Descriptive epidemiology of Cholera Outbreak, Kasai Oriental Province, Democratic Republic of Congo, 2018 (Characteristics in Mbuji-Mayi city vs Rural area)

Article by Dongmo, N.T[1, 2], Mutombo, M.B[3, 5], Ateudjieu, J[4, 6], Folefack, T.G[7], Gabo, P[7], Miwanda, N.B[8], Akilimali, L[7], Tshizemba M.A[3], Diwampovesa, M.C.G[7]., Nkweshieu, A.S[1], Mbopi-Keou F.X.[4, 9]

[1]*Cameroon Society of Epidemiology, Yaounde, Cameroon*
[2]*Texila American University, Guyana, South America*
[3]*Provincial Division of Health, Mbuji-Mayi City, Kasaï Oriental Province, DRC*
[4]*Ministry of Public Health, Yaounde, Cameroon*
[5]*Faculty of Medicine, University of Mbuji-Mayi, Mbuji-Mayi, KOR Province, DRC*
[6]*Faculty of Medicine and Pharmaceutical Sciences, University of Dschang, Cameroon*
[7]*World Health Organization, WHE, Kinshasa, DRC*
[8]*National Institute for Biomedical Research, Kinshasa, DRC*
[9]*Faculty of Medicine and Biomedical Sciences, University of Yaounde, Yaounde, Cameroon*
E-mail: flledongmo@yahoo.fr

Abstract

Cholera remains the major public health problem in the world. DRC is frequently affected by cholera introduction of 7th pandemic in the country in 1974. The 2018 cholera outbreak affected Kasai Oriental Province more than 14 years after the previous one despite constant poverty and lack of potable water. Our main objective was to describe this epidemic focusing on Mbuji-Mayi vs. rural area. We conducted a descriptive study using the line listing data. The case definition used was that of the ministry of public health. Analyses were performed using Microsoft Excel 2010. Out of 5,869 suspected cholera cases including 277 deaths (CFR: 4.7%), 3,228 including 144 deaths (CFR: 4.5%) were from Mbuji-Mayi and 2,626 cases including 133 deaths (CFR: 5.1%) from rural area. Mbuji-Mayi with an Attack Rate of 144 cases per 100,000 inhabitants, were less affected than rural area of the Province (AR: 137 cases per 100,000 inhabitants). Vibrio cholera group 01 was incriminated. This outbreak started after 15 years without cholera in city of Mbuji-Mayi but later, also affected rural area. AR and CFR were higher in rural area.

Keywords*: Outbreak, cholera, epidemiology, Mbuji-Mayi.*

Introduction

Cholera a very contagious infectious enteric disease caused by a gram-negative curved bacterium named *Vibrio cholera*. The disease is endemic in some part of the world and is responsible for many outbreaks (WHO, 2019). The bacillus was discovered twice firstly by Paccini in 1854 and then by Koch in 1883 (*cholera, wikipédia*). Two types of *Vibrion cholera,* type O139 and type O1 are now known to be related to cholera epidemic or disease. The El Tor biotype gives 2 mains circulating serotypes in our environment: Ogawa and Inaba (WHO, 2014). From the 19th century (1817), the disease is spread all over the world from its reservoir, in the Ganges delta in India (*cholera Encyclopedia*). According to WHO (WHO, 2014; WHO, 2017), the world is currently facing its 7th pandemic of cholera disease. According to WHO (2019), the annually notified cholera cases estimation worldwide by WHO is between 1.3 to 4.0 million of which 21,000 to 143,000 deaths. But public health experts estimated that these WHO data represented approximately 5% to 10% of real cases and this can widely justify that cholera cases are worldwide underestimated despite the reasons mentioned above (WHO, 2019; GTFCC, 2017). In Africa, cholera has become endemic in almost all sub-Saharan countries especially in East Africa (great lakes region) where some environmental conditions are met to host continuously cholera vibrio circulation (Bompangue, 2009; WHO, 2019; GTFCC, 2017). Since the introduction of cholera in DRC in 1974, only two cholera outbreaks have

DOI: 10.21522/TIJPH.2013.SE.19.02.Art028
ISSN: 2520-3134

been reported in the KOR province before the current one on study in 2018. The first reported one was in 1992 (Bompangue, 2009) but no specific data on the management of this outbreak was available neither at the level of the Provincial Division of Health (DPS), nor at the level of the WHO archives a part from knowing that this outbreak started and remained confined in Mwene-Ditu, a city neighbouring Katanga one of the Province in DRC where cholera is endemic (Bompangue, 2009).However, Mwene-Ditu is no longer part of the actual KOR province following DRC's administrative redistribution of provinces effective since 2015 (PDH, 2018). The second cholera outbreak was the major one the KOR province ever faced and was reported in 2002-2004. It was also the first one which affected heavily Mbuji-Mayi city and its surrounding localities, with cumulated suspected cases of 9,767 including 571 deaths, CFR: 5.8 %, and a global attack rate (AR) per 100,000 populations 13.5. This 2002-2004 cholera epidemic had not been the subject of any detailed descriptive study to show the trend of this cholera epidemic within the time as well as the identification of risk factors affected population in both Mbuji-Mayi and rural areas of the Province. If one or more scientific study taking into account all the aspects mentioned above was conducted during the previous cholera epidemics in this province, especially the major one of 2002-2004, this would have certainly contributed to a better understanding and better management of future cholera outbreak in this area. The aims of this study was firstly to contribute to the control of the current 2018 cholera outbreak in the KOR Province by providing regular data so we should take into account shortcomings in the management of the two previous cholera outbreak in the province and then to produce evidence base data very useful for the understanding of the dynamics of this outbreak. All of this could be of major interest in the management of previous cholera epidemics in this province.

Methodology

Study setting

The Kasaï Oriental (KOR) province is one of the 26 Provinces of the Democratic Republic of Congo (DRC). It has a population estimated at 5,030,071 inhabitants for an area of 9,699 Km2, a density of 504 inhabitants / Km^2. The main city of the province is Mbuji-Mayi [PDH] with 62% of the population living in 10 health's Zone (HZ) and the remaining population are in 9 HZ located in the rural area. Its rainfall pattern includes a 9-month rain season (September to May) and a 3-month dry season (June to August). The average annual temperature varies from 25 °C in the North to 22.5 °C in the South of the Province. The annual variations are important (1.5 to 2 °C) of difference according to the seasons. On the other hand, diurnal and nocturnal temperature differences are important. It is bounded on the north by the provinces of Kasai Central and Sankuru, on the east and south by the province of Lomami and on the west by the province of Kasai Central (Figure 1).

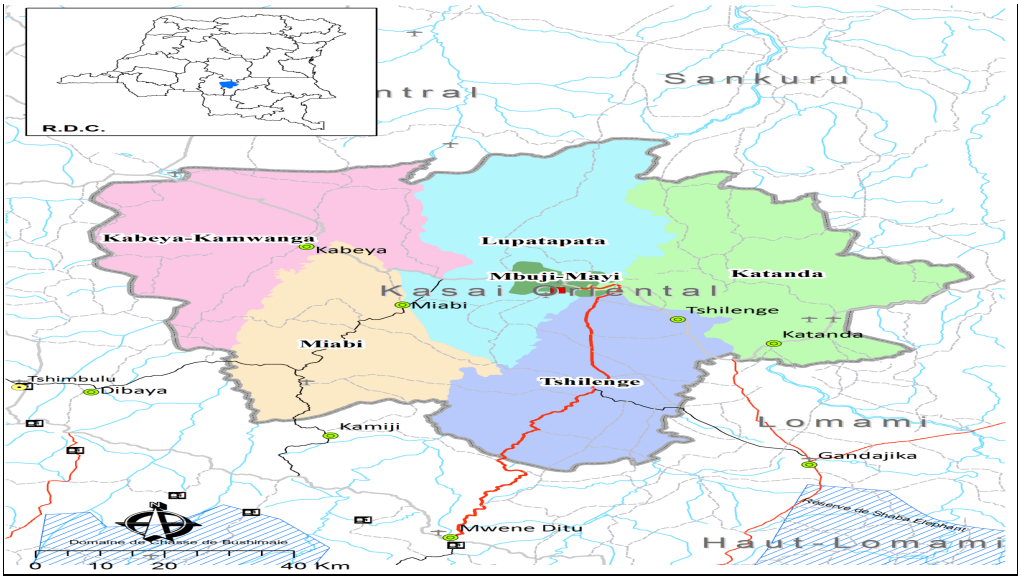

Figure 1. Map of KOR in DRC after 2015 effective administrative distribution

Study design

It was a cross sectional descriptive study with the analysis of primary and secondary data. Most of this data was collected during our stay as expert epidemiologist deployed to provide support to the PDH, which was facing one of the most serious cholera outbreaks in the province and lasted from W7-W52 of 2018.All reported cases cholera of death during this period registered in one of the 10 HZ was registered in the line listing and send daily to the PDH.

Study population and sampling

The **figure 2** above explained how we obtained the study population and non-inclusion criteria.

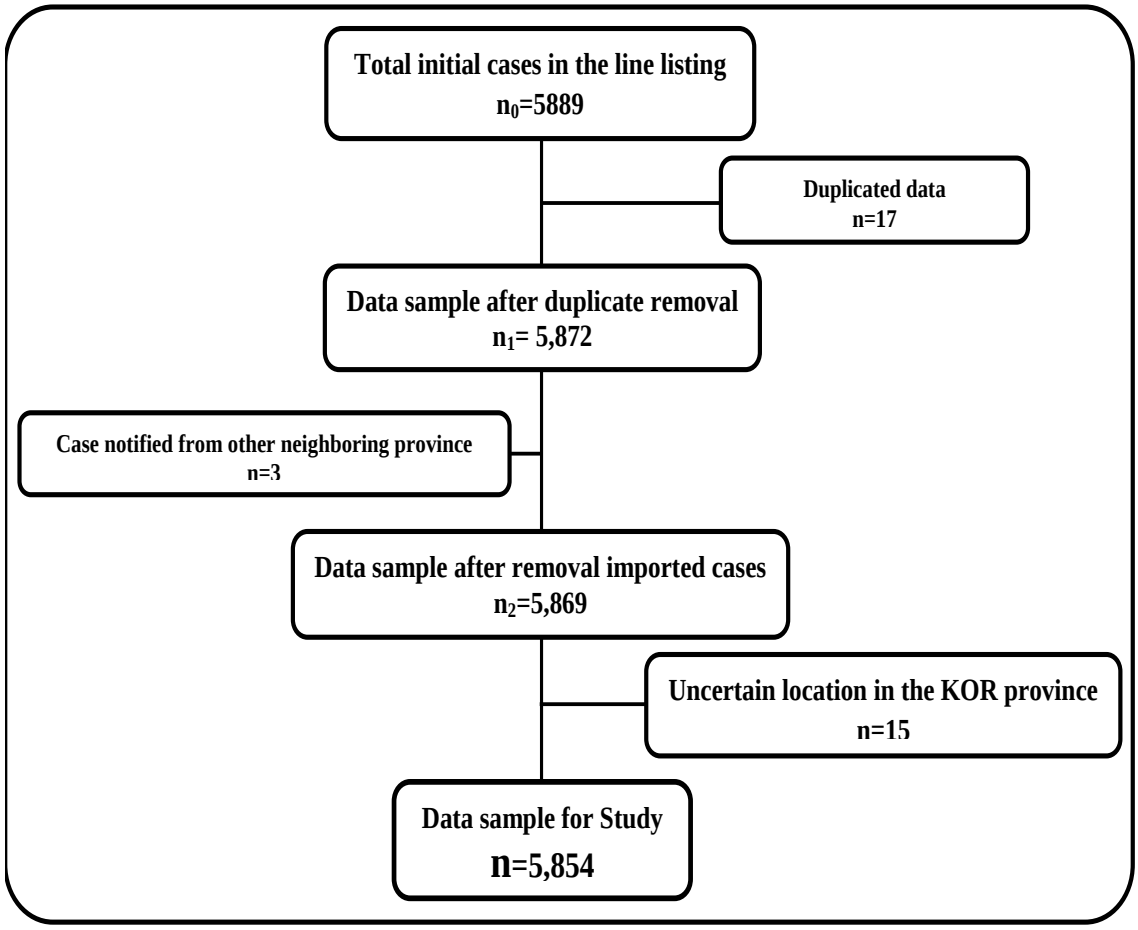

Figure 2. Process of managing cholera data from the line-listing of the PDH, KOR province, W7-W52, 2018

Key definition of few variables and indicators

Cholera outbreak

In KOR province, were cholera is not endemic, one confirmed case or more notified by on HZ means de outbreak and should be declare by local authority.

Cholera suspected case

It is defined as any person aged one year or more, usually residing in one of the 19 ZS of KOR province and having presented, since W7 of 2018 till the moment of investigation a sudden appearance acute diarrhea with at least three liquid stools in 24 hours, with or without vomiting, with or without dehydration, or any "death from acute watery diarrhea in the same age group (MoH, 2012, MSF, 2018).

DOI: 10.21522/TIJPH.2013.SE.19.02.Art028
ISSN: 2520-3134

Confirmed cholera case

It is defined as a suspect case or death of cholera residing in one of the 19 ZS of KOR province, with laboratory confirmation of isolation of *Vibrio cholera* O1 or O139 in the National Institute of Biomedical Research of Kinshasa (NIBR)

Cholera death

Any death registered among cholera cases in treatment unit/center or any community death following watery diarrhea based on the results of the investigation during the investigation period.

Age

Numerical variable that was transformed in categorical variables with 5 modalities (< 1year/1-4years/5-9years/10-14 years/≥15years).

Epidemiological Week (Epi-Week)

According to Epidemiological calendar of DRC, one Epi-week starts from Monday till Sunday, means 7 days and one years is 52Epi-weeks.

Urban area

It is one of the 10 HZ located in the urban perimeter in the city of Mbuji-Mayi and where suspected cholera case was notified.

Rural area

One of the 9HZ of the KOR province located out of Mbuji-Mayi and where suspected cholera case was notified.

Case Fatality Rate (CFR%)

Number of deaths attributable to cholera recorded in one or more of the 19 health zone during the period of the epidemic x100 / Number of cases notified of death of cholera in the same Health Zone in the same period (WHO, Case management).

Attack rate (AR) per 100,000 inhabitants

Number of new suspected cases or death of cholera notified by one or more of the 19 of the health zones during a given period x 100,000 / Population at risk in the same 19 HZ during the same period.

Positive VC O1

Isolation in the laboratory by culture technique of *Vibrio cholera O1* in the stool sample of suspected cholera case.

Negative

Stool sample from suspected cholera case without any *V. cholera* isolation by culture technique.

Data management and analysis

During this study, we had two main source data: The line listing of cases and deaths of cholera during the epidemic period available at the PDH level (Excel2007 format) and the data base of the stool sample collected from the cholera suspected cases on patients from KOR province and shipped to the National laboratory (INRB). The only laboratory data available were from W7-W41, also in Excel 2007 format. Basic analysis of personal characteristics such as: sex, age, categorical, Area of residence (Mbuji-Mayi city/Elsewhere in rural area), health zone of residence, laboratories characteristics. To conduct appropriate statistical descriptive analysis and generate number and percentage, we exported the line listing in *Epi-Info 7* software. Laboratory data analyses were perform using Excel 2007 to generate tables and graphs. Primary of our study outcomes included AR and case fatality rate (CFR). We also describe cholera outbreak in terms time, place and of person using graph or/and tables.

Ethical consideration

Non-Applicable as it was a part of response activities and the data used was what in the line listing.

Results. Weekly evolution of the outbreak and some highlights of response. All the 19 health Zone (10 in Mbuji-Mayi city and 9 in Rural area) were affected by this 2018 cholera outbreak resulting in notification of a total of 5,854 cases included 277 deaths (CFR: 4.7%) from W7-W58. Figure 3 shows in epidemiological curve weekly evolution of cases and CFR and also some highlights of the consequence response.

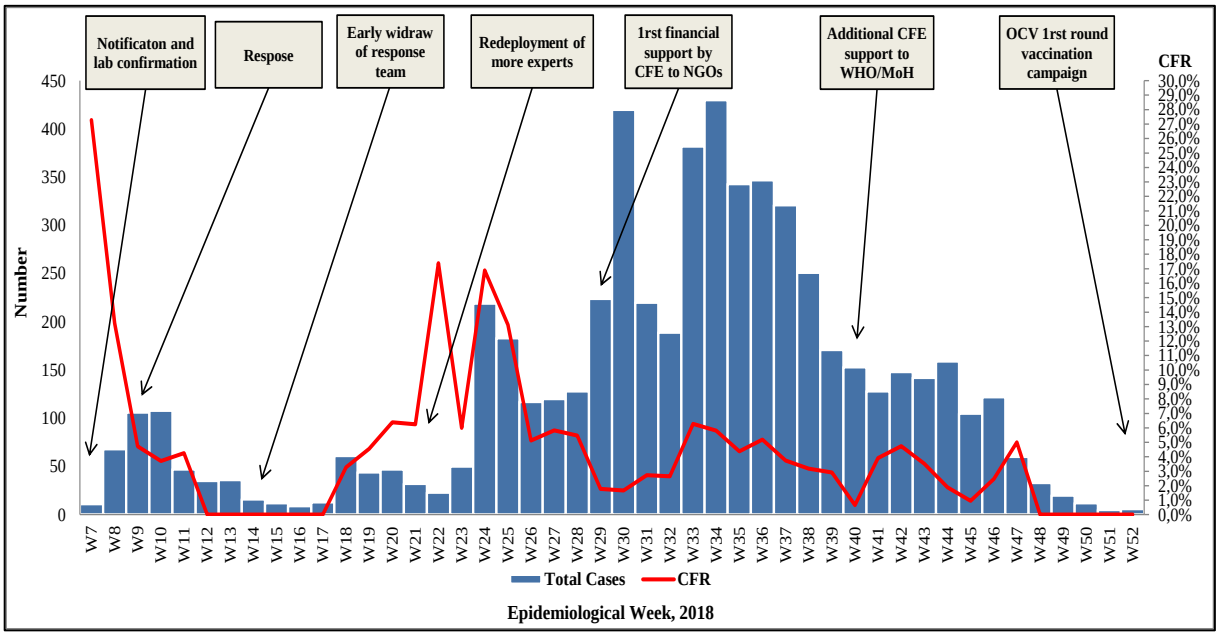

Figure 3. Weekly reported suspected cholera cases and CFR (%) in kasaï oriental province, DRC, from W7 to W52, 2018

Week7

The index case was notified on February 12, 2018 in the Diulu HZ (Mbuji-Mayi City). A woman aged 35 years, after attending a funeral in the neighboring Lomami province. The case was investigated and stools were collected in the *Cary Blair* medium and sent to the National Institute of Biomedical Research (NIBR) of Kinshasa. The outbreak was confirmed in the same week following *V. cholerae* O1 isolation from stool samples. This outbreak started with a very high CFR (27%).

Week9

Effective response started with the arrival of experts and partners coming from the national and international level in support to the PDH of KOR.

Week14

While observing the reduction of cases and CFR, partners started hastily withdraw thinking that the outbreak is over.

Week18

One month after expert's withdrawal, another wave of cholera case resumed with a CFR that starts rising which forced the partners to return to the field.

Week20 / Week21

Experts began redeployment; the Provincial Crisis Committee (PCC) was reactivated under the direct authority of the Governor of the province; an outbreak response plan was developed and validated for funding and operationalization of a coordinated local response; first funding and the creation of technical commissions (Coordination, Surveillance, Case management, Wash, Risk

DOI: 10.21522/TIJPH.2013.SE.19.02.Art028
ISSN: 2520-3134

Communication and Logistics) under the technical coordination of the head of division of Health KOR province, Institution of weekly coordination and technical meeting. Reception of more Wash kits (Chlorine, aquatabs, hand washing kits, soap ...) and cholera drugs such as Ringer lactate, Oral Rehydration Solution (ORS), Antibiotics (Doxycycline and Azithromycin).

While their new organization was put in place, the outbreak continues to increase in the city of MbujiMayi registering 219 cases in W24 with a CFR 17%. It is precisely from this Week 24 that the outbreak started spraying in the rural area of the KOR province and reached h its peak at Week30 and will not fall until the end of 2018 (Figure 4).

Week28

As a major cholera hotspot amongst in DRC, in 2018, KOR province benefited of the first funding of the Contingency Fund for Emergencies (CFE). This found was allocated to NGOs mainly involved in the Wash and Cases management but the outbreak was still very active.

Week40

Second CFE funding benefited to WHO when the epidemic curve started decreasing, focused on the coordination, the strengthening surveillance, the cases management in the Cholera treatment center (CTC), Cholera treatment unit (CTU) and the Wash This epidemic curve declined till Week52.

Week52

Launch of the first round of the OC V vaccination campaign: On an expected target of 866,463 people selected from the 8 targeted HZ of the 19, 831,169 received the first dose, i.e. 98%.

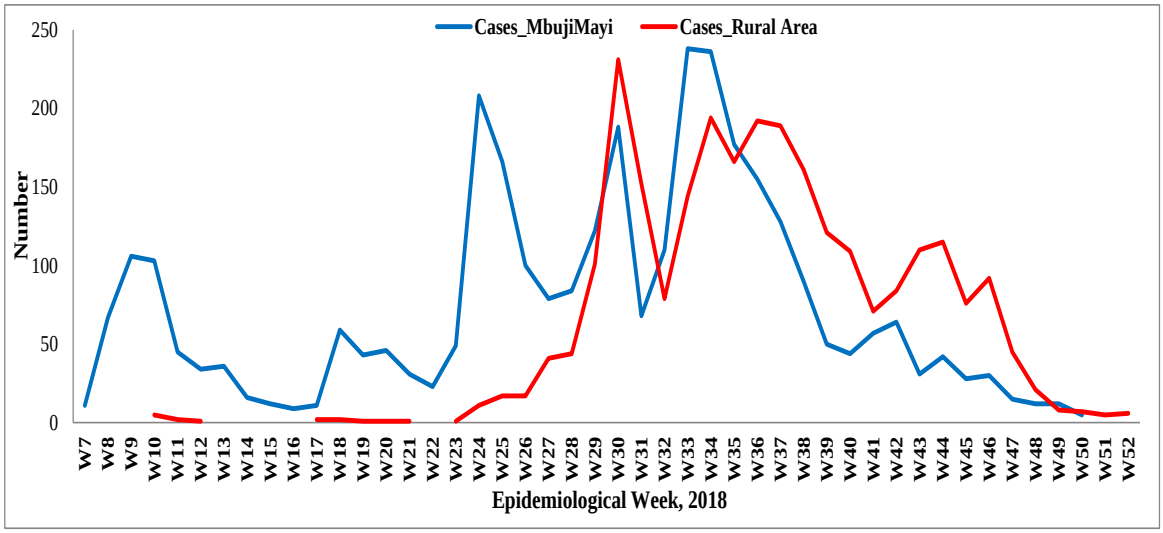

Figure 4. Weekly evolution of cholera outbreak showing in the first stage, outbreak only in mbuji-mayi city and then also in the rural areas of kasaï oriental province, DRC, from W7 To W52 of 2018

Distribution of cholera cases and deaths by age and sex

Out of a total of 5854 cases, 3000 were male, a sex ratio Male /Female of 1.0.;

In Mbuji-Mayi, large number of cases affected was aged ≥15 years both in women (74%) and in men (66%) while in Rural area, the same trend was observed with 80% of female cases aged ≥15years and 75% of male cases aged ≥15years (**figure 5a**).

Of a total of 277 recorded deaths, 151 were male, a sex ratio of 1.2 to 1.2. Women aged ≥15years accounted for 82% of deaths in Mbuji-Mayi compared to 88% in rural areas. While among men of the same age group, 83% were registered on both sides (**Figure 5b**).

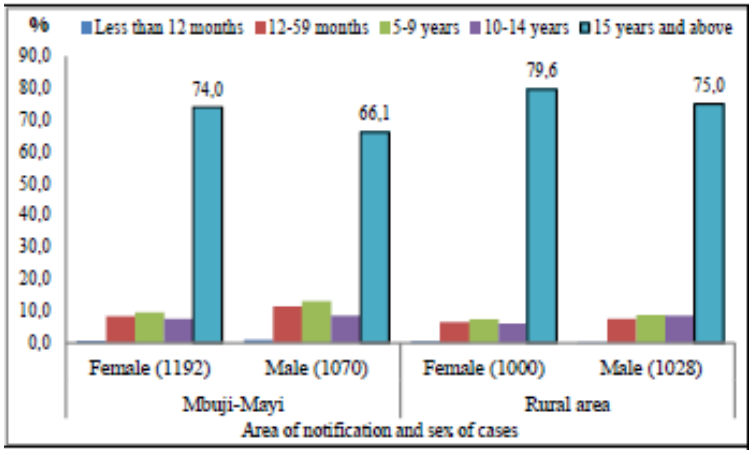

Figure 5a. Total cases of cholera in mbuji-mayi and in rural area according to age and sex, KOR, DRC, 2018

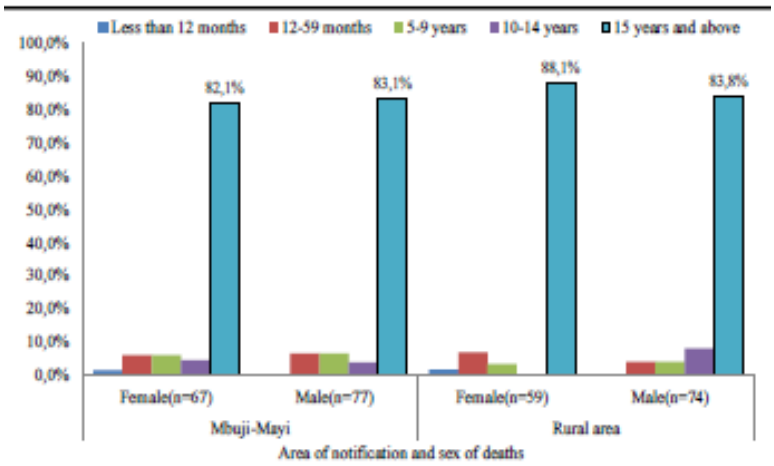

Figure 5b. Total deaths of cholera in mbuji-mayi and in rural area according to age and sex, KOR, DRC, 2018

Distribution of cholera cases and deaths by place

A total of 5854 suspected cases registered in one of the 19 HZ of the KOR province in 2018. 15 had uncertain. In MbujiMayi city, all 10 HZ were affected with a total of 3228 (55.1%) cases, while those from the 9 HZ of the rural area were 2626(44.9%). **Figure 6** showed the cases and deaths distribution in each area and HZ.

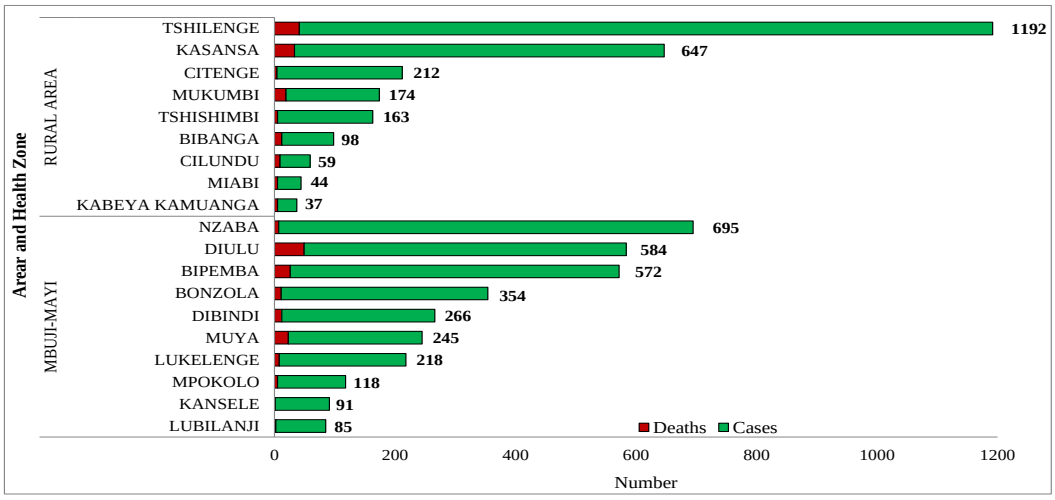

Figure 6. Cases and death distribution of cholera in the health zone of mbuji-mayi and rural area, KOR province, DRC, 2018

DOI: 10.21522/TIJPH.2013.SE.19.02.Art028
ISSN: 2520-3134

The AR over 100,000 inhabitants during the cholera outbreak in the province was 117. In Mbuji-Mayi, it was lower (103) than in the rural area (137). The same is true of the CFR which was slightly high in the rural area (5.1%) compared to Mbuji Mayi (4.5%)). **Table 1** below showed all indicators per HZ.

Table 1. Distribution des cases and deaths as well as CFR et AR per area et per health zone

N°	Health Zone	Total Pop (2018)	Area	Cumuled cases (W7-W52)	Cumulated Deaths (W7-W52)	Attack Rate per 100.000 inhabitants	Cas Fatality Rate (CFR)
1	Nzaba	318027	Urban	695	7	219	1,0%
2	Bonzola	195627	Urban	354	11	181	3,1%
3	Bipemba	388081	Urban	572	26	147	4,5%
4	Diulu	403984	Urban	584	49	145	8,4%
5	Dibindi	292797	Urban	266	12	91	4,5%
6	Lukelenge	299230	Urban	218	8	73	3,7%
7	Muya	363053	Urban	245	23	67	9,4%
8	Mpokolo	303597	Urban	118	5	39	4,2%
9	Kansele	277153	Urban	91	1	33	1,1%
10	Lubilanji	278657	Urban	85	2	31	2,4%
HZ of Mbuji-Mayi City		3120206	Urban	3228	144	103	4,5%
1	Tshilenge	315891	Rural	1192	41	377	3,4%
2	Kasansa	224077	Rural	647	33	289	5,1%
3	Mukumbi	160340	Rural	174	19	109	10,9%
4	Tshishimbi	196543	Rural	163	5	83	3,1%
5	Citenge	259038	Rural	212	4	82	1,9%
6	Bibanga	166074	Rural	98	12	59	12,2%
7	Cilundu	201078	Rural	59	9	29	15,3%
8	Miabi	170072	Rural	44	5	26	11,4%
9	Kabeya-Kamuanga	216753	Rural	37	5	17	13,5%
HZ of Rural area		1909866	Rural	2626	133	137	5,1%
//	Uncertain location	//	//	15	0	//	0,0%
KOR Province		5030071		5869	277	117	4,7%

Laboratory data

Data available were during the period W7-W41 of 2018 when the line listing included a total of 5064 suspected cases including 255 deaths (CFR: 5.0%).

Out of 5064 suspected cases, 101(2%) samples reach national Lab and were analyzed **table 2** shows the results.

Table 2. Results of laboratory cultures on the stool samples in NIBR, DRC, 2018

Area of notification	Mbuji-Mayi		Rural area		KOR Province	
Culture result	n	%	n	%	n	%
VC O1 Positive	24	35,3	14	42,4	38	37,6
Negative	44	64,7	19	57,6	63	62,4
Total	68	100,0	33	100,0	101	100,0

Out of 101 cultures performed, 68(67.3%) were collected in Mbuji-Mayi.

The positive rate in the whole province was 37.3 % (38/101).

14 stool samples over 33 (42.4%) from Rural area were positive as well as 35.3% (24/68) of the stool samples from Mbuji-Mayi. See weekly distribution of stool samples collection and laboratory results during de cholera outbreak in figure 7.

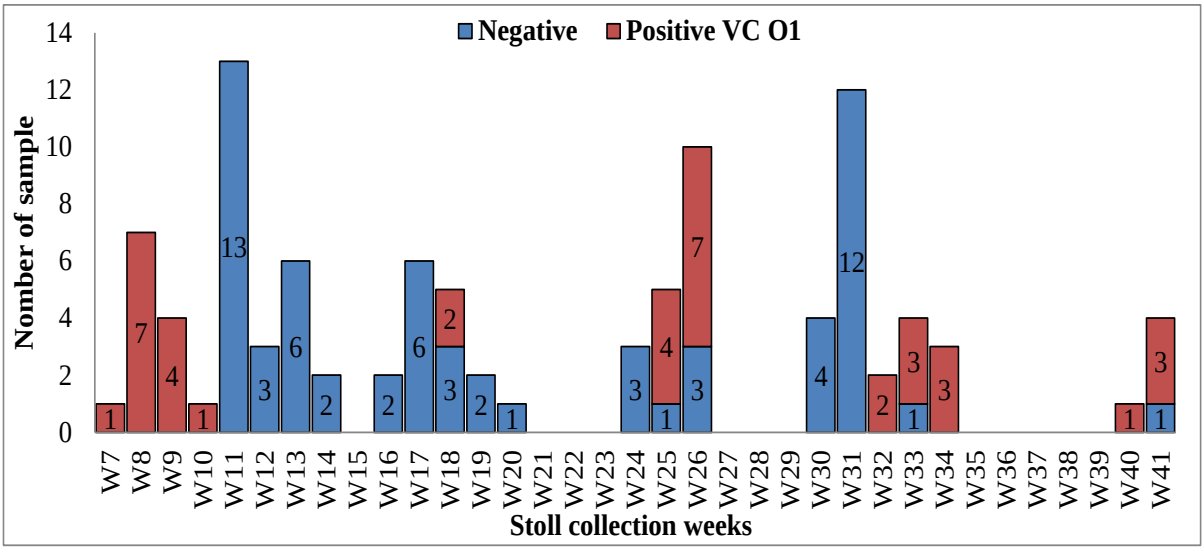

Figure 7. Weekly evolution of sample stool collection and analysis, from KOR Province, W7-W41, 2018

We noticed that at the beginning of the outbreak, all stool samples were positive.

Most of the samples arrived to the national laboratory within 3 days. But more than 50% of stools samples reached INRB laboratory within 5days but in some cases samples reached INRB within 24 days.

After 6weeks of consecutive results (W11-W17) with 32 stool samples tested negative, we had another positive case at W18.

The average number of stool samples analyzed per week was 2.5 (101/41) with extremes of 0 to 13 samples.

We noticed irregular transfer of stool samples in the laboratory during the period (No stool sample analyzed on W15, W21-W23, W27-W29, W35-W39).

Discussions

Limitations of the study

Using a line listing for analyzing, it was data secondary data with too many missing in some variables especially for some with did not have daily or direct impact on the management of the cholera response. Indeed, the information with the greatest completeness in the linear list was that collected during the first moments of the investigation at the level of the health zones or the care

DOI: 10.21522/TIJPH.2013.SE.19.02.Art028
ISSN: 2520-3134

centers even as here we noted for certain variables a lot of information missing. On the other hand, information that should be supplemented secondarily in the lists such as patient management and follow-up data as well as laboratory data was virtually empty with completion rates of only about 20% for some variables. As a result, we were unable to exploit and analyze some important epidemic variables such as occupation, level of study, and virtually all clinical data except for the laboratory data that we were able to solicit and obtain at the level of the epidemic. national laboratory. This was not possible for case management and patient follow-up data because case management in this epidemic was managed by partner structures in the Ministry of Health but this area was mainly managed by International partners and NGOs working mainly in emergencies and therefore having left the premises just after their activities. In addition, descriptive data on activities such as Wash, communication and case management were not the subject of our study.

The descriptive analysis of the cholera epidemic in the KOR province in 2018, in connection with some major actions observed during the response allowed us to make the following point.

Regarding the weekly evolution of the epidemic. We have a total of 5869 suspected cases including 277 deaths (CFR: 4.7%). In all 10 HZs in Mbuji-Mayi City, the CFR was slightly lower (4.5%) than in all 9HZ in the rural part of the province (5.0%). In all cases, these CFR rates remained very high, in comparison with the 1% limit for well-managed epidemics (WHO, Cases Management) and then comparing these data with the African average, which is about 2% (Mengel et al., 2014) or even those obtained by Elimian et al. (2019) in Nigeria as well as in Ghana (Lwanga et al., 2017.) When analyzing the situation by locality, the CFR in the rural part of the province is higher than the norms of epidemic management. of MSF rural areas (less than 5%) It should be noted that this high CFR in the city of Mbuji-Mayi was predictable due to certain contributing factors such as overpopulation, promiscuity and poverty in an environment very sensitive to erosions. therefore very favorable to permanent floods (MSF, 2017, Shomba and Olela, 2015), but it should be remembered that this CFR could be overestimated for two possible reasons: by using a definition of cholera cases based essentially on diarrhea many deaths could be wrongly attributed to cholera (WHO, Casa management) .Also in a context of poverty where burials of cholera deaths were made free by the teams of the response some families could notify false cases of death.

The cholera AR in the province was 117 cases per 100,000 inhabitants, a value not far removed from that found in Nigeria and Ghana (Elimian et al., 2019, Lwanga et al., 2017). It was lower in the city of Mbuji-Mayi (103 cases per 100,000) with a variation between the different urban health areas between 31cas per 100,000 and 219 cases per 100,000. It remained higher in the two Urban Health Zones where the W7 outbreak began. On the other hand, this AR was even higher in the rural part of the province (137 cases per 100,000) with variations between health zones of 17 cases per 100,000 to 377 cases per 100,000). Overall, the ARs registered in the different HZs of the city of KOR remained weak compared to ARs in the different states affected by the 2014 cholera outbreak in Nigeria ranged between 0.40 cases per 100,000 and 175 cases for 100,000. These high ARs are usually found in overcrowded areas or refugee camps (MSF, 2017).

The observation of disaggregated epidemic curves in Mbuji-Mayi and in rural areas allows us to observe a multiplicity of peaks. This shows the diversity of sources of contamination (Oyugi et al., 2017).

Sex and age

In our study, persons aged ≥15years were most affected both in man and women. The same trend was observed in MbujiMayi and in rural area.

This is explained by the fact that there are permanent round-trip populations between the city of Mbuji-Mayi (where the main activities are work in diamond mines and small businesses with a very high unemployment rate) and Rural areas whose main activities are mining, farming, farming and fishing. (Shomna and Olela, 2015). This trend is confirmed by numerous studies in the DRC, notably that of Otshudiema et al., 2009. But this characteristic is not observed in other epidemics like that of Uganda in 2015, where it is the children 5-9 years who were most affected (Bwire et al, 2017).

The trend of deaths during this epidemic followed that of cases with of a total of 277 recorded deaths, 151 were male, a sex ratio of 1.2 to 1.2. Women aged ≥15years accounted for 82% of deaths

in Mbuji-Mayi compared to 88% in rural areas. While among men of the same age group, 83% were registered on both sides

Laboratory data (data from W7-W41)

The analysis of laboratory results correlated with the epidemic curve shows that the epidemic was confirmed by the national reference laboratory the same week as the index case notification. This shows the existence of an efficient network of sample transmission and feedback with the KOR DPS. On the contrary, we would have expected the distance between Kinshasa and Mbuji-Mayi. In some cases, studies report 18-day delays between the notification of the index case and confirmation of the epidemic. (Oyango et al., 2010). On the contrary, out of a total of 5064 suspected cases notified to the W41, 101 (2%) analyzed at the National Laboratory which is very weak. Is this the number of samples actually collected and transferred? Is it just the number of samples received in the lab? Is the number of samples analyzed after exclusion of the wrong samples? We did not have any answers. Still, WHO recommends that once a cholera outbreak is confirmed, it is no longer necessary to have biological confirmation of all cases, but to collect only a small proportion of stool samples to verify if it is the same strain that persists along the epidemic and monitor the emergence of resistance (WHO, 2016). But what is the appropriate proportion of stool to be collected during a cholera outbreak? The proportion of stools samples analyzed in the laboratory during a cholera outbreak in Nigeria was 12% (Elimian, 2019) which was considered very weak by the author.

WHO (2016) states that 20 stool samples are needed to confirm the end of an outbreak? But he does not say on what period these samples should be taken. We observed that between W11 and W17, during which the response teams had stopped their activities in the cholera response, 32 stool specimens taken over a period of 7 weeks had been tested with all negative results, well beyond of the 20 mentioned by WHO. On this point one could say that the increasing number of cases observing in Week that followed was a new epidemic. Entire periods and sometimes even more than one month remained without receiving samples at the reference laboratory. This poses a problem in the ongoing biological monitoring of the epidemic.

Conclusion

The present descriptive study revealed that the 2018 cholera epidemic was the largest recorded in the KOR province after 15 years with no reported cases of cholera. We were able to understand that this epidemic, which was confirmed very quickly (strain V. cholerae 01), started in the city of Mbuji-Mayi with a high CFR at W7 and persisted for 17 weeks before starting as early as W24 to expand in rural areas of the province. The epidemic then persisted in both parts of the province before falling back towards the end of 2018. It was characterized by a very high CFR especially in rural areas.

Figure 8. People looking for water to drink in mbuji-mayi City, KOR Province, DRC, September 2018

DOI: 10.21522/TIJPH.2013.SE.19.02.Art028
ISSN: 2520-3134

Acknowledgements

Ministry of health DRC
PDH KOR
WHO, UNICEF, OCHA, MSF

References

[1]. WHO : Organisation Mondiale de la Santé (2019). *Choléra*. Centre des Médias. *Principaux répères, Janvier 2019. Consultable sur* http://www.who.int/fr/news-room/fact-sheets/details/cholera.
[2]. OMS. Organisation Mondiale de la Santé (2014) Relevé épidémiologique hebdomadaire N° 31, 86 325 - 340. Avalable at : http://www.who.int.wer.
[3]. OMS : Organisation Mondiale de la Santé (2013) *Guide pour la lutte contre le choléra*. Publications hors-séries.
[4]. NGWEJI KAZAJI, D. (2016): Factors contributing to the prevalence of cholera during 2008 to 2009 in Yhembe District of Limpopo Province, South Africa, Master pf Public Health Dissertation, University of Limpopo, South Africa, 123pp.
[5]. DUBOIS A., SINKALA M., KALLUR P., MAKASA-CHIKOYA. (2016) Epidemic cholera in urban Zambia: hand soap and dried fish as protective factors. Epidemiol. Infect. 134, 1226–1230.
[6]. Mutonga, Abade, Amwayi, Ope, Limo, Mintz, Quick, Breiman, Feikin (2017). High Mortality in a Cholera Outbreak in Western Kenya after Post-Election Violence in 2008. *Am J Trop Med Hy. 83:370-373.*
[7]. BOMPANGUE D. (2009) ; *Dynamique des épidémies de choléra dans la région des grands lacs africains : cas de la République Démocratique du Congo*, Thèse de Doctorat en Sciences de la vie et de la santé, Université de Franche-Comté, France, 265pp.
[8]. MSP/PENECHOL-MD : Ministère de la Santé Publique/Programme National d'Elimination du Choléra et des maladies diarrhéiques (2018). Plan global de riposte d'urgence aux épidémies de choléra en cours en RDC, Non publié.
[9]. PDH : Provincial Division of Health, Kasaï Oriental (2018), Plan de Renforcement de la riposte contre l'épidémie de choléra dans la province du KOR, Mars 2018, 19pp.
[10]. PDH: Provincial Division of Health, Kasaï Oriental (2018). *Rapport annuel d'activités, Exercice 2017* ; 37pp.
[11]. OMS : Organisation Mondiale de la Santé (2018) : Crise Humanitaire Complexe de la République Démocratique du Congo, Bureau OMS de Kinshasa, RDC, Sem. Epi. 40, 2018.
[12]. REBAUDET, S. (2014). Étude dynamique des épidémies de choléra en Afrique et en Haïti et application à la mise en place de stratégies d'élimination, Thèse de Doctorat en épidémiologie, Université d'Aix-Marseille, Marseille, France, 200pp.
[13]. SWERDLOW D. L, MALENGA G., BEGKOYIAN G., NYANGULU D., TOOLE M, WALDMAN R., PUHR D., TAUXE V. (2007). Epidemic cholera among refugees in Malawi, Africa: treatment and transmission *Epidemiol. Infect.* 118, 207 - 214.
[14]. PDH : Division Provinciale de la santé du Kasaï Oriental (2015), Surveillance Intégrée de la Maladie et Réponse : Plan Provincial de Préparation et Réponse aux Epidemies Urgences et Catastrophes ; du KOR, Juillet 2015, 19pp.
[15]. Cholera. (2009). In *Encyclopedia Britannica*. Retrieved in November 22, 2019, from Encyclopedia Britannica Online: https://www.britannica.com/science/cholera/Cholera-through-history.
[16]. Cholera. (2009). In *Wikipedia the free encyclopedia*. Retrieved in November 22, 2019 from http://en.wikipedia.org/wiki/Cholera.
[17]. SNOW J (1885) - *On the mode of communication of cholera*. J. Churchill, 2nd ed., 1855, London, p.1-162.
[18]. PDH : Division Provinciale de la Santé du Kasaï Oriental (2017). Rapport Annuel d'Activités de la PDH du Kasaï Oriental, Mbuji-Mayi, Exercice 2017, 35p.
[19]. PDH : Division Provinciale de la Santé du Kasaï Oriental (2017). Plan de Préparation aux Urgences épidémiques 2019, Mbuji-Mayi, 25p.
[20]. MSF : Medecins Sans Frontiere (2018): Management of an CHOLERA EPIDEMI, Practical guide for doctors, nurses, laboratory technicians, health auxiliaries, health technicians and logisticians; 2018 Edition,

Retrieved in December 2, 2019 from https://medicalguidelines.msf.org/msf-books-hosting/23444436-Francais.pdf.
[21]. WHO: World Health Organization (2004). Cholera Outbreak: Assessing the Outbreak Response and improving preparedness, Global Task Force for cholera control. Retrieved in December 2, 2019 from
GTFCC: Global Task Force on Cholera Control (2017). *Ending Cholera - A Global Roadmap to 2030*. 32p Retrieved in December2, 2019 from https://www.who.int/cholera/publications/global-roadmap/en/.
[22]. Last JM (2008) *A dictionary of epidemiology*. New York, Oxford University Press/International Epidemiological Association, 5th Edition.
[23]. WHO: World Health Organization (2018). *Weekly epidemiological record*, 93, 489–500 Retrieve on December, 3 2019 from https://apps.who.int/iris/bitstream/handle/10665/274654/WER9338.pdf?ua=1.
[24]. Kelsey et al.,[nd] *Methods in Observational Epidemiology*, 2nd Edition, Table 12-15; and Fleiss, Statistical Methods for Rates and Proportions, formulas 3.18 & 3.19 Online in http://web1.sph.emory.edu/users/cdckms/sample%20size%202%20grps%20case%20control.html.
[25]. Shomba K.S. and Olela N.N. (2015). Monograph of the city of Mbuji-Mayi, CRDI, Ed. MES. 104P. Retrieved on December, 7 2019 from https://www.idrc.ca/sites/default/files/sp/Documents%20EN/Monographie.pdf.
[26]. Mengel M, Delrieu I, Heyerdahl L, et al., (2014), Cholera outbreaks in Africa. Curr Top Microbiol Immunol. 379:117–44.
[27]. Elimian K.O., Musah A, Mezue S., Oyebanji O., Yennan S., Jinadu A., ,Williams N., Ogunleye A., Soce Fall I., Yao M., Eteng Eteng W., Abok P., Popoola M., Chukwuji M., Haj Omar N., Ekeng M., Balde T., , Mamadu I., Adeyemo A., Namara G., Okudo I., Alemu WG., Peter C., and Ihekwea C. (2019), Descriptive epidemiology of cholera outbreak in Nigeria, January–November, 2018: implications for the global roadmap. BMC Public Health 19:1264. Retrieved on October, 28 2019 from https://doi.org/10.1186/s12889-019-7559-6.
[28]. Lwanga NC., Issah K., Kenu1 E., Bachan EG., Nuoh RD., NyarkoKM., Appiah P. and Letsa T.; (2017), Large cholera outbreak in Brong Ahafo Region, Ghana, BMC, 10:389. Retrieved on October, 22 2019 DOI 10.1186/s13104-017-2728-0.
[29]. Elvis O. Oyugi, Waqo Boru, Mark Obonyo, Jane Githuku, Dickens Onyango, Alfred Wandebal, Eunice Omesa, Tabitha Mwangi, Hudson Kigen, Joshua Muiruri, and Zeinab Gura (2017) An outbreak of cholera in western Kenya, 2015: a case control study, The Pan African Medical Journal. 28 (Supp 1):12. DOI: 10.11604/pamj.supp.2017.28.1.9477.
[30]. Bwire G, Munier A, Ouedraogo I, Heyerdahl L, Komakech H, Kagirita A, et al. (2017) Epidemiology of cholera outbreaks and socio-economic characteristics of the communities in the fishing villages of Uganda: 2011-2015. PLoS Negl Trop Dis 11(3). E0005407. https://doi.org/10.1371/journal.pntd.0005407.
[31]. Otshudiema, JO., Shamavu RR., Masimango M., Burhola MM., Kabongo, M., and Kokolomani JH., (2009), Epidémie de choléra à Bukavu (R.D. Congo) de 2006-2007 : Données épidémiologiques et de contrôle, Ann. Afr. Med., Vol. 3, N° 1.
[32]. Onyango D., Karambu S., Abade A., Amwayi S., and, OmoloJ., (2010) High case fatality cholera outbreak in Western Kenya, August 2010, PMJ?