. Ministries of Health in Africa should consider periodic retraining of clinical staff and assessments of rehydration supplies in facilities in areas with high cholera burden.

We also found that taking antibiotics at home was protective against death. Antibiotics can reduce the intestinal microbial load of V. cholerae, interfering with production of cholera toxins, and can reduce the stool volume and duration of illness. Home use of antibiotics might also have been an independent marker of persons who are more attentive to their health status and more likely to seek medical treatment. It is also possible that more controls than cases had bacterial diarrhea other than cholera in which antibiotics might have been effective. More controls than cases reported fever and bloody diarrhea, which suggested other etiologies, such as shigellosis. A limitation of this study was that a clinical case definition of cholera was used, and most participants in the case-control study did not have microbiologic confirmation of cholera. Only four cholera patients reported ORT use at home. Consistent with this finding, use of ORT has been declining in recent years in Africa. The value of ORT in preventing deaths associated with dehydrating diarrhea has been long established. Last, having been educated about cholera before onset of illness by health workers was protective against death. In addition to knowledge on how to prevent cholera, education can increase awareness of the use of ORT at home and encourage early care-seeking at health facilities.

Our study highlighted several important points about cholera mortality in Africa. Cholera cases and particularly deaths are under-reported, suggesting that the true burden of cholera morbidity and mortality are underestimated in Africa. Second, improving access to early and correct treatment at health facilities can prevent cholera deaths. This can be achieved by a combination of efforts to improve education about cholera in remote communities and ensuring that health facilities are adequately staffed and supplied and that universal and continuous access to health facilities is maintained, which is particularly relevant during times of civil unrest. Cholera continues to spark disrupted populations, which unfortunately still occur too often throughout Africa, as witnessed by the recent situation in Zimbabwe, where >98,000 cholera cases and 4,000 cholera deaths have occurred in 2009. As Africa comes to account for an increasing proportion of the world’s cholera burden, a concerted effort is needed to implement life-saving primary and secondary prevention strategies that have been highly effective in Asia and Latin America. Received July 15, 2009. Accepted for publication August 13, 2009.

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REFERENCES


