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The Outbreaks of Cholera in Zambia – How Far from Eradication?

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ABSTRACT

Cholera is a preventable and curable disease that is caused by the toxigenic bacterium, Vibrio cholerae, serogroups O1 or O139. The disease causes more deaths in children and is caused by ingestion of contaminated food or water. Moreover, various factors such as poverty, stunted economic development and poor sanitary facilities contribute to the outbreak of the disease especially in the third world countries. The outbreaks of the disease have been occurring in Zambia for the past four decades. However, due to several awareness campaigns and strategic measures toward the prevention of cholera, Zambia has seen the reduction in the numbers of recorded cases and mortality rates. Despite stringent measures implemented by the government and other cooperating partners, sporadic outbreaks have continued to terrorize various parts of the country. Moreover, the commonest strain associated with outbreaks in Zambia is Vibrio cholerae O1, serotype Ogawa, biotype E1 Tor which has been reported with resistance to commonly utilized antimicrobial agents such as chloramphenicol, furazolidone, nalidixic acid, tetracycline, doxycycline, trimethoprim–sulfamethoxazole and ciprofloxacin. Therefore, understanding the outbreak pattern of cholera, identifying factors that elicit the outbreaks and the spread of drug resistance may help in choosing appropriate intervention strategies to eradicate the disease. Most outbreaks have been associated with drinking contaminated water from open shallow wells. Thus, improving access to safe water, hygiene promotion and sanitation, making use of Oral Cholera Vaccines as a disease control plan and reinforcing disease surveillance, can help eradicate cholera in Zambia.

Keywords: *Vibro cholerae, Cholera, outbreaks, Zambia.*

INTRODUCTION

Cholera is among the leading causes of death in children 1 to 5 years of age, and estimated to affects 3–5 million people each year, killing 120,000 (1, 2). It is an acute diarrheal disease caused by ingestion of food or water comprising of toxigenic *Vibrio cholerae*, serogroups O1 or O139. Its transmission is mainly through ingestion of contaminated food or drinking-water, or by person-to-person contact through the faecal-oral route. The bacterium is capable of surviving and proliferating outside the human body and can quickly spread in densely populated places, area with unprotected water sources and places with unsafe faecal waste disposals (3).

Since the discovery of the bacterium *Vibrio cholerae* by an Italian anatomist, Filippo Pacini (1812-83) in 1854 (4), cholera still remains a significant public health problem in many parts of the world (5). World Health Organisation (WHO) report has shown cholera cases rising from everywhere around the globe (6). However, developed countries in Europe, Latin America and USA, managed to eliminate cholera by water and sewage treatment over a century ago while Africa has been struggling with the infection till date (7). The escalating levels of poverty, stunted economic development and inadequate access to basic social needs such as health services, clean water supply and improved sanitation continues to regulate the transmission of cholera in Africa (8).

According to the information reported in the WHO 2015 report (5), cholera cases in southern African countries may not reflect the true picture of what is prevailing in these countries. This could be due to the inconsistences in data capturing/reporting using the Integrated Disease Surveillance and Response (IDSR) system. Data captured through the IDSR system is reported yearly to WHO and deposited on an online database, the global health atlas which can be accessed freely on the internet. For instance, the

WHO 2015 report (5) only captured cholera cases for Zimbabwe (60 cases), Mozambique (8739 cases) and Malawi (693 cases) with the case fatality rate (CFR) of 1.6% and 0.7% for Malawi and Mozambique, respectively. The Global Health Observatory Map Gallery (http://gamapserver.who.int/mapLibrary/app/searchResults.aspx; accessed December 12, 2017) includes Zambia amongst countries that were reporting cholera cases from 2010 to 2014, but not among the 2015 and 2016 cholera reporting countries. Also, a discrepancy was observed after comparing national data from the IDSR database and the Zambian cholera data on the global health atlas (8). However, with the exception of the periods from 1994 to 1995 and 2000 to 2002, Zambia has continued to experience the outbreaks of cholera in various places, more specially the capital city, Lusaka. Outbreak refers to a sudden increase in the incidences of an infection in a certain period of time and place. Therefore, to clearly understand the outbreaks of cholera in Zambia, this review focuses on the pattern of cholera outbreaks, and discusses the risk factors and potential solutions that can be integrated in the already existing ones for long lasting prevention and control of cholera outbreaks in Zambia.

ZAMBIA'S GEOGRAPHICAL LOCATION

Zambia is a landlocked country in southern Africa, surrounded by eight neighbouring countries, *i.e.*: Angola, Democratic Republic of Congo, Botswana, Namibia, Malawi, Mozambique, Tanzania and Zimbabwe (Fig. 1). It is divided in ten provinces with the total projected 2017 population of 16 405 229 (9). The capital city is Lusaka in Lusaka province which has the smallest land area (2.9% of total area of Zambia) but has the highest concentration of people in Zambia (10). People migrate from all over the country and settle in Lusaka in search of better living conditions such as employment and other business opportunities. Thus, the province is reported to be densely populated with a population density of 100.1 persons per square kilometre; and administratively, the province is divided into four districts (Lusaka, Chongwe, Kafue and Luangwa; Fig. 2), the densely populated district being Lusaka district (10).

Figure1. *The Zambian geographical location in Africa (courtesy of SmartDraw 2013 software)*

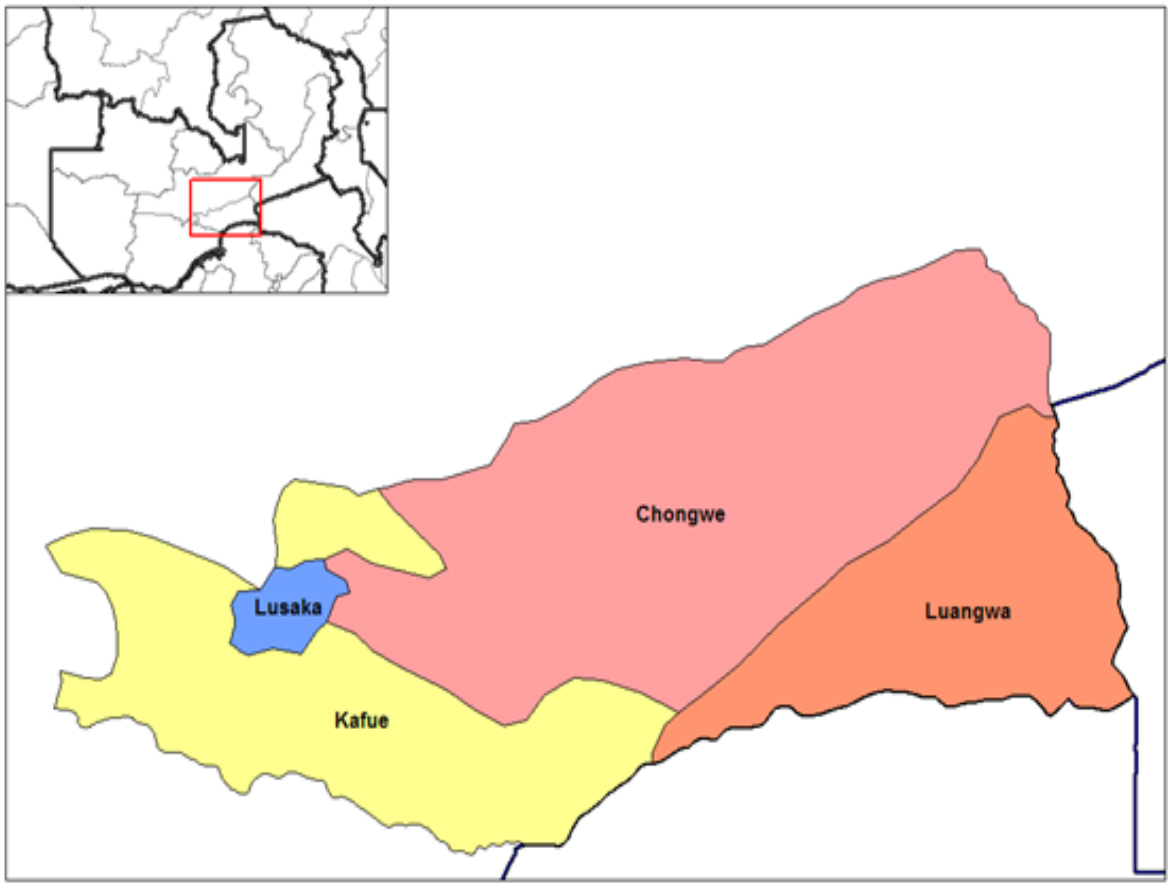

Figure2. *The map of Lusaka province showing four administrative districts (courtesy of www.bing.com/images)*

The Burden of Cholera in Zambia

Since 1977/78 when the first outbreak was recorded, Zambia had suffered major outbreaks of cholera that have claimed many lives (8). The epidemics recording the largest number of cases occurred in 1991 (>12 000), 1992 (>11 000) and 1999 (>11 000), 2004 (>12 000) and 2010 (> 6 000) as shown in Fig. 3A-C; while that of November 2003 to February 2004 reported a case fatality rate of 3.5% in Lusaka (11, 12). However, sporadic outbreaks have continued to terrorize various parts of the country. Certain parts of the country are more prone to experiencing these outbreaks especially the capital city, Lusaka. This could be as a result of high population densities in affected areas and also poor access to safe water and proper sanitation, as population density, lack of sanitation and poor health infrastructure are some factors that contribute to the increase in cholera mortality rates (1). However, the survival of *Vibro cholerae* (*V. cholerae*)-the causative agent of cholera in the environment hinges on the optimal temperature and physicochemical conditions such as salinity, pH, and humidity (13). Precipitation encourages the spread and transmission of the pathogen (14, 15), and more cholera cases happen in flooding periods than in non-flooding periods (1). The natural habitat of *V. cholerae* is marine environment which strengthens the pathogen to withstand suboptimal conditions by way of interacting with aquatic plants (16), although sequencing data has confirmed that it is a versatile bacterium that is able to live and survive in several habitat forms and causes havoc to the human gastrointestinal tract (14). Therefore, the pattern of cholera outbreaks in Zambia tend to spread throughout the year as previous reports have confirmed the common occurrence to levitate between the months of August and June (11, 17), and thus the most affected periods being the rainy and dry seasons.

However, due to quick response by the government and cooperating partners towards mitigating cholera epidemics, Zambia saw a huge decline in reported cholera mortalities. For example, mortality cases were high in 1979 (CFR of 91.8%) and 1989 (CFR of 100%) but reduced drastically in 2012 (CFR of 1%) with no death occurrences in 1981, 1997 and 1998 (Fig. 3A and 3B).

Figure3. *The prevalence of cholera cases in Zambia from 1978 to 2012, of which cases from 1978 to 1990 (A), 1991 to 2000 (B), and 2001 to 2012 (C). Data obtained from WHO Global Health Atlas database (12)*

In 2016, a United Nation Children's Fund report detailed a cumulative total of 1 179 cholera cases that were reported since February 5, of which 192 cases were laboratory confirmed and 31 deaths occurred, representing a CFR of 16.1% (18). The report further revealed the distribution of cholera cases in eight districts of five provinces: Lusaka {953} and Rufunsa {8} in Lusaka Province, Chibombo {23} and Kabwe {2} in Central Province, Nsama {66} in Northern Province; Ndola {28} in Copperbelt Province and, in Mazabuka {50} and Monze {49} districts of Southern Province. The Nsama district outbreak was associated with the outbreak in the neighbouring country, Democratic Republic of Congo whereas the remaining district cases were associated with the Lusaka outbreak (18). This suggested that affected

individuals from these districts migrated from either DR Congo or Lusaka, or had direct contact with goods or people from these two regions. Furthermore, ingestion of contaminated water, contaminated food and inadequate sanitation were reported as sources of the infections that were worsened by low levels of hygiene practices (18). Later in September 2016, the outbreak was reported in Lukanga fishing camp of Central province (19). In this outbreak, 27 cases were recorded with 2 deaths (CFR of 7.4%) and the infection was due to contaminated water. The authors reported that more cases were recorded in Kapiri Mposhi (5), Kabwe (3) and Chibombo (1) from people who visited the Lukanga fishing camp (19).

Recently, the Ministry of Health identified the cholera epidemic-prone districts in Zambia as Sinazongwe, Monze, Mazabuka, Kafue, Lusaka, Chongwe, Kapiri Mposhi, Mpulungu, Kaputa, Chiengi and Nchelenge (Fig. 4, (20)). However, from October 6, 2017 to January 2, 2018, Lusaka has been hit with the cholera outbreak and so far, 1901 cases and 45 deaths have been reported, having the CFR of 2.37%, while across the country the cumulative total of cases has reached 1940 with 48 deaths, representing the CFR of 2.47% (20). The report further revealed the source of infection as contaminated water and food, and *V. cholerae* 01 Ogawa as the prominent causative agent. The cases has kept on rising and the government of Zambia has swung into action to mitigate the scourge.

Figure4. *The detailed map of Zambia (courtesy of www.bing.com/images)*

According to these incidence reports, it is suffice to say that Lusaka and Central provinces has been the hub of cholera infection in Zambia. Although, this may not be entirely true because some outbreaks from certain parts of the country have either been improperly or not been documented. Therefore, it is difficult to conclude that the remaining provinces have never experienced or reported any cholera case in a country where the epidemics occur throughout the year. This could be attributed to the challenges faced in many districts regarding timely and quality of data collection as noticed in the UNICEF report (18), perhaps due to lack of skilled training. Moreover, several inconsistencies had been observed after comparing case statistics from the WHO-global health atlas (WHO-GHA) database and those published elsewhere. As for the year 1991, 13 511 cases were recorded on WHO-GHA database while 11 535 cases were reported elsewhere (11). Also, a cumulative total of 20 061 cases from 2003 to 2006 were recorded on the WHO-GHA database whereas a total of 13 069 cases were reported elsewhere for the same period (13). This inconsistencies suggest that much trainings on quality data collection and reporting are required. Therefore, more research in this area should also be encouraged by public health institutions such as the Zambia National Public Health Institute, and more short-course trainings should be provided to health workers to lessen the discrepancies in quality data collection and reporting. Thus by doing so, may provide a broader and accurate picture on the burden of

cholera in Zambia. However, it is worth noticing that, with the launch of *The Health Press* – Zambia's journal on public health, disease surveillance, prevention and control which is hosted by the Zambia National Public Health Institute (http://znphi.co.zm/thehealthpress/), we anticipate and hope for informative articles on disease surveillance reports and research article publications to increase.

On the other hand, the commonest strain associated with outbreaks in Zambia is *Vibrio cholerae* O1, serotype Ogawa, biotype E1 Tor (11, 13, 17, 21). This strain is reported with resistance to common antimicrobial agents such as chloramphenicol, furazolidone, nalidixic acid, tetracycline, doxycycline, trimethoprim–sulfamethoxazole and ciprofloxacin (11, 21). Mwansa *et al* (21) examined 69 isolates of *V. cholerae* for the presence of virulence factor genes such as *ctxA* gene that codes for the B subunit of cholera toxin, *tcpA* gene that codes for biosynthesis of the toxin co-regulated pili, *rstR* genes that codes for the repressor gene of the CTX prophage, SXT element that encodes the resistance markers for streptomycin and trimethoprim, and *intl1* gene codes for class 1 integrons. In this study, they found that all strains had significant epidemic markers such as *rfbO1*, *ctxA*, *rstR2*, and *tcpA* E1 Tor, except two strains that lacked the *ctxA* and *rstR2* genes. This calls for urgent interventional strategies to prevent future outbreaks because once the drug resistant strains spread across, the CFR may drastically increase. Also, the re-assessment and monitoring of resistant patterns of *V. cholerae* towards commonly utilized antibiotics should be considered.

Possible Causes of Cholera Out breaks in Zambia

Cholera is a preventable disease. This is so when the community is sensitized about hygienic practices or living. According to literature, various factors such as poverty, stunted economic development and poor sanitary facilities among others elicit the outbreak of the disease especially in the third world countries. In addition to the natural occurrences such as temperature and precipitation (14, 15), previous reports have pointed out that most outbreak cases especially in Lusaka were associated with drinking contaminated water from open shallow wells (20, 22). Lack of sufficient and well maintained drainage system causes rainwater to flood most areas thereby increasing the risk of cholera outbreak. Since, the flooded regions have no clear water flow path, they end up washing or mixing with improperly maintained latrines and later pouring into open shallow well. As it has been reported before, rainfall increases the risk of transmission of *V. cholerae* (17) and lack of access to safe water, sanitation facilities and proper hygiene practices, facilitate the spread of the outbreak.

Besides rainy water, drinking water contaminated with faecal waste especially in fishing areas precipitates the transmission and spread of the bacterium thereby eliciting an outbreak. Fishing areas are mostly affected with the problem of defecating in open areas near water bodies or in water by fishermen and people visiting these areas, supposedly due to lack of sanitation facilities, as discovered in Lukanga fishing swamps (19). These trends of human waste disposal are quite common in rural settlement, where people opt to defecate in open areas (i.e., street gutters, behind bushes or into open bodies of water) (23).

On the other hand, consumption of improperly washed raw vegetables was established as a source of cholera outbreak in Lusaka (11). Most of the streets of Lusaka are infested with vendors, and lack enough sanitation facilities in strategic places. Moreover, the collection of wastes is poorly managed. Despite efforts by local authorities to provide waste bins on some streets, people still have the tendency of littering wastes in the streets which becomes more challenging to maintain cleanness in these areas. This is the common trend in most districts. The local authority broadcasts sensitization messages on radio and local television but the rate of response towards these messages is low. However, the problem still remains and outbreaks may continue. Hence, possible measures are needed to be sought or put in place to curb this plight.

Possible Solution and Future Perspectives

It is certain that poor living conditions exacerbate the outbreak of cholera. Despite the constraints faced by these third world countries like Zambia, finding long lasting solution to this plight is cardinal. Usually, during cholera outbreaks, the government of Zambia through the ministry of health works hard to reduce the fatality incidences by providing safe drinking water and temporary sanitation facilities. In fact, with the quest to improve water supply and sanitation in rural and urban sectors, government of Zambia directed that the WASHE (Water, Sanitation, and Health Education) program be rolled to districts

levels in 1996 through the 1994 National Water Policy (which covered water resource management, urban and rural water supply and sanitation, water quality and water tariffs) (23). But, once the outbreak is contained, the government, the community and other cooperating partners, give it a 'blind eye' till the next outbreak incidence. These short term solutions or managing the infection when it occurs (crisis management) has not been helpful in eradicating the infection. However, as the adage goes, 'prevention is better than cure', proper planning may bring an end or minimize the occurrences of outbreaks. The 'troubleshooting' type of response is not enough to eradicate the problem of cholera in Zambia. The root cause analysis needs to be performed in order to discover possible non-conformances that should be worked on to phase out cholera. Developed countries have managed to eradicate the problem of cholera outbreaks. For instance, countries in Europe, Latin America and USA eliminated cholera through water and sewage treatment coupling with hygiene practices by the community (7). In spite of various economic challenges faced by third world countries, emulating some of the strategies used in developed countries may help in sorting out cholera outbreaks once and for all. This can be done systematically and strategically so as not to over burden the economic budget. Governments, religious organisation, non-governmental organisation, the community and other cooperating partners should work together to alleviate the plight of cholera outbreaks in third world countries.

Most areas that experience cholera outbreaks in Lusaka - Zambia have no access to municipal water system or piped water. They fetch their water from wells, predominantly shallow wells. However, providing piped water to these affected areas may play a huge role in the reduction of infection. To avoid over burdening the economic budget through provision of piped water to every household, strategic points may be selected in these areas where the community can be fetching treated water. Moreover, the provision of safe water and excreta disposal facilities combining with a well-planned infrastructure for drainage networks to lessen the overflow of rainwater can reduce the risk of transmission of cholera and other diarrhoeal diseases for a long term (17). Market places are usually hit with drainage blockages perhaps due to insufficient waste collection tanks/bins which may fuel the bacterium transmission risks especially through the unhygienic consumption of raw vegetables (11), since the bacterium can live for 2-5 days on raw produce (24). So, people increasingly litter rubbish in drainages thereby blocking or worse burring them. Hence, during rainy seasons, this causes flooding, a risking factor for the outbreak of diarrhoeal infections. For this reason, local authorities should endeavour to work hand-in-hand with market authorities to improve market-generated waste management and provide sufficient sanitation facilities. Moreover, a sense of responsibility may be imparted in the community through various campaign messages such as 'keep your environment clean', and many others. If the cleanliness is maintained and monitored throughout the year, cholera outbreaks may soon be a thing of the past.

Due to the escalating levels of street food vendors in various parts of Zambia, provision of waste collection tanks/bins and running water, sufficient latrines, and hygiene interventions should be considered as a cholera prevention strategy (11). Intensive sensitization of the public and food vendors on safe food handling may revolutionize people's mind-sets and change the situation.

The transmission of various diseases like cholera, diarrhoea, dysentery, hepatitis A, typhoid and polio is associated with poor sanitation, and it is for this reason that the WHO along with UNICEF are implementing a global plan aiming at promoting universal access to drinking water, sanitation, and hygiene in health care facilities and homes by 2030 (25, 26).

As one of the five global public health strategies for controlling and eliminating neglected tropical diseases, increased access to improved sanitation was recognized as a human right by the UN General Assembly in 2010 (25). Despite efforts by the government of Zambia to implement the WASHE concept as a national strategy for the delivery of water supply and sanitation services, sanitation facilities were insufficient and open space defecation was being practiced which led to the presence of coliforms in water from shallow wells (23). This suggests that some modes of educating messages on hygiene practices may not be enough or may not have reached the rural community. Therefore, involving religious gatherings and traditional leaders may help in disseminating education materials and messages to the community and the public at large.

Looking at some of the eliciting factors of cholera outbreaks in Zambia, these outbreaks may be lessened or prevented by considering and implementing strategies such as but not limited to the following:

- Having a well maintained and structured drainage system to control and avoid rainwater flooding.
- Increasing access to safe clean water by rural communities through connecting them to Municipal water system.
- Providing waste collection tanks/bin in populated streets that should at least be emptied on a daily basis to control flies thereby maintaining clean roads
- Providing deliberate policies such as environmental cleaning day on a monthly basis. This can allow the community to go to the streets and market premises to clean. This may also reduce the habit of littering rubbish on the streets or anyhow except throwing them in designated areas.
- Designing and inclusion of hygiene- related topics in the school curriculum may let children grow up with the knowledge of proper hygienic practices.
- Providing sufficient sanitation facilities in streets occupied by food vendors and market premises, and educating food vendors to exercise or implement hygiene practices.
- Although the long term cholera preventive solution still remains access to safe water, hygiene promotion and sanitation, making use of Oral Cholera Vaccines as a cholera control plan to complement the WASHE measures, and reinforce disease surveillance, can help in eradicating cholera in Zambia (27).
- Inclusion and/or reinforcement of the "keep Zambia clean" law in the constitution and attach a penalty for anyone who careless litter rubbish anyhow, may help the community to champion cleanness.

Nevertheless, this study does not present a broader overview about the status of cholera outbreaks in Zambia due to the scarcity of published articles this subject. Despite incidences of cholera outbreaks being reported in various places such as local and social media, little has been documented/published. Therefore, more research should be encouraged and conducted to fully understand the burden of cholera in Zambia.

CONCLUSION

Cholera is a preventable and curable disease. Its incubation period varies from 18 hours to 5 days but can cause death within 24 hours from onset. The common modes of transmission include water and food through unhygienic sanitations and practices. In Zambia, cholera outbreaks occur throughout the year, and more predominant in Lusaka due to increased population density, lack of properly structured drainage system, lack of access to sufficient water and insufficient sanitation facilities. In addition, lack of hygienic practices due to illiteracy levels in certain rural areas cause irresponsible littering of garbage in drainages and on roads. However, looking at some of the eliciting factors of cholera outbreaks in Zambia, these outbreaks may be lessened or prevented by considering and implementing strategies such as but not limited those outlined above.

Moreover, more research is needed in order to understand the prevalence of cholera in Zambia, as most outbreaks in places outside Lusaka have their sources traced back to Lusaka. However, with the reported multidrug resistance in some outbreaks (11, 21), assessing the spread levels of resistance in Zambia, can only be understood when research works are encouraged and conducted.

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