SUPPLEMENT ARTICLE

Cholera Surveillance in Uganda: An Analysis of Notifications for the Years 2007–2011

Godfrey Bwire,[1] Muggaga Malimbo,[2] Issa Makumbi,[2] Atek Kagirita,[3] Joseph Francis Wamala,[2] Peter Kalyebi,[1] Aloysius Bingi,[4] Sheba Gitta,[4] David Mukanga,[4] Martin Mengel,[5] and Melissa Dahlke[4]

[1]Ministry of Health Uganda, Control of Diarrheal Diseases Unit, [2]Ministry of Health Uganda, Epidemiology and Surveillance Division, [3]Ministry of Health Uganda, Central Public Health Laboratory, and [4]African Field Epidemiology Network (AFENET), Kampala, Uganda; and [5]Agence de Médecine Préventive (AMP), Paris, France

Introduction. Cholera outbreaks have occurred periodically in Uganda since 1971. The country has experienced intervals of sporadic cases and localized outbreaks, occasionally resulting in prolonged widespread epidemics.

Methods. Cholera surveillance data reported to the Uganda Ministry of Health from 2007 through 2011 were reviewed to determine trends in annual incidence and case fatality rate. Demographic characteristics of cholera cases were analyzed from the national line list for 2011. Cases were analyzed by district and month of report to understand the geographic distribution and identify any seasonal patterns of disease occurrence.

Results. From 2007 through 2011, Uganda registered a total of 7615 cholera cases with 181 deaths (case fatality rate = 2.4%). The absolute number of cases and incidence per 100 000 varied from year to year with the highest incidence occurring in 2008 following heavy rainfall and flooding in eastern Uganda. For 2011, cholera cases occurred in 1.6 times more males than females. The geographical areas affected by the outbreaks shifted each year, with the exception of a few endemic districts. No clear seasonal trends in cholera occurrence were identified for this time period.

Conclusions. We observed an overall decline in cases reported during the 5 years under review. During this period, concerted efforts were made by the Ugandan government and development partners to educate communities on proper sanitation and hygiene and provide safe water and timely treatment. Mechanisms to ensure timely and complete cholera surveillance data are reported to the national level should continue to be strengthened.

Keywords. Africa; cholera; epidemic; epidemiology; Uganda; surveillance; *Vibrio cholerae*.

Diarrheal diseases including cholera are among the leading causes of morbidity in Uganda [1]. Among children <5 years old, diarrhea contributes 23% of all illnesses in the communities [2]. Cholera outbreaks have been reported periodically in Uganda since 1971 [3]. The country has experienced intervals of sporadic cases and localized outbreaks sometimes resulting in prolonged widespread epidemics.

Uganda is divided into several geographical regions and has tropical weather conditions that are moderated by the high altitudes. The Central, Eastern, and Western regions of the country have 2 rainy seasons per year, with heavy rains from March to early June and light rains between September and December. The level of rainfall decreases toward the north, turning into just 1 rainy season per year from April to October. Uganda's vegetation varies between tropical rain forest in the south and savannah woodlands and semidesert in the northeast. The population density is higher in the Central and Western regions and declines toward the North [4].

Cholera outbreaks have been reported from every region of Uganda, with endemic areas located near rivers or lakes in the western Rift Valley especially Lakes Albert, Edward, Katwe, and George. In Uganda, cholera has also frequently affected communities located along borders with neighboring countries, especially Democratic Republic of Congo, South Sudan, and Kenya, where there is a greater chance of importation due to frequent travel by the community across borders and also influx of refugees during conflicts. The vulnerable populations associated with cholera outbreaks frequently include: fishing communities, refugees, and residents of large urban informal settlements such as in

Correspondence: Melissa Dahlke, African Field Epidemiology Network, Kampala, Uganda (mdahlke@afenet.net).

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Kampala City [5]. However, sporadic cases may also occur at any time of the year and in any part of the country, especially when access to safe water is compromised or where sanitation and hygiene are poor.

The largest cholera outbreak ever reported in Uganda occurred in 1997–1998 associated with the heavy rainfall and flooding that occurred as a result of the El Nino weather phenomena [6]. During this time period, several countries of the Horn of Africa were already affected by cholera outbreaks [3]. In Uganda, this epidemic resulted in a total of 38 697 cases and 1576 deaths officially reported to the World Health Organization (WHO) in 43 of the then existing 45 districts [7]. In subsequent years, reports of cholera cases declined but were still recorded annually in most districts until the end of 2001, when occurrence became restricted to a few "endemic districts" along the eastern branch of the Rift Valley, especially those surrounding Lake Albert [8]. These districts were Kasese, Bundibugyo, Hoima, Nebbi, and Arua. In addition, districts in Northern and Eastern Uganda have also intermittently recorded cholera cases. In 2002–2003, Uganda experienced cholera outbreaks, again associated with similar circumstances as in 1997–1998, during another episode of El Nino rains [9]. Between 2003 and 2006, Uganda has recorded an average of 10–15 outbreaks per year in various districts [10].

Cholera surveillance was established by the British colonial government in Uganda long before the first cases were recorded in 1971, to prevent the potential importation by immigrant laborers. In 2000, cholera surveillance in Uganda became part of the Integrated Disease Surveillance and Response (IDSR) strategy, which was adopted from the WHO. This strategy emphasizes early detection of cases and timely and adequate response [11]. Cholera surveillance is coordinated at the national level by the Uganda Ministry of Health (MOH) and overseen by the Epidemiology and Surveillance Division (ESD) and the Control of Diarrheal Diseases Unit (CDD). Weekly aggregate data are reported by the districts to the national level through IDSR, and active case reporting may be carried out during epidemic periods. In 2011, the country introduced enhanced cholera surveillance in 5 districts of Eastern Uganda through the support of the African Cholera Surveillance Network (Africhol) (http://www.africhol.org).

Case management for cholera patients is based on the national treatment guidelines adopted from the WHO. The mainstay of cholera treatment is rehydration therapy with oral rehydration salt, and intravenous therapy plus antibiotics for severe cases. During epidemics, suspected cases are managed in cholera treatment centers and oral rehydration corners, which are established in the nearest health facilities or in the affected communities. The health workers are also supported by the volunteer community health workers, called the Village Health Teams (VHTs), whose main role is identification of suspected cholera cases in the communities, provision of oral rehydration therapy, and referral of serious cases to treatment facilities.

A majority of districts do not have adequate laboratory capacity to conduct microbiological diagnosis of cholera. Microbiologic assessment of stool may be performed in some private health facilities, and district or regional referral hospital laboratories where adequate culture and diagnostic testing capacity exists. Stool samples from suspect cholera cases in districts with insufficient laboratory capacity, and isolates of suspected *Vibrio cholerae,* are referred for confirmation to the Central Public Health Laboratory (CPHL) in Kampala, which serves as the national reference laboratory for diagnostic testing of bacterial pathogens. At the beginning of an outbreak, 5–10 stool specimens are collected for confirmation. However, additional samples may be collected at various intervals to monitor the antibiotic sensitivity patterns and to confirm the end of an outbreak. Laboratory results are provided back to the districts and the national level departments responsible for cholera control within 36 hours of specimens reaching the laboratory. This feedback is used to guide and augment response activities.

For disease control, the government of Uganda has used a multisectoral approach spearheaded by the MOH to promote a number of interventions [12]. These interventions include: timely reporting of cases, treatment using oral rehydration salt or other homemade rehydration solutions for mild cases, intravenous treatment for serious cases, and measures targeting prevention of infection. Key among the preventive measures are health education, provision of safe water, and hygiene and sanitation promotion. Provision of safe water and latrine coverage have also been slowly improving [13, 14].

This article describes the cholera surveillance data reported to the MOH Uganda from 2007 to 2011 using the weekly aggregate IDSR reports and available line lists.

METHODS

In Uganda, cases of cholera are clinically diagnosed by health workers based on the national case definitions. The MOH has produced standard operational guidelines to aid health workers to identify signs and symptoms of cholera [12, 15].

There are 2 standardized case definitions based on the level of detection, either at the community or health facility levels.

1. At the community level, a suspected cholera case is defined as "any person with plenty of watery diarrhea." This broad case definition is used in the community to ensure identification of any suspect case and encourage presentation to a health facility. Suspect cases are referred to health facilities where a more refined case definition is used.

2. At the health facility level, a suspected cholera case is defined as profuse, acute watery diarrhea among patients aged ≥5 years, or death in a person with acute watery diarrhea, in areas not previously known to have an epidemic. Or as profuse,

acute watery diarrhea among patients aged ≥2 years, in an area where an outbreak has been confirmed.

For either community or health facility level, a confirmed case of cholera requires laboratory confirmation by culture of *V. cholerae*. A cholera death is a patient who meets the standardized case definition and dies from cholera, whether this is before or after reaching the health facility.

Health facilities notify any suspected cholera case meeting the national case definition to the District Health Officer (DHO) using standard reporting forms including: (1) notifiable disease case forms, reported within 24 hours, (2) line lists, reported within 24 hours, and (3) weekly and monthly reports of aggregate data. Other than these formal case reports, the health workers also report cholera cases using telephone and internet to quickly communicate data to the higher levels. This informal communication is later formalized by sending reports to the district. Whenever a suspect case is reported, a field investigation is carried out at the district level by a rapid response team composed of a clinician, a surveillance officer (or epidemiologist), laboratory personnel, and environmental health officer. This is performed under the guidance of a District Health Management Team (DHMT). After concluding their investigation the district health team submits a written report to the national level.

When reports reach the national level, a team from the MOH may be dispatched to support further investigations and initiation of response activities, depending on the initial findings of the investigation. Once the outbreak has been confirmed by the laboratory, the MOH reports the results to the WHO country office within 24 hours and thereafter provides daily and weekly updates.

The cholera surveillance data collected by the MOH through the IDSR system are aggregate case counts and deaths reported from the district for each epidemic week. All suspect cholera cases that either sought treatment at public health facilities or were identified during community investigations by the district surveillance team are included in the weekly surveillance data reported to the national level, even if they are not laboratory confirmed. At the district level, the more detailed clinical, demographic, and epidemiologic data are captured for each case on a line list, which may not be routinely collated and analyzed at the national level.

Data Management

The health facilities send their report to the district health office where it is compiled into a district report, which is then submitted to the national level. The reports from the health facilities are entered into the district database. There are special officers, namely, the District Surveillance Focal Person and the District Biostatistician who are assigned to compile the district surveillance report. However, efficiency and functionality of the district data management is variable due to resource challenges (mainly human and equipment).

Cholera data reported weekly from the districts are entered into a database maintained at the MOH. At the national level, the surveillance data are compiled and analyzed to generate weekly summaries of cases and deaths, which are disseminated through several channels including a surveillance bulletin published in the major national newspapers.

Laboratory

Once a patient is suspected to have cholera, stool samples (rectal swabs) are collected by health workers before initiation of antibiotic treatment. The rectal swabs are placed in Cary-Blair media for transport to the nearest regional referral hospital laboratory or CPHL and plated on Thiosulphate Citrate Bile Salts Sucrose (TCBS) agar. Colonies of growth are subcultured and evaluated using standard biochemical reactions, and *Vibrio cholera*-positive isolates are serogrouped and serotyped using agglutination tests with commercial polyvalent O1 and monovalent Ogawa and Inaba antisera.

Antibiotic sensitivity testing is performed using the disk diffusion technique to determine susceptibilities to a standard panel of 7 antimicrobial agents. Isolates are tested for susceptibility to ampicillin, chloramphenicol, ciprofloxacin, doxycycline, erythromycin, tetracycline, trimethoprim/sulfamethoxazole as described by the National Committee for Clinical Laboratory Standards (NCLS) [16]. Antibiotic sensitivity testing is performed for the duration of an outbreak to monitor patterns and guide treatment recommendations.

Data Analysis

In this article we reviewed national cholera surveillance data reported to the MOH Uganda for 2007–2011. We extracted the total number of cholera cases and deaths from the national database for this 5-year period and analyzed the data to determine the incidence per 100 000 population and case fatality rate (CFR) at the national level and by district for each year under review. Population projections were obtained from the Uganda Bureau of Statistics (UBOS), under the Uganda Ministry of Finance, Planning, and Economic Development.

For this study, district cholera line lists were only available for a single year, 2011. We combined the available district line lists to create a single national line list for our analysis of the age and sex distribution of reported cholera cases. Laboratory data were compiled and analyzed to present a summary of total specimens tested and the serotypes identified. We mapped the annual incidence by district to determine the geographic distribution of cholera outbreaks for 2007–2011. Maps were developed using Health Mapper. We analyzed the surveillance data by month of case report for 2007 through 2011 to identify any patterns in seasonality. Analysis was carried out using STATA (version 11).

Table 1. Number of Suspect Cholera Cases and Deaths, Uganda 2007–2011

Year	No. of Cases	No. of Deaths	Case Fatality Ratio (%)	Population (millions)	Incidence (per 100 000)
2007	1662	35	2.1	28.6	5.8
2008	2630	54	2.1	29.6	8.9
2009	1076	23	2.1	30.3	3.5
2010	2017	64	3.2	31.7	6.4
2011	230	5	2.2	32.9	0.7
Total	**7615**	**181**	**2.4%**	30.6	. . .

Table 2. Annual Number and Results of Stool Samples Tested for *Vibrio cholerae*, Uganda, 2007–2011

Year	Total Suspect Samples Analyzed, no.	Total Positive *V. Cholerae*, no. (%)	Serotype Inaba, no. (%)	Serotype Ogawa, no. (%)
2007	78	33 (42%)	33 (100%)	0
2008	111	47 (42%)	19 (40%)	28 (60%)
2009	39	24 (62%)	16 (67%)	8 (33%)
2010	54	21 (39%)	20 (95%)	1 (5%)
2011	29	5 (17%)	5 (100%)	0
Total	**311**	**130**	**93 (72%)**	**37 (28%)**

RESULTS

Between 2007 and 2011, the Uganda MOH received a total of 7615 reports of cholera cases. Of these, 181 were reported as cholera deaths, corresponding to an overall case fatality rate (CFR) of 2.4%. Total cholera cases varied annually from the maximum in 2008 (2630 cases and 54 deaths, CFR = 2.1%), to a 5-year minimum in 2011 (230 cases and 5 deaths, CFR = 2.2%) (Table 1).

The peak cholera incidence during this period occurred in 2008 (8.9 per 100 000 population), associated with heavy rains and flooding, which led to contaminated water sources. National incidence decreased during the 5 years dropping to the lowest level in 2011 (0.7 per 100 000 population), a 92% percent decrease from the peak.

Case fatality rates remained stable at 2.1% for the first 3 years under review 2007–2009 (Table 1). In 2010, the CFR reached 3.2% before returning to near previous levels in 2011 (2.2%). The CFR never dropped below 2.1%, which is above the 1% CFR threshold recommended by the WHO.

Laboratory Results

Of the 7615 cases reported to the MOH from 2007 through 2011, a total of 311 (4%) specimens were tested at CPHL for confirmation and antimicrobial susceptibility (Table 2). *Vibrio cholerae* O1 EL Tor was confirmed for 130 (42%) specimens. Monovalent serotyping of 130 *Vibrio cholerae* resulted in 93 (72%) serotype Inaba and 37 (28%) serotype Ogawa isolates.

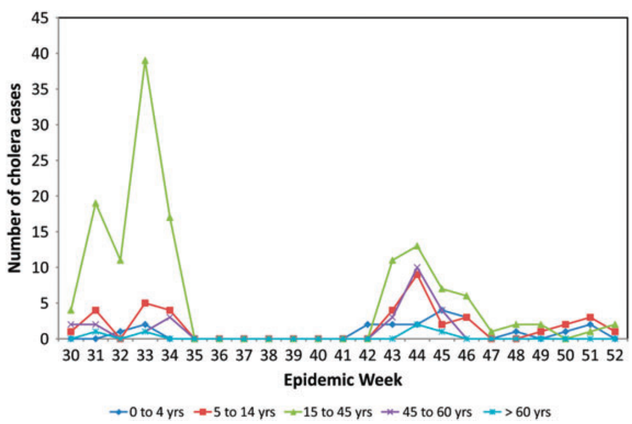

Figure 1. No. of cholera cases reported, by age group, and week, Uganda, 2011.

Demographic Analysis

Detailed demographic characteristics of the affected communities could not be described for 2007–2010 due to missing information at the national level because districts often send aggregated data and not line lists. However, in 2011, all cholera cases reported in the country were compiled on a national line list. Cholera outbreaks occurred in only 2 districts, Rukungiri (123 cases, 2 deaths, CRF = 1.6%) and Kasese (107 cases, 3 deaths, CFR = 2.8%) during that year. Demographic characteristics of these cases are presented in Table 3. Among the 227 cases whose age was known, a majority of cases occurred among those aged 15–45 years (139, 61.2%), followed by children aged 5–14 years (41, 18.1%). Children <5 years old accounted for only 8.4% (n = 19) and cases >60 years accounted for only 1.8% (n = 4). The mean age of cases was 26 years (range, from <1 year to 80 years). Cases occurred in 1.6 times more males (n = 141, 61%) than females (n = 89, 39%).

Figure 1 depicts the age distribution of cholera cases by epidemic week for 2011 when 2 discrete cholera outbreaks occurred in Uganda. The first outbreak took place in Rukungiri

Table 3. Distribution of Cholera Cases by Sex and Age Group, Uganda, 2011

Sex	Frequency, no. (%)
Male	141 (61)
Female	89 (39)
Total	230 (100)
Age Group (years)	
0–4	19 (8.4)
5–14	41 (18.1)
15–45	139 (61.2)
46–60	24 (10.6)
>60	4 (1.8)
Total	**227 (100)**

district from late July through early September 2011. The second outbreak affected Kasese district from late October through December 2011. In Rukungiri district, cases occurred predominately in the 15–45-year age group. In Kasese district, the most affected age group was also 15–45 years; however, the differences between age groups were less pronounced than Rukungiri district. The distribution of cases in Kasese district shows that cholera affected the population more equally across the various age groups.

Cholera Cases by District

Analysis of annual cholera incidence by district showed yearly variations in the number and location of affected districts from 2007 to 2011 (Supplementary Figure 1). A total of 48 different districts reported cholera cases for 1 or more years during this period. Of these, 6 districts (Arua, Kotido, Moroto, Kasese, Kampala, and Buliisa) accounted for 53% (n = 4035) of all cholera cases reported in the country. The most frequently affected districts annually were Kasese, which reported cases during each of the 5 years, whereas other districts, Kitgum, Buliisa, and Kampala, reported cases for 3 out of the 5 years. The highest incidence rate of any single district during the analysis period was reported by Buliisa district in 2007 (575.5 cases per 100 000 residents).

In 2007, the majority of cases occurred in the northwestern part of the country and along the western border of Uganda with DRC. In 2008, cholera cases persisted in some of the same districts along the western border, but several districts in the east also experienced outbreaks. In 2009, the affected locations receded as the outbreaks were brought under control with some scattered cases still reported in the same areas affected during the previous year. In 2010, cholera outbreaks were reported in 8 districts in the Central, Eastern, and Southwestern regions, and for the first time in the study period cases were reported in the Karamoja subregion (northeastern part of Uganda), showing an almost complete shift in geographical location from 2007. In 2011, there was a significant decline with cases reported in only 2 districts in western Uganda, Kasese, and Rukungiri.

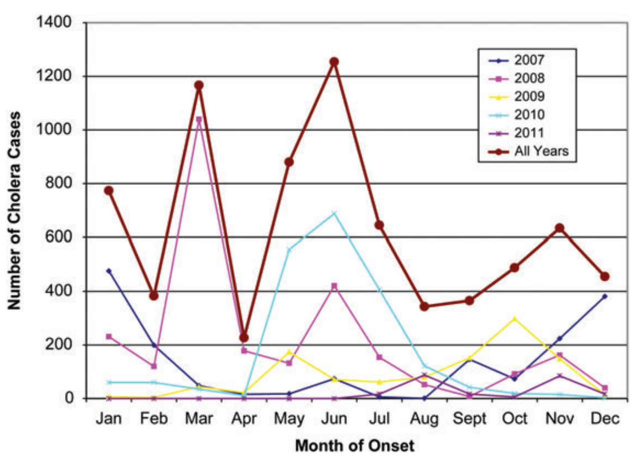

Figure 2. Cases of cholera by month of illness onset, Uganda, 2007–2011 (n = 7614).

Seasonality

The cholera surveillance data were analyzed by month of case report for 2007–2011 to identify any trends in seasonality. From analysis of all cholera cases combined over the 5 years, multiple peaks of cholera cases occurred during various months of the year (Figure 2). Notable peaks of reported cases were observed during the months of January (n = 774, 10.2%), May (n = 880, 11.6%), and June (n = 1254, 16.5%). The sharp increase in cases shown in March (n = 1040, 15.3%), was an isolated occurrence attributed to the outbreak in Arua district in 2008, with the highest number of cases diagnosed in a single month in a single district for any outbreak during the 5 years. An overall rising trend in cases was also seen during September through November (n = 1487, 19.5%), coinciding with the light rainy season. The fewest cases for any month occurred in April (n = 227, 3.0%).

DISCUSSION

More than 40 years after the first cholera outbreak was recorded in Uganda [3], the disease continues to cause significant morbidity and mortality in the country. Review and analysis of the cholera surveillance data reported to the Uganda MOH from 2007 to 2011 showed that outbreaks have continued to occur annually in Uganda; however, their locations and magnitude have varied and may be influenced by various factors.

Cholera incidence varied from year to year with an overall decline from 2007 to 2011. Uganda experienced a particularly high number of cholera cases in 2008 following heavy rainfall and floods, which affected the eastern part of the country, causing landslides and serious contamination of water sources and disruption to sanitation facilities in 5 districts of Eastern Uganda namely: Mbale, Pallisa, Tororo, Butaleja, and Manafwa. Similar increases in cholera disease activity occurred previously in 1998 and 2002–2003 following prolonged heavy rains associated with the El Nino weather phenomenon [9, 17]. To avoid repetition of cholera outbreaks following adverse weather conditions, the government should always prepare in advance, ahead of expected rainy seasons and follow meteorological reports of heavy rainfall to provide the communities with safe water. Long-term enhanced disease surveillance could provide additional information to understand the triggers for cholera and how it is propagated in these environments and climates.

Following 4 years of outbreaks reported from across the country in 2007–2010, there was a significant decrease in cholera cases reported in 2011. This decrease may be in reaction to the heightened awareness and added prevention and control efforts instituted by the Ugandan government with the support of development partners. These efforts included health education, improved surveillance and case management, especially the use of village health teams for case identification, provision of safe water, and promotion of good sanitation and hygiene practices.

In 2010, cases occurred mainly in the Karamoja subregion, an area not typically affected by cholera outbreaks according to historical surveillance information. When cholera occurs in an unprepared community, case fatality rates may be high, usually because there are no facilities for treatment or because treatment is given too late. In contrast, a well-organized response in a country with a well-established diarrhea disease control program can limit the case-fatality rate to <1% [18]. The cholera case fatality rate in Uganda remained more or less stable during 2007–2011 at an average CFR of 2.2%, with the exception of 2010 (CFR 3.2%) when an increase in community deaths occurred related to misconceptions on the cause of cholera (eg, attributed to witchcraft) that delayed care seeking. In order to prevent community deaths, continuous education is needed about the signs and symptoms of cholera and proper treatment and preventive measures. To improve access to care, the government of Uganda has expanded training of the community health workers (Village Health Teams), whose mandate is to identify cases, and provide oral rehydration therapy and timely referral of severe cases to treatment facilities.

The results of our demographic analysis of cases for 2011 showed that more males (61%) were affected by cholera than females (39%). For these outbreaks, this difference is thought to be associated with possible occupational risk factors. For example, males are usually more involved in fishing and farming in the affected districts. These occupations are often linked to certain risk factors for transmission of cholera, including poor hygiene and access to sanitation facilities. The results of our age distribution analysis showed a majority of cases occurred in those 15–45 years old (61.2%). However, the data analysis on sex and age distribution could only be carried out for a single year due to missing information at the national level. Because few cases were reported in 2011 and occurred in only 2 districts, the results may not represent the true distribution of cholera nationwide. An active review of health district data during outbreaks showed that the age distribution of cholera cases followed the age distribution of the population [19].

In this study, June was the month with the most reported cholera cases combined over the 5-year period and April had the lowest. This is in contrast to findings in a multicountry study covering 1974–2005, which included Uganda, in which the highest reported cholera peak occurred during the month of August [20]. Apart from a suggested association in Uganda between cholera outbreaks and heavy rainfall and floods in 2008 and 2010, there was no clear and consistent seasonal association for the 5-year period. Therefore, cholera outbreaks may be difficult to predict in Uganda as they may come about suddenly or as a result of an external factor. These factors include disruption of services or displacement of persons due to armed conflicts, as have occurred previously in communities along the borders of Democratic Republic of Congo and Sudan. In refugee settings, overcrowding, poor sanitation, and inadequate water supply increase the risk of cholera outbreaks [17]. Our data show that outbreaks can occur in Uganda in any area and at any time if the risk factors are present. In Uganda, these risk factors have also been known to include prolonged water shortages in urban settings resulting from power interruptions. Because cholera can occur at any time of the year, health workers should always include cholera in the differential diagnosis of acute watery diarrhea year-round.

During the large cholera outbreaks in 1997–1998, all of Uganda was affected [3]. Thereafter, the outbreaks retreated to some areas along the borders and the lakes especially in the western branch of the Rift Valley. Our analysis for 2007–2011 concurred with this geographic distribution of cholera in Uganda. Historically, and in our analysis, outbreaks are reported more frequently in communities along the lakes and rivers, at landing sites, and in areas with refugee camps or large urban informal settlements [21]. This review shows that although the location of cholera epidemics in Uganda can shift sporadically, there is a continuing potential for outbreaks and a clear indication that joint efforts should focus along water bodies and border crossing posts. Preventive measures such as enhanced surveillance, health education, and sanitation and hygiene promotion should be maintained and strengthened. Prepositioning of cholera treatment supplies in strategic locations with plans for their disbursement after confirmation of an outbreak should also be considered.

Common risk factors for cholera are present in several regions of Uganda, including: contaminated water supply, poor hygiene, and inadequate sanitation facilities [2, 4, 13, 14]. For instance, in Kampala city in 2011, access to hand-washing facilities was reported to be 30% while in rural areas it was 24%. Household latrine coverage in rural areas was 70% in 2011, while in cities, excluding Kampala [14], it was 81%, up from 58% in 2006 [13]. The spread of outbreaks has been favored by these risk factors and complicated by weak local leadership and low-literacy levels in some of the affected locations. The government is working to strengthen the public health infrastructure and improve the quality of public health disease surveillance. As much as possible, collaboration is sought from the District Health Office (District Health Inspector [DHI]), District Water Office (District Water Officer [DWO]) and the Community Development promoters at district level (District Community Development Officer).

Great efforts have been made to contain the spread of cholera. For disease control, the government of Uganda has used a multisectoral approach spearheaded by the MOH with support from the Ministry of Local Government; Ministry of Finance Planning and Economic Development; Ministry of

Water, Sanitation and Natural Resources, Office of the Prime Minister, Ministry of Education and Sports, and others. The partnering agencies include WHO, UNICEF, WFP, UNHCR, and UNOCHA, and NGOs like MSF, Uganda Red Cross, World Vision, and others.

During outbreaks, Uganda conducts regular cholera task force meetings at the national and district levels to coordinate response, mobilize resources, and review progress of ongoing interventions. The MOH works with the WHO, development partners, and affected districts to mobilize resources and institute appropriate interventions to prevent the spread of cholera and control the outbreaks. The measures employed include disease surveillance and case management, provision of safe water, proper fecal disposal, safe food handling, and promotion of personal hygiene and health education. The response efforts illustrate that it is possible to effectively control outbreaks when the necessary financial and human resources are available and the response is coordinated early. Refresher trainings have been delivered periodically to medical and public health personnel on the prevention and response to cholera outbreaks. There is also cross border collaboration between states in East Africa and regular sharing of information on outbreaks through entities such as East African Public Health Laboratory Network (EAPHLN). Although this cooperation is active at the central level, the collaboration is weak at the local level in most districts. A framework should be developed to expedite implementation of these prevention and control protocols at the local level.

LIMITATIONS

The results of this study should be interpreted considering the following limitations. First, the completeness of the weekly IDSR based cholera reporting from health facilities may have varied during the review period, leading to underascertainment of cases and inflated CFRs. It is also possible for the number of reported cases to have been under- or overestimated because diarrhea is among the leading causes of morbidity in Uganda [1], and most cases are detected using the clinical case definition based on syndromic diagnosis, which is less specific than laboratory confirmation. Thus, the true burden of cholera in Uganda may not be reflected accurately.

Second, all age and sex data for this analysis were reported for 2011 only, when the cases were few and originated from only 2 districts in Uganda and thus may not accurately represent the national distributions.

Third, a significant proportion of sick persons in Uganda have been found to seek care from informal health care providers, such as drug shops and traditional healers [22]. These cases are therefore not captured by district and national reports.

Finally, the weak laboratory capacity at district and regional levels may have led to false negative results for cholera. Although some district health facilities are able to diagnose cholera; this is generally reserved for regional referral hospitals, and the Central Public Health Laboratory. Usually, only a few cholera cases are laboratory confirmed at the beginning and the end of an outbreak.

CONCLUSION

Resources to establish robust systems to detect and investigate cases are limited. Therefore, surveillance data are often incomplete, which complicates analysis and estimation of the epidemiological burden of disease.

Cholera surveillance data for Uganda from 2007 to 2011 showed that cases declined overall, and the geographical areas affected were reduced such that only 2 districts were affected in 2011. These developments coincided with efforts by the Ugandan government and development partners to implement preventive cholera control interventions such as education of communities on proper sanitation and hygiene, provision of safe water, strengthening of cholera surveillance, and timely treatment of cholera cases. Implementation of enhanced surveillance to cover more districts and special planning to mitigate effects of adverse weather conditions are required to consolidate the gains and ensure that cholera is eliminated.

Supplementary Data

Supplementary materials are available at *The Journal of Infectious Diseases* online (http://jid.oxfordjournals.org/). Supplementary materials consist of data provided by the author that are published to benefit the reader. The posted materials are not copyedited. The contents of all supplementary data are the sole responsibility of the authors. Questions or messages regarding errors should be addressed to the author.

Notes

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