Original article

Epidemic cholera in Kakuma Refugee Camp, Kenya, 2009: the importance of sanitation and soap

Abdirahman S. Mahamud[1], Jamal A. Ahmed[2], Raymond Nyoka[2], Erik Auko[1],Vincent Kahi[3], James Ndirangu[3], Margaret Nguhi[3], John W. Burton[4], Bosco Z. Muhindo[4], Robert F. Breiman[2], and Rachel B. Eidex[2]

[1]*Kenya Medical Research Institute/ Centers for Disease Control and Prevention, Nairobi, Kenya*
[2]*US Centers for Disease Control and Prevention, Nairobi, Kenya*
[3]*International Rescue Committee, Nairobi, Kenya*
[4]*United Nations High Commissioner for Refugees, Nairobi, Kenya*

Abstract
Introduction: Cholera remains a major public health problem that causes substantial morbidity and mortality in displaced populations due to inadequate or unprotected water supplies, poor sanitation and hygiene, overcrowding, and limited resources. A cholera outbreak with 224 cases and four deaths occurred in Kakuma Refugee Camp in Kenya from September to December 2009.
Methodology: We conducted a case-control study to characterize the epidemiology of the outbreak. Cases were identified by reviewing the hospital registry for patients meeting the World Health Organization (WHO) case definition for cholera. For each case a matched control was selected. A questionnaire focusing on potential risk factors was administered to cases and controls.
Results: From 18 September to 15 December 2009, a total of 224 cases were identified and were hospitalised at Kakuma IRC hospital. Three refugees and one Kenyan national died of cholera. *V. cholerae* O1, serotype Inaba was isolated in 44 (42%) out of 104 stool specimens collected. A total of 93 cases and 93 matched controls were enrolled in the study. In a multivariate model, washing hands with soap was protective against cholera (adjusted odds ratio [AOR] =0.25[0.09-0.71]; p<0.01), while presence of dirty water storage containers was a risk factor (AOR=4.39[1.12-17.14]; p=0.03).
Conclusion: Provision of soap, along with education on hand hygiene and cleaning water storage containers, may be an affordable intervention to prevent cholera.

Key words: Cholera; refugee; soap; sanitation; Kenya

J Infect Dev Ctries 2012; 6(3):234-241.

(Received 16 March 2011 -- Accepted 06 October 2011)

Introduction
Kenya hosts over 370,000 refugees from neighbouring countries, mainly from Somalia and Sudan, in two large camps, Kakuma and Dadaab Refugee Camps. Refugee camps are adversely affected by cholera outbreaks because of inadequate or unprotected water supplies, poor sanitation and hygiene, overcrowding which can lead to pressures on the water and sanitation infrastructure, and limited resources [1-3]. Kakuma Refugee Camp is located in Turkana district in northwest Kenya, close to the borders with Sudan, Ethiopia, and Uganda. The camp was established in 1991 to accommodate refugees fleeing from the conflict in southern Sudan. Kakuma town and surrounding villages rely on the infrastructure provided by the agencies supporting the camp. There is a great deal of interaction, trade, and movement between the local Kenyans and refugees.

As of November 2009, the Kakuma Refugee Camp population was estimated at 62,015 (58% Somali, 26% Sudanese, 9% Ethiopians, and 7% combined from the Democratic Republic of Congo (DRC), Burundi, Uganda, Rwanda, Tanzania, Djibouti, and Namibia. The International Rescue Committee (IRC) is the primary provider of health and sanitation services in the camp. IRC runs one main hospital and two clinics that offer free health services. Water, pumped from boreholes around the camp, is provided and maintained by the Lutheran World Federation (LWF). The United Nations High Commissioner for Refugees (UNHCR) plays a lead role through coordination and is responsible for the overall protection of refugees.

In August 2009, cases of cholera were first reported among the local communities in villages all over Turkana District. Cases were then confirmed in September 2009 among Kenyan nationals living in and around Kakuma (IRC, unpublished report). The first suspect case was identified in Kakuma Refugee Camp on 18September 2009, but the first culture-confirmed case had onset on 2 October 2009. The last case was reported on 15 December 2009. This outbreak was happening in the context of the largest nationwide cholera outbreak in the last decade with over 11,000 cases [4]. Between 2000 and 2009, cases of cholera were reported each year in several parts of Kenya [4]. Although there is close interaction between the refugees and the host (Kenyan) community, the only confirmed large cholera outbreak in Kakuma in the last decade in the camp was in 2005 [8]. Following recommendations from an investigation of this outbreak, refugee aid agencies worked towards increasing the water supply to at least 20 litres per person per day, improving latrine coverage, and making camp-wide bi-monthly distribution of soap. However, the movement of 12,000 new refugees from the overcrowded Dadaab refugee camp in August 2009 may have worsened the sanitary and hygiene conditions in the camp and this may have triggered the outbreak in 2009.

In response to the outbreak, from October to December 2009, UNHCR, IRC, and LWF undertook several interventions, including establishing a cholera treatment centre and an interagency cholera taskforce to coordinate response efforts, increasing household volume of water supply, active case finding by community outreach workers, increasing community health education, distributing point-of-use water treatment products, increasing latrine construction, and distributing prophylactic antibiotics to close contacts of cholera cases.

We conducted a case-control study to 1) identify the risk factors associated with transmission of cholera in Kakuma; 2) understand the specific dynamics of the outbreak in Kakuma; and 3) provide evidence-based recommendations to prevent future outbreaks.

Methodology

Characterizing the outbreak

According to Kakuma's camp Health Information System, which is primarily based on syndromic reporting, the incidence of acute watery diarrhoea among camp residents increased sharply in September 2009 (IRC, unpublished data), about the same time as the first cases of cholera were being reported from the refugee camp.

Rectal swabs were obtained from patients with diarrhoea, and all specimens immediately placed in Cary-Blair transport medium and then tested according to CDC guidelines [5] at Kakuma IRC Laboratory.

Case-control study

The study was conducted between 29 November and 9 December 2009. A case was defined as watery diarrhoea (≥ three watery stools in 24 hours) in any resident of Kakuma refugee camp ≥two years old, who was admitted to the IRC hospital cholera treatment centre, with onset of illness after 1 October 2009. Cases were selected from the IRC hospital cholera treatment centre patients' records (which included notes on demographics, hospital admissions, treatment, and laboratory results). A chart review was then performed to select cases meeting the case definition. We excluded 70 cases who could not be located for an interview. New arrivals to the camp were defined as those refugees who arrived after 1 June 2009, two months before 12,000 refugees were relocated to Kakuma camp from Dadaab.

As part of the case-control investigation, matched and unmatched controls were identified; however, the matched analysis was found to be more robust and no new information was obtained through the unmatched analysis. For the purposes of this paper, only the matched methodology and analysis will be presented here.

For each case a matched control was selected based on area of residence within the camp and age group (younger than five years old, 5 to 14 years, 15 to 24 years and older than 25 years). The camp is divided into four areas: Kakuma I, Kakuma II, Kakuma III, and Kakuma IV. The areas are divided into zones, which are further sub-divided into blocks. Controls were selected for each case by first randomly selecting blocks by using probability proportionate to the block population and then randomly selecting controls from within those blocks. A direction was chosen randomly by spinning a bottle from the centre of the block. Each compound from the centre to the edge of the block in this direction was given a number, and one compound number was selected randomly. All eligible controls living in the compound were listed and numbered, and one control who met the frequency matching criteria was chosen randomly. Individuals who reported episodes of acute watery diarrhoea after 20 September 2009 were excluded as controls.

Data on demographic information and potential risk factors including food, water, sanitation, and hygiene practices were collected through a standardized questionnaire. The questionnaire was administered by local multilingual trained community health workers after obtaining informed consent of the respondent. In circumstances for which a child was a case or control, questions were asked to a proxy adult within the compound who knew the child, preferably a parent if present. The questionnaire included an observational component involving interviewer assessment of water, sanitation, and hygiene. The internal surface of the household water storage containers were classified by observers into very clean (no dirt visible), clean (very little dirt visible), dirty (grossly contaminated containers with mud, food substance and other dirty materials). Household water consumption was assessed by asking the household head the number of jerry cans collected in a day and the size of the household. Free residual chlorine (FRC) levels in water stored in households or obtained from the tap stand were measured using the N,N-diethyl-phenylenediamine (DPD) colorimetric method (Hach Co, Loveland, CO, USA).

Questionnaires were double entered into a Microsoft Access 2007 database and then analysed by using SAS version 9.2 (SAS Institute, Cary, NC, USA); discrepancies were corrected by reviewing the questionnaire. Bivariate analyses using matched conditional logistic regression were performed to compare proportions by use of maximum likelihood estimates. Medians were compared by using the Wilcoxon rank sum test. The significance of difference in means for continuous variables was tested using the t-test. For multivariable analysis with matched controls, conditional logistic regression was performed in which variables from bivariate analysis with $p < 0.05$ were included in the model. A full model was fitted for the multivariate analysis and variables that were significant at $p < 0.05$ were considered to be associated with the outcome variable.

Results

Descriptive epidemiology

From 18 September to 15 December 2009, a total of 224 cases, including 163 refugees and 61 Kenyan nationals (non-refugees) from the nearby area, were identified and were hospitalised at Kakuma IRC hospital (Figure 1). Three refugees (CFR=1.8%) and one national (CFR = 1.6%) presenting at Kakuma IRC hospital died. *V. cholerae* O1, serotype Inaba was isolated in 44 (42%) out of 104 stool specimens collected. Antimicrobial susceptibility testing was completed for 42 of the 44 isolates. Resistance to antimicrobial agents was common: ampicillin (63.6%), tetracycline (50.0%), nitrofurantoin (81.8%), nalidixic acid (68.2%), and trimethoprim–sulfamethoxazole (83.3%). Isolates showed uniform sensitivity to amoxicillin-clavunic acid, cephalexin, cefaclor, and gentamycin.

Clinical data were available for 93 cases; mean duration of illness was 3.3 days. Symptoms included diarrhoea (100%), vomiting (90.1%), abdominal cramps (75%), subjective fever (60.7%), and bloody stool (9%). Males comprised 53% (n = 87) of the refugee cases. While the overall attack rate (AR) for the whole camp was 2.7 cases/1,000 persons, Kakuma II, which had the highest proportion of full latrines (not usable), had the highest AR (9.5 cases/1000 persons) (Figure 2).

Matched case-control study

A total of 93 cases and 93 matched controls were enrolled into the study (Table 1). In bivariate analyses (Table 2), significant reduction in the risk of cholera was observed in individuals who reported the presence of soap in the home during the week preceding illness (odds ratio [OR] 0.29, 95% confidence interval [CI] 0.12-0.54, $p < 0.001$) and those who reported washing their hands with soap (OR 0.29, 95% CI 0.15-0.57, $p < 0.001$).Having a latrine inside the household compound and access to a clean latrine was associated with a lower risk of contracting the illness (Table 2). Sharing a communal latrine with neighbouring households was associated with an increased risk of illness (OR, 3.33, 95% CI 1.34-8.30, $p = 0.001$) (Table 2). Cases were significantly more likely than controls to have human faeces visible on the grounds of their compound (OR 6.50, 95% CI 1.47-28.80, $p = 0.014$) and cases were not more likely to report contact with a person with diarrhoea during the week preceding the onset of illness (OR 1.81, 95% CI 0.98-3.34, $p = 0.056$). No significant association was found between illness and consumption of specific foods or ingesting food or drinks outside of the home (Table 2). A protective effect was found among those who ate cooked vegetables (OR 0.40, 95% CI 0.19–0.83, $p = 0.014$) or drank milk at home (OR 0.52, 95% CI 0.27-0.99, $p = 0.046$). Using dirty water storage containers

Figure 1. Epidemic curve of cholera cases admitted to Kakuma Hospital, September–December 2009

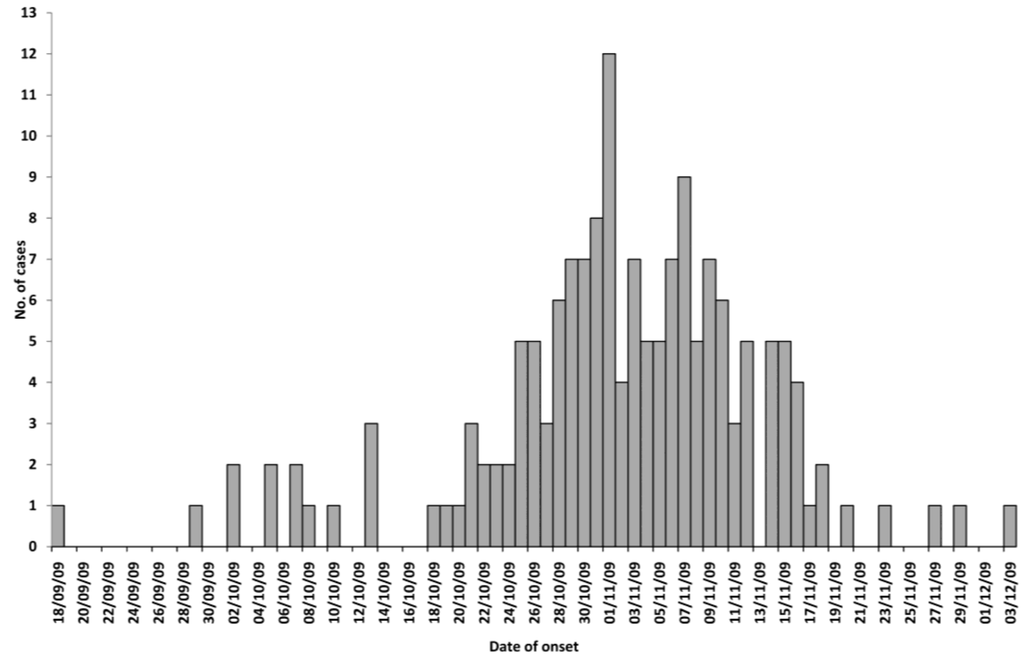

Figure 2. Map of Kakuma Refugee Camp indicating distribution of cholera attack rate and percentage of latrine that is full (not usable) in various areas of Kakuma, December 2009

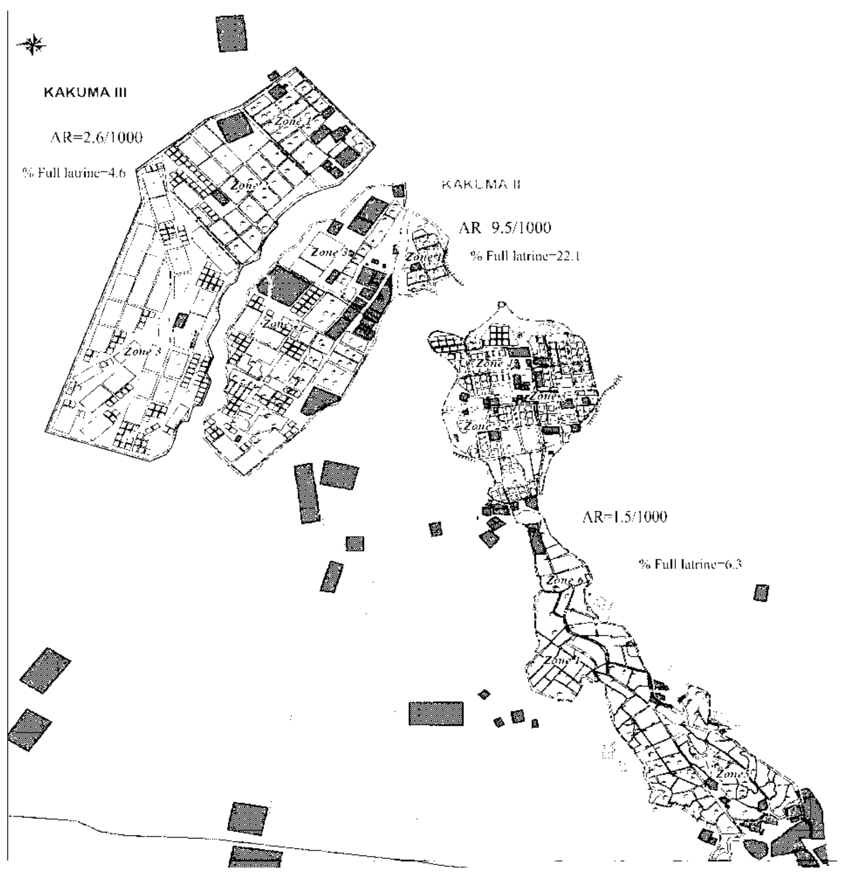

Table 1. Descriptive epidemiology of cases and controls, Kakuma, September – December, 2009

Demographics	Cases (N=93) n (%)	Matched controls (N=93) n (%)
Male,	48 (51.6)	37 (39.8)
Age groups (years)		
<5	20 (21.5)	20 (21.5)
5-14	30 (32.3)	32 (34.4)
15-24	16 (17.2)	15 (16.1)
≥ 25	27 (29.0)	26 (28.0)
Nationality		
Somali	68 (73.1)	69 (74.2)
Somali Somali	29 (31.2)	29 (31.2)
Bantu	25 (26.9)	21 (22.6)
Other Somali ethnic groups	14 (15.1)	19 (20.4)
Sudanese	11 (11.8)	19 (20.4)
Ethiopian	13 (14)	0 (0)
Others	1 (1.1)	5 (5.4)
Household mean size	7.0	7.4

increased the risk of illness, whereas treating water by either boiling it or treating it with chlorine before drinking was protective against cholera (Table 2).

Significant factors found in the multivariate model were as follows: washing hands with soap, which was protective against cholera (Adjusted OR [AOR] 0.25, 95% CI 0.09-0.71, p = 0.010); and the presence of dirty water storage containers, which was a risk factor (AOR 4.39, 95% CI 1.12-17.14, p = 0.034) (Table 3).

Study participants reported multiple water sources. The main source of water was the communal taps (96.2%). Other sources of water were stagnant water around the tap stand (12.2%) and shallow wells in the riverbed (5.8%). Water samples from households of 24 cases and 33 controls were tested for FRC. The mean FRC at household level was 0.28 for cases and 0.33 for controls (p = 0.500). A large fluctuation of the FRC levels (range 0-3.5 mg/L) was noted in the household water. Water was treated by chlorination through manual batching (adding 50 g of chlorine powder per 10,000 L of water to achieve a chlorine residual of 0.5 mg/L at water reservoirs). The quantity of water consumed per person per day was calculated to be 9.8 L for cases and 12.2L for controls (p = 0.039). The majority of the respondents (98.4%) used jerry cans to store water. Of the respondents, 90.7% retrieved water out of the storage container by pouring it out, while the rest used either cups or hands to get water out of the storage container. There was no difference in the risk of contracting infection when water was obtained from storage containers by cups or hands (OR 1.05, 95% CI 0.144-7.63, p = 0.965).

Discussion

Cholera outbreaks are common in situations with crowded living conditions, inadequate or unprotected water supplies, and poor sanitation [6]. These conditions are common in many of the refugee camps in Africa [7]. There have been previous reported cholera outbreaks in Kakuma Refugee Camp, most recently an outbreak involving 418 cases and four deaths in April 2005 [8]. In August 2009, a cholera outbreak was reported from districts around Kakuma Refugee Camp (Ministry of Health, Turkana Central cholera report, unpublished). The close interaction between local Kenyans and the refugees facilitated by porosity of the camp might have introduced cholera into the camp from the neighbouring districts. The most significant protective factor identified in the multivariate analysis was washing hands with soap, and the risk factor was using dirty water storage containers. Bivariate analysis also revealed additional risk factors, including sharing a communal latrine and visible faeces in some houses, which were biologically plausible and are worthy of consideration.

Table 2. Bivariate analysis of selected potential risk factors associated with cholera in case-patients and matched controls in Kakuma, September – December, 2009

Risk Factors	Cases n (%) N = 93	Matched controls (%) N = 93	OR (95% CI)	*P* value
Male	48 (51.6)	37 (39.8)	1.65 (0.90 - 3.01)	0.1046
Somali	68 (73.1)	69 (74.2)	0.91 (0.39 - 2.14)	0.8273
New arrivals(after 6/1/09)	30 (58.8)	21(41.2)	1.83 (0.68 - 4.96)	0.2324
Soap present in the home	57 (61.3)	81 (87.1)	0.25 (0.12-0.54)	0.0005
Used soap to wash hands	40 (44.9)	68 (76.4)	0.29 (0.15-0.57)	0.0003
Latrine in compound	49 (52.7)	65 (69.9)	0.47 (0.25-0.88)	0.0185
Communal latrine	34 (41)	21 (23.9)	3.33 (1.34 - 8.30)	0.0097
Observed faeces on ground	13 (14.6)	2 (2.2)	6.50 (1.47-28.80)	0.0137
Neighbour/family member had diarrhoea	43 (47.3)	31 (33.3)	1.81 (0.98-3.34)	0.0562
Use water from sources other than tap	18 (19.8)	13 (14.3)	1.45 (0.68 - 3.13)	0.3387
Dirty water storage containers	25 (27.5)	11 (12.2)	11.44 (2.85-45.95)	0.0006
Treated water before drinking	3 (3.3)	12 (12.9)	0.25 (0.07-0.89)	0.0317
Eat or drink anything outside the home	16 (18.4)	10 (11.4)	1.57 (0.61 - 4.05)	0.3499
Ate cooked vegetables at home	37 (39.8)	52 (55.9)	0.40 (0.19-0.83)	0.0143
Drank milk at home	24 (25.8)	37 (39.8)	0.52 (0.27-0.99)	0.0461

Table 3. Multivariate analysis of risk factors associated with cholera in Kakuma, September – December, 2009

Risk Factors	Adjusted Odds Ratio (95% confidence limits)	P value
Dirty water storage containers	4.39 (1.12-17.14)	0.0335
Used soap to wash hands	0.25 (0.09-0.71)	0.0097

Washing hands with soap after visiting the latrine was protective, a finding consistent with observations from other studies conducted in similar settings. Some studies have suggested that hand washing reduced risk of diarrhoea by more than 40% [9]. Soap was shown to be effective in reducing hand contamination regardless of whether contaminated or chlorinated water was used for hand washing [10]. In a study on the effect of soap distribution on diarrhoea involving 402 households at Nyamithuthu Camp in Malawi, a reduction of diarrhoeal incidence by up to 27% was shown during days when soap was present in the households [11]. In another study from Western Kenya, a reduction in cholera-related mortality was found in households with soap before onset of cholera illness [12]. Therefore, provision of regular and adequate soap rations to refugees and hand hygiene education is an important intervention in cholera prevention and in reducing diarrhoeal disease burden in refugee camps.

Dirty water storage containers were significantly associated with illness in the multivariate model. Other studies implicated inadequate washing of water storage containers as a cause of significant contamination of household water [13]. Cleaning containers with a high-strength chlorine disinfectant has been indicated as an effective means of reducing the incidence of diarrhoeal diseases in refugee camp settings [14]. Although we did not conduct a microbiological analysis of household water during the investigation, an analysis performed by LWF in October 2009 showed water sampled from homes within Kakuma II had a much higher degree of contamination with fecal coliforms than other areas of the camp (IRC unpublished minutes of the interagency Cholera Taskforce). Because treating drinking water was protective in the bivariate analysis and deterioration of stored water quality is well recognized [15], household water treatment or rigorous water container cleaning programs should be considered in such settings.

Our investigation also looked at household water consumption. Official water consumption estimates based on pumping rates at Kakuma camp range from 20 to 23 litres per person per day. However, we found average household consumption per person per day to be 38% to 57% below the levels reported. We attributed this difference to many factors. The high leakage rate and frequent breakdowns of pumps due to aging infrastructure have a major impact on the water actually consumed by the refugees. In addition, a substantial amount of water was used by newly arrived families to construct houses from mud bricks. Therefore, the average calculated at the source may not be the same as is available for household consumption. A study done in another refugee camp in Kenya found that discrepancies between the reported water availability and actual availability at the household may also be attributed to higher than accounted for institutional use and leakage (CDC-Kenya, unpublished data). The inequality in the water distribution in Kakuma refugee camp was noted in the last cholera outbreak [16].

The absence of latrines in the compound may have increased the risk of transmission of cholera through ill persons defecating in the nearby bushes and riverbeds or sharing a communal latrine with other households. Sharing latrines with three or more households has previously been associated with an increased risk of cholera in refugee camps [10,11] and other diarrhoeal disease [17]. Lack of latrines was significantly associated with a high incidence of cholera in Zambia [18]. Thus construction and maintenance of family latrines should be a priority for the long-term prevention of cholera.

In our investigation, poor hygiene and sanitation was significantly associated with an increased risk of cholera. Faeces was visible in some houses, which might be an indirect indicator of poor hygienic habits related to limited availability of latrines or cultural beliefs in some of the communities, in which some mothers consider children’s faeces harmless. Similar behavioural practises in which mothers indiscriminately dispose of children's faeces have been significantly associated with diarrhoeal illness [19, 20]. Mothers' behaviour with regard to disposal of children's waste has been reported to be an important determinant in reducing diarrhoeal disease [21]. Therefore, hygiene education may be an effective approach to reduce diarrhoeal disease burden including cholera in Kakuma.

The level of resistance of the isolates to the first-line antimicrobial drugs such as tetracycline, and trimethoprim–sulfamethoxazole, represents a significant and serious public health problem. The high resistance could be due to overuse of antibiotics throughout the region; ampicillin/amoxicillin are the most frequently used drugs for the treatment of respiratory illness while trimethoprim-sulfamethoxazole is the most commonly used antibiotic for the treatment of adult and childhood diarrhoea [22,23]. Tetracycline is frequently used for the prophylaxis of cholera. The issue of tetracycline-resistant cholera strains in Kenya was reported in the 1980s and 1990s following widespread therapeutic and prophylactic administration of tetracycline [24,25]. The resistance patterns found in this investigation support the judicial use of antibiotics. Results from other studies have found that chemoprophylaxis should not be given to close contacts of cholera because it does not prevent secondary transmission and it contributes to increasing antimicrobial resistance [25,26].

We did not identify a clear single source or route of transmission of cholera in this outbreak. The cholera outbreak ended in December 2009. It is difficult to point out the main reason for its termination but the exhaustion of susceptible individuals, improved water and sanitation, and dissemination of cholera preventive messages in local languages might have contributed to its decline. To prevent future cholera outbreaks we recommend that refugee aid agencies make the availability and wide distribution of soap a high priority. Refugee aid agencies should also increase health education messages regarding the cleanliness of water storage containers, along with improving basic sanitation and availability of an adequate supply of drinking water.

This study had certain limitations. The retrospective nature of the investigation, which inquired about exposures that occurred up to two months before the interview, had the potential for recall bias. Ill persons may have had better recall of the time surrounding the outbreak compared with controls. The camp’s location has a history of previous cholera outbreaks. There is a possibility that some of the controls included in the study were either immune or asymptomatic cholera cases. In addition, the true attack rate may be underestimated, since we included only hospitalized cases in our study, and it is likely that there were many more asymptomatic or mild cholera cases who did not seek care at the hospital.

Acknowledgments
We are very grateful for the assistance, advice, and participation of all the staff from UNHCR, IRC, LWF, KEMRI, Ministry of Health, and Kakuma Mission Hospital. This manuscript is published with permission of the director of the Kenya Medical Research Institute.

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official views or policy of CDC. The authors report no conflicting financial interests.

References
1. Zuckerman JN, Rombo L, Fisch A (2007) The true burden and risk of cholera: implications for prevention and control. Lancet Infect Dis 7: 521-530.
2. Gaffga NH, Tauxe RV, Mintz ED (2007) Cholera: a new homeland in Africa? Am J Trop Med Hyg 77: 705-713.
3. WHO (2009) Cholera: global surveillance summary, 2008. Wkly Epidemiol Rec 84: 309-324.
4. WHO: Cholera, 2009. Wkly Epidemiol Rec2010, No. 31: 293-308.
5. Bopp CA, Allen AR, Wells JG: Laboratory Methods for the Diagnosis of Epidemic Dysentery and Cholera. Centers for Diseases Control and Prevention 1999. WHO/CDS/CSR/EDC/99.8
6. WHO (2003)Cholera. In Global defence against the infectious disease threat(Editor Mary K. Kindhauser). Geneva;. WHO/CDS/2003.15
7. Swerdlow DL, Malenga G, Begkoyian G, Nyangulu D, Toole M, Waldman RJ, Puhr DN, Tauxe RV (1997) Epidemic cholera among refugees in Malawi, Africa: treatment and transmission. Epidemiol Infect 118: 207-214.
8. Shultz A, Omollo JO, Burke H, Qassim M, Ochieng JB, Weinberg M, Feikin DR, Breiman RF (2009) Cholera outbreak in Kenyan refugee camp: risk factors for illness and importance of sanitation. Am J Trop Med Hyg 80: 640-645.
9. Curtis V and Cairncross S (2003) Effect of washing hands with soap on diarrhoea risk in the community: a systematic review. Lancet Infect Dis 3: 275-281.
10. Luby SP, Agboatwalla M, Raza A, Sobel J, Mint ED, Baier K, Hoekstra RM, Rahbar MH, Hassan R, Qureshi SM, Gangarosa EJ (2001) Microbiologic effectiveness of hand washing with soap in an urban squatter settlement, Karachi, Pakistan. Epidemiol Infect 127: 237-244.
11. Peterson EA, Roberts L, Toole MJ, Peterson DE (1998) The effect of soap distribution on diarrhoea: Nyamithuthu Refugee Camp. Int J Epidemiol 27: 520-524.
12. Shikanga OT, Mutonga D, Abade M, Amwayi S, Ope M, Limo H, Mintz ED, Quick RE, Breiman RF, Feikin DR (2009) High mortality in a cholera outbreak in western Kenya after post-election violence in 2008. *Am J* Trop Med Hyg 81: 1085-1090.
13. Ahmed SA, Hoque BA, Mahmud A (1998) Water management practices in rural and urban homes: a case study from Bangladesh on ingestion of polluted water. Public Health 112: 317-321.
14. Walden VM, Lamond EA, Field SA (2005) Container contamination as a possible source of a diarrhoea outbreak in Abou Shouk camp, Darfur province, Sudan. Disasters 29: 213-221.
15. Swerdlow DL, Mintz ED, Rodriguez M, Tejada E, Ocampo C, Espejo L, Greene KD, Saldana W, Seminario L, Tauxe RV, *et al.* (1992) Waterborne transmission of epidemic cholera in Trujillo, Peru: lessons for a continent at risk. Lancet 340: 28-33.
16. Shrestha DC and Aiden A (2006) The right to water and protecting refugees Waterlines 24: 12-14.
17. Brooks JT, Shapiro RL, Kumar L, Wells JG, Phillips-Howard PA, Shi YP, Vulule JM, Hoekstra RM, Mintz E, Slutsker L (2003) Epidemiology of sporadic bloody diarrhea in rural Western Kenya. Am J Trop Med Hyg 68: 671-677.
18. Sasaki S, Suzuki H, Igarashi K, Tambatamba B, Mulenga P (2008) Spatial analysis of risk factor of cholera outbreak for 2003-2004 in a peri-urban area of Lusaka, Zambia. Am J Trop Med Hyg 79: 414-421.
19. Dikassa L, Mock N, Magnani R, Rice J, Abdoh A, Mercer D, Bertrand W (1993) Maternal behavioural risk factors for severe childhood diarrhoeal disease in Kinshasa, Zaire. Int J Epidemiol 22: 327-333.
20. Ghosh S, Sengupta PG, Mondal SK, Banu MK, Gupta DN, Sircar BK (1997) Risk behavioural practices of rural mothers as determinants of childhood diarrhoea. J Commun Dis 29: 7-14.
21. Gorter AC, Sandiford P, Pauw J, Morales P, Perez RM, Alberts H (1998) Hygiene behaviour in rural Nicaragua in relation to diarrhoea. Int J Epidemiol 27: 1090-1100.
22. Omari MA, Malonza IM, Bwayo JJ, Mutere AN, Murage EM, Mwatha AK, Ndinya-Achola JO (1997) Pattern of bacterial infections and antimicrobial susceptibility at the Kenyatta National Hospital, Nairobi, Kenya. East Afr Med J, 74: 134-137.
23. Bejon P, Mwangi I, Ngetsa C,Mwarumba S, Berkley JA, Lowe BS, Maitland K, Marsh K, English M, Scott JA (2005) Invasive Gram-negative bacilli are frequently resistant to standard antibiotics for children admitted to hospital in Kilifi, Kenya. J Antimicrob Chem 56: 232-235.
24. Finch MJ, Morris JG, Jr., Kaviti J, Kagwanja W, Levine MM (1988) Epidemiology of antimicrobial resistant cholera in Kenya and East Africa. Am J Trop Med Hyg 39: 484-490.
25. Shapiro RL, Otieno MR, Adcock PM, Phillips-Howard PA, Hawley WA, Kumar L, Waiyaki P, Nahlen BL, Slutsker L (1999) Transmission of epidemic *Vibrio cholerae* O1 in rural western Kenya associated with drinking water from Lake Victoria: an environmental reservoir for cholera? Am J Trop Med Hyg 60: 271-276.
26. Bhattacharya K, Kanungo S, Sur D, Lal Sarkar B, Manna B, Lopez AL, Bhattacharya M, Nandy S, Kumar Niyogi S (2011) Tetracycline-resistant *Vibrio cholerae* O1, Kolkata, India. Emerg Infect Dis 17: 568-569.

Corresponding author
Abdirahman S. Mahamud
Medical Officer
Department of Africa Refugee Health Program CDC-KEMRI
Kenya Medical Research Institute/CDC
Nairobi, Kenya
amahamud@cdc.gov

Conflict of interests: No conflict of interests is declared.