How did disaster and lack of improved sanitation and drinking water sources contribute to the 2008 cholera outbreak in Zimbabwe and the 2010 cholera outbreak in Haiti?

By

Nickie Williams-Singleton

A Master's Paper submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Master of Public Health in the Public Health Leadership Program.

University of North Carolina at Chapel Hill

Spring Semester 2015

[Signature]
Anna Sebrock, PhD
April 13, 2015

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13 April 2015
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Abstract

**Background:** Cholera is an acute, communicable diarrheal disease caused by the bacterium *Vibrio cholerae*. Because of its short incubation period of two hours to five days, cholera has a high propensity to spread within a population. Contaminated water supplies are often the primary modes of transmission for sudden cholera outbreaks. During outbreaks, cholera is typically spread by compromised sanitation and drinking water sources. The purpose of this collective case study is to conduct a comparative analysis of cholera outbreaks in Zimbabwe and Haiti and examine factors that most significantly contributed to both outbreaks. Haiti and Zimbabwe were chosen as comparative studies based on five criteria: (1) socioeconomics, (2) political instability, (3) use of improved sanitation facilities and improved drinking water sources, (4) cholera outbreak history (2000 to present), and (5) disaster occurrence – manmade or natural.

**Methods:** Data for this case study were collected via primary, secondary, and grey literature reviews. PubMed, Google Scholar, and Google were the primary database and search engines use to collect data. Guidelines outlined by Watson, Gayer, and Connolly, Johns Hopkins University, and the World Health Organization (WHO) on assessing the threat of and detecting cholera outbreaks served as frameworks for the data review. Data were collected for each country based on their relevance and support of each point in the guidelines. Upon review, side-by-side data comparisons were made for each country.

**Results:** Two contributing factors heavily influenced the cholera outbreaks in Zimbabwe and Haiti: (1) the occurrence of natural and manmade disasters, in Haiti and Zimbabwe respectively, and (2) the lack of and/or maintained improved water and sanitation. Research revealed after being absent from the country for more than a century cholera was introduced to Haiti by human
activities following the January 2010 earthquake. It proliferated through the country by way of unprotected water sources and poor sanitation conditions. While cholera was endemic to Zimbabwe, it reached unprecedented proportions in 2008. The disease spread through compromised water and sanitation sources that had been neglected due to civil unrest and a decimated economy.

Conclusion: Natural and manmade disasters and compromised water and sanitation sources were major factors that contributed to cholera outbreaks in Haiti and Zimbabwe. Cholera was introduced to Haiti and was able to quickly manifest to outbreak level as a result of an earthquake-damaged country and lack of improved sanitation and drinking water sources. Not only did the country lack these resources, but in many regions of the country, the basic infrastructure to support these resources was not in place. Unlike Haiti, Zimbabwe did have improved sanitation and clean drinking water infrastructure in place for majority of its population in urban cities where its cholera outbreak began. However, it was the lack of maintenance of this urban infrastructure led to the proliferation of cholera in the urban populations of a country where the disease was typically more endemic in rural areas.
Introduction

Cholera is an acute, communicable, diarrheal disease caused by the bacterium *Vibrio cholerae*. There are two serogroups of cholera known to cause epidemics – *Vibrio cholerae* serogroup O1 and *Vibrio cholerae* serogroup O139. Of the two, the O1 serogroup biotype El Tor is responsible for most outbreaks (Ministry of Health and Child Welfare and World Health Organization (WHO), 2009). The bacteria are found in natural reservoirs including algal blooms, coastal waters, and other bodies of water where saltwater and freshwater meet. The bacteria are also found in food and water sources contaminated by the feces of a person infected with cholera (Centers for Disease Control and Prevention (CDC), 2014). In the case of pathogenesis, humans serve as cholera reservoirs, as well.

The bacteria are transmitted to humans through the ingestion of food or water contaminated with the bacteria. Even though the disease can be contracted by consuming undercooked, contaminated shellfish from waters where the bacteria are found, the disease is most often contracted by ingesting food or water that has been contaminated by the feces of a person infected with cholera (WHO, 2014). Whether introduced by way of natural or man-made disasters, cholera has plagued populations since recorded history. Many cholera outbreaks have been reported since 2000 (WHO, 2015), but the outbreaks in Zimbabwe and Haiti were of unique interest. The 2008 outbreak in Zimbabwe and the 2010 outbreak in Haiti had the most cases of cholera and the most deaths. Zimbabwe and Haiti, respectively, also had the greatest duration of cholera for a single country as compared to other countries. When comparing recent cholera outbreaks, these countries served as ideal comparatives because of five factors: (1) socioeconomics, (2) political instability, (3) use of improved sanitation facilities and improved
drinking water sources, (4) cholera outbreak history, and (5) disaster occurrence – manmade or natural.

While the outbreak in Zimbabwe has long been contained, the outbreak in Haiti is still claiming lives. Measures that influenced the cholera outbreaks in both countries were believed to be directly related to the occurrence of disaster – natural or manmade – and the lack of improved and/or maintained drinking water and sanitation sources. In order to assess this belief, it was necessary to identify guidelines that served as frameworks for assessing the risk of and detection of cholera outbreaks. Watson, Gayer, and Connolly, Johns Hopkins University, and the WHO provided criteria that should be considered to assess the risk and detection of cholera. Using these guidelines, in conjunction with an analysis of the five comparative factors based on their relevance and support of each point of the guidelines, the question of the impact of disaster and lack of improved sanitation drinking water sources on cholera will be ascertained.

**Background**

*Cholera:* Cholera is an acute, diarrheal disease caused by the bacterium *Vibrio cholerae.* It is endemic to more than 50 countries (Ali et al., 2012). WHO reports that the disease is contracted by ingesting food or water that has been contaminated with the bacterium (2014).

The cholera incubation period, or the time between infection and the development of symptoms, is on average two hours to five days. Contaminated water supplies are often the primary modes of transmission for sudden cholera outbreaks. In the case of most outbreaks, the feces of an infected individual are typically the source of the contamination. Figure 1 illustrates a typical
pathway of a cholera outbreak. Outside of natural immunity, whether or not an individual contracts the disease is influenced by the number of bacteria ingested as represented by Appendix I (John Hopkins Bloomberg School of Public Health, 2014; Codeço, 2001). Because of the high number of bacteria required to cause an infection, rarely is cholera contracted from coming in contact with an infected individual (John Hopkins Bloomberg School of Public Health, 2014; CDC, 2014). Instead, due to its short incubation period, those infected quickly introduce more cholera bacteria to the environment, which lends to its propensity to rapidly spread.

With the exception of nursing infants who receive immunity from their mothers if their mothers have had cholera, everyone is at risk for contracting cholera (Mayo Clinic, 2015). Children under five years of age are at the greatest risk (Ali et al., 2012). If left untreated, cholera can kill adults and children alike within hours, due to the rapid and massive loss of body fluids that result from the watery diarrhea caused by cholera (WHO, 2014). Even though most cholera cases go unreported, the CDC reports there are an estimated 3 – 5 million cholera cases reported annually (2014). Of these cases, an estimated 100,000 – 120,000 result in death.

Assessing the risk of cholera: Ahmed et al. posits that cholera outbreaks are frequently associated with natural and manmade disasters, especially where the disease exists (2011). Assessing the risk of cholera is paramount for helping curb the introduction of the disease in regions where it does not exist and preventing the spread of the disease in regions where it does exist. Seven risk factors that should be evaluated for communicable disease transmission after disasters include:

1. Living conditions of the affected population
2. Underlying nutritional status and immunization coverage among population
3. Degree of access to healthcare and to effective case management

4. Availability of safe water and adequate sanitation facilities

5. Recent deterioration of water and sanitation conditions by natural or man-made disaster

6. Endemic and epidemic diseases that are common in the affected area

7. Introduction of workers from [cholera] endemic countries to an area with poor standard water and sanitation (Watson, Gayer, and Connolly, 2007; Johns Hopkins University, 2014)

Of these factors, the availability of safe water and adequate sanitation facilities is the most significant factor that lends to sudden cholera outbreaks. Poor sanitary conditions, including a lack of improved drinking water sources, promote the rapid spread of *Vibrio cholerae*. An “improved” water source, as defined by the Joint Monitoring Programme (JMP) is “one that, by nature of its construction and when properly used, adequately protects the source from outside contamination, particularly from faecal matter.” JMP also defines an “improved” sanitation facility as “one that hygienically separates human excreta from human contact.” Appendix II identifies examples of improved and unimproved sources of drinking water and sanitation facilities (JMP, 2015). Evaluating these factors can help categorize the cholera risks. If risk is present, the appropriate measures can be taken to mitigate the introduction of the disease or control the spread.

**Detecting a cholera outbreak:** Just as important as assessing the risk of cholera is the detection of an outbreak. Surveillance is one measure used for detecting a cholera outbreak. For regions where the disease is endemic, it is important to monitor an increase in the number of baseline cases. In those regions where the disease is not endemic, a single case of the disease
should be reported (CDC, 1994). In both endemic and non-endemic regions, the WHO (2004) suggests evaluating the following questions in assessing a potential outbreak:

1. At the beginning, what alerted people to the possibility of an outbreak?
2. How were the first cases notified to health authorities?
3. On what basis was it decided that this was an outbreak?
4. How long did the information take to reach decision-making level from the area where the outbreak occurred?
5. What were the first actions taken at the central level?

Disease verification steps must be made in order to clinically confirm a suspected cholera outbreak. Once completed, steps must be made to control the spread of the disease if an outbreak is confirmed.

_Haiti:_ Haiti is one of two countries that occupy the Caribbean island of Hispaniola. With a population of just over 9.7 million people in 2009, more than 80% of the population lived under the poverty line (The World Bank Group, 2015). The World Bank (2014) identified Haiti as a low-income country, which is a country where the gross national income (GNI) per capita is $1,045 or less. Being the poorest country in the Western hemisphere, Haiti has a long history of political corruption. Buss and Garner (2006) reported that Haiti ranked in the “bottom one percent of all countries on corruption and government effectiveness.” A corrupt government, low levels of education, abject poverty, and most recently, a natural disaster, have stifled Haiti’s economic growth.

In spite of international support from government and non-governmental organizations (NGOs), Haiti has had some of the worst health outcomes in the Western hemisphere. Prior to the 7.0 magnitude earthquake in 2010, which devastated an already crippled healthcare system,
the country experienced a severe physician shortage and weak healthcare infrastructure, especially in rural communities. There was also a subpar public health infrastructure. Canals, streams, and rivers were often primary water sources for drinking, cooking, washing, and bathing. It was not uncommon to find waterways filled with debris, human waste, and animal waste. In 2009, 63% of Haiti’s population had access to an improved drinking water source (Salaam-Blyther, 2012). The majority of those who did not have access to an improved drinking water source lived in rural areas. The statistics for access to sanitation facilities were worse. Only 17% of the total population had access to improved sanitation facilities, and those who did not lived in rural areas (Salaam-Blyther, 2012).

**Zimbabwe**: Zimbabwe is a land-locked, low-income country located in southern Africa. It is bordered by Botswana, Mozambique, South Africa, and Zambia. At the turn of the 21st century, Zimbabwe entered into spiraling political and civil instability that heavily affected aid workers and political opponents. It also affected white landowners who had historically controlled the majority of the arable land and water resources. In addition to a collapsing economy, the country’s healthcare and public health systems began to deteriorate in the midst of the turmoil (International Coalition for the Responsibility to Protect (ICRtoP), n.d.). On top of a surge in the number of HIV/AIDS cases, there was a mass exodus of health professionals and international aid (ICRtoP, n.d.).

Even though in 2007 roughly 70% of the population lived below poverty, 69% of Zimbabwe’s rural population and 98% of its urban population had access to an improved drinking water source. The statistics for access to sanitation facilities were less favorable. Fewer than 40% of the total population, which at the time was 12.74 million, had access to improved
sanitation facilities. Of the population who did not have access to improved sanitation facilities, more than half lived in urban areas (The World Bank Group, 2015).

**Methods**

Haiti and Zimbabwe were chosen as comparative targets because of similarities in five primary areas:

1. Socioeconomic factors
2. Political instability
3. Use of improved sanitation facilities and improved drinking water sources
4. Cholera outbreak history (2000 to present)
5. Disaster occurrence – manmade or natural

In conjunction with these factors, the frameworks for assessing risks and detecting outbreaks that were previously outlined served as guidelines for data collection and review. Data were reviewed and analyzed based on their influence of cholera outbreak in each country. Types of data selected for each country include:

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Research Questions and Themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Socioeconomic</td>
<td>What is the country’s socioeconomic background, i.e. low-income or high income, level of corruption, and human development?</td>
</tr>
<tr>
<td>Influence of political instability</td>
<td>Has political stability influenced and/or increased the country’s risk of a cholera outbreak? If so, how?</td>
</tr>
<tr>
<td>Access to healthcare</td>
<td>Does the country have a reliable access to healthcare with the recommended a physician density to meet population needs?</td>
</tr>
<tr>
<td>Influence of natural or man-made disaster</td>
<td>Has a natural or man-made disaster increased the risk of a cholera outbreak? If so, how?</td>
</tr>
<tr>
<td>Cholera</td>
<td></td>
</tr>
<tr>
<td>Cholera history</td>
<td>Was cholera endemic to the country?</td>
</tr>
<tr>
<td>Source of cholera</td>
<td>If non-endemic, how was cholera introduced to the country?</td>
</tr>
<tr>
<td>Outbreak detection</td>
<td>How was the outbreak detected and reported?</td>
</tr>
<tr>
<td>Outbreak confirmation</td>
<td>How was the outbreak confirmed?</td>
</tr>
<tr>
<td>Measures to control spread</td>
<td>What measures, if any, were implemented to control the spread of the disease?</td>
</tr>
</tbody>
</table>
Data for this case study were collected via primary, secondary, and grey literature reviews. PubMed, Google Scholar, and Google were the primary database and search engines used to collect data. Reference lists and bibliographies of cited materials also served as research instruments. Sourcing from these locations will provide a higher level of data accuracy. Reporting factual data and sampling a sufficient sample size of literature for comprehensive research will combat data bias.

The following is a list of keywords and phrases that were used to compile this review:


**Results**

*Cholera Risk Assessment.*

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Living conditions of the affected population</td>
<td>Low-income country</td>
<td>Low-income country</td>
</tr>
<tr>
<td>(including socioeconomics factors)</td>
<td>High corruption</td>
<td>High corruption</td>
</tr>
<tr>
<td></td>
<td>Low human development</td>
<td>Low human development</td>
</tr>
<tr>
<td>Underlying nutritional status and immunization coverage</td>
<td>Chronic malnutrition</td>
<td>Undernourished</td>
</tr>
<tr>
<td>among population</td>
<td>Natural population immunity</td>
<td>No natural population immunity</td>
</tr>
<tr>
<td></td>
<td>No immunization coverage</td>
<td>No immunization coverage</td>
</tr>
<tr>
<td>Degree of access to healthcare (physician)</td>
<td>0.06 - 0.16 per 1,000 population</td>
<td>0.25 per 1,000 population</td>
</tr>
<tr>
<td></td>
<td>Ineffective case management</td>
<td>Ineffective case management</td>
</tr>
</tbody>
</table>
Table 1. Cholera risk factors for Zimbabwe and Haiti

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Zimbabwe</th>
<th>Haiti</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessibility of safe water and adequate sanitation facilities</td>
<td>Water: 81%</td>
<td>Water: 63%</td>
</tr>
<tr>
<td>(percentage of population with access)</td>
<td>Sanitation: 46%</td>
<td>Sanitation: 17%</td>
</tr>
<tr>
<td>Recent deterioration of water and sanitation conditions by natural or man-made disaster</td>
<td>Yes, Civil instability and economic collapse</td>
<td>Yes, Earthquake</td>
</tr>
<tr>
<td>Endemic and epidemic diseases that are common in the affected area</td>
<td>Endemic and epidemic to cholera</td>
<td>Non-endemic and non-epidemic to cholera</td>
</tr>
<tr>
<td>Strains: <em>Vibrio cholerae</em> O1 serotype Ogawa biotype El Tor</td>
<td><em>Vibrio cholerae</em> O1 serotype Inaba biotype El Tor</td>
<td></td>
</tr>
<tr>
<td>Introduction of workers from cholera endemic countries to an area with poor standard water and sanitation</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 1 provides a high-level, side-by-side comparison of the cholera risk factors for both Haiti and Zimbabwe. In order to establish their impacts, a more thorough review of each factor is necessary.

**Living conditions of the affected population (including socioeconomics factors).**

During their respective years of cholera outbreaks, Zimbabwe and Haiti had low human development indices (HDI). HDI, which ranges from 0.0 – 1.0, is a “summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living” (United Nations Development Programme, 2015). In 2008, Zimbabwe had an HDI of 0.422, and, in 2010, Haiti’s was 0.462 (United Nations Development Programme, 2015). Both Haiti and Zimbabwe were low-income countries with gross national incomes per capita of $1,045 or less. According to the corruption perception index (CPI), which measures the perceived corruption of a county, both countries had high corruption. The corruption perception index ranges from 0 – 10, with 0 being highly corrupt.
and 10 being highly clean. In 2008, Zimbabwe had a CPI of 1.8. In 2010, Haiti had a CPI of 2.2 (Transparency International, 2015). In general, corruption threatens a country’s economic development abilities. According to Labelle, corruption and poverty go hand-in-hand (2013). In regions where there is high corruption, there tends to be high rates of poverty.

Underlying nutritional status and immunization coverage among population.

As reported by WHO (2011), 58% (2006) of the Haiti’s population was undernourished, and 47% (2006) of Zimbabwe’s population was chronically malnourished. There is a direct correlation between nutrition and infection. Undernutrition and malnutrition are linked to decreased immune function, which increases ones susceptibility to infectious disease, especially diarrhea-related infectious disease (Katona & Katona-Apte, 2008). While neither country had prior cholera vaccinations, Zimbabwe did have some natural population immunity due to the fact cholera is endemic to the region. By contrast, Haiti had no natural population immunity because cholera had not been in the country for over a century (Clemens, 2011).

Degree of access to healthcare (physician density) and to effective case management.

With an estimated physician to population ratio of 0.25 per 1,000 in 1998 (earliest available data), Haiti lost almost 30% of its healthcare providers to the United States and Canada between 2005 and 2008. (Central Intelligence Agency, n.d.; Ivers, 2011). The country’s 2009 health expenditures were 6.7% of its gross domestic product (GDP) (The World Bank Group, 2015). In 2007, Zimbabwe had an estimated 0.16 physicians per 1,000 population (Zanamwe & Devillard, 2010; The World Bank, 2015). By 2009, this number had decreased to 0.06 physicians per 1,000 population (Central Intelligence Agency, n.d.). Data indicated that in 2001 (earliest available data), Zimbabwe spent approximately 0.67% of its GDP on health expenditures (Health Finance and Governance (HPG) Project, 2013).
The WHO suggests fewer than 2.3 healthcare workers per 1,000 would be inadequate to meet basic healthcare needs (Central Intelligence Agency, n.d). While this includes all healthcare workers – physicians, nurses, and midwives – both Haiti and Zimbabwe had severe provider shortages, which made case management a challenge.

Availability of safe water and adequate sanitation facilities.

Haiti’s struggle with achieving countrywide improved water and sanitation has been ongoing since the beginning of the 20th century. Recognizing the country’s need for assistance in achieving this goal, international aid and technical assistance began flowing into the country as early as 1915 with the United States committing resources to improving water supplies and sanitation (Gelting, Bliss, Patrick, Lockhart, & Handzel, 2013). After decades of attempts by the international community, efforts were thwarted in the 1970’s due to political strife under the ruling of Jean-Claude Duvalier. At the time of Duvalier’s collapse and transition to a new regime in the late 1980’s to early 2000’s, achieving any gains on improving sanitation and water in Haiti was a challenge (Buss & Gardner, 2006).

Even though international funding still trickled in to the country, it was not until 2006 that any meaningful progress was made in Haiti. The country experienced a substantial increase in international aid (Buss & Gardner, 2006). In 2009, improving water and sanitation were at the top of the country’s reformation agenda, which the country desperately needed. Per the Salaam-Blyther (2012), 63% of the population had access to improved drinking water sources, and only 17% of the population had access to improved sanitation.

Unlike Haiti, Zimbabwe was applauded in the late 1980’s for the gains it made with providing access to safe, well-maintained, drinking water sources for 84% of its population (Musemwa, 2008). This accolade was short-lived as the result of economic and political
instability in the early 2000’s. Per the WHO (2011), in 2006, 81% of the population had sustainable access to improved water sources, and 46% of the population had proper sanitation facilities.

*Recent deterioration of water and sanitation conditions by natural or man-made disaster.*

Haiti had a long history of insufficient water and sanitation conditions. Efforts to bolster the countries water and sanitation services were underway when the country was hit by a 7.0 magnitude earthquake in January 2010, which ravaged the nation. As a result, all efforts were halted as aid went to try and stabilize a crippled country.

Zimbabwe’s water and sanitation conditions deteriorated as a result of neglect due to civil and economic instability over the course of a few years. Zimbabwe gained its independence in 1980, and for the next 20 years was able to reasonably sustain the economic and public health needs of the country. The 1990s brought a growing population, as well as drought that affected the country’s agriculture (Cohen, 2013). Agriculture had been the pillar of Zimbabwe’s economy, as well as one of the main objects of its economic decline in 2000. This decline started with the introduction of the Land Acquisition Act by the poorly managed, corrupt government of Zimbabwe. The purpose of the act was to redistribute arable land from the predominantly owning white Zimbabweans farmers to black Zimbabwean farmers. Successful implementation of the Land Acquisition Act failed for multiple reasons, one of greatest significance being the replacement of experienced white farmers with inexperienced black farmers who failed to produce sufficient crop yields. In 2008, the country reached the peak of its economic deterioration. It faced a countrywide food shortage due to failed agricultural and industrial production. Nearly 70% of the population depended on food from the international community. The country’s official unemployment rate was 94% (Mason, 2009), and its currency
was of no value. Increased social instability ensued in violence (Africa Economic Development Institute, 2009).

During this time, the country’s water system was highly political and fraught with contention. Water ownership was forcibly transitioned from majority, private, white ownership to a public resource, which was headed by the Zimbabwe National Water Authority (Youde, 2010). As a result of lack of maintenance and funding for upkeep, there was a decline in sanitation services and clean water sources. Funding that would have been used to maintain infrastructures such as public sanitation and drinking water sources had to be diverted to providing food to a chronically malnourished population (United Nations Office for the Coordination of Humanitarian Affairs, 2008). In 2005, the managing authority for the water of the country’s largest urban area was forcibly transferred from the local authority to the state government. The previously well-maintained water system fell into disrepair due to severe government mismanagement. For in the city of Harare alone, the city lost 40% of its water supply every day due to faulty pipes (Youde, 2010).

Endemic and epidemic diseases that are common in the affected area.

Cholera was both endemic and epidemic to Zimbabwe. By comparison, cholera was neither endemic nor epidemic to Haiti.

Introduction of workers from cholera endemic countries to an area with poor standard water and sanitation.

Cholera was endemic to Zimbabwe where two different strains were found to be circulating in the population – *Vibrio cholerae* O1 serotype Ogawa biotype El Tor and *Vibrio cholerae* O1 serotype Inaba biotype El Tor (Islam et al., 2011). However, cholera was introduced to Haiti by infected foreign workers from a cholera endemic country who were in
Haiti to support humanitarian relief efforts after the earthquake.

*Overall risk assessments.*

Based on the risk assessment factors, the risk of cholera in Haiti appeared to be low. This was mainly attributed to the fact the country had not seen cholera in a century. Conversely, the threat of cholera in Zimbabwe was high, mainly as a result of the history of cholera in the country and the state of the country’s water and sanitation facilities.

*Outbreak detection.*

<table>
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<tr>
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<tbody>
<tr>
<td>At the beginning, what alerted people to the possibility of an outbreak?</td>
<td>118 reported cholera cases St. Mary’s and Zengeza wards on August 20, 2008</td>
<td>Patients with severe diarrhea who were admitted to hospital in Mirebalais on October 17, 2010.</td>
</tr>
<tr>
<td>How were the first cases notified for health authorities?</td>
<td>Notification were made via reported surveillance data</td>
<td>Notification to the Haitian Ministry of Public Health and Population of patients presenting with severe diarrhea in the Artibonite and Centre Departments</td>
</tr>
<tr>
<td>On what basis was it decided that it was an outbreak?</td>
<td>Increased number of cases based on country surveillance data as reported by the Ministry of Health and Child Welfare</td>
<td>Pathogen analysis and confirmation of stool samples from admitted patients</td>
</tr>
<tr>
<td>How long did the information take to reach decision-making level from the area where the outbreak occurred?</td>
<td>Varied - depending on region of outbreak and surveillance capabilities</td>
<td>Approximately two days</td>
</tr>
<tr>
<td>What were the first actions taken at the central level?</td>
<td>Establish cholera treatment centers and units Restore Zimbabwean health sector Provide water treatment chemicals for heavily impacted metro areas Repair dilapidated water, sanitation, and hygiene programs</td>
<td>Increase access to oral and IV rehydration Improve access to safe water, sanitation, and hygiene supplies Establish national surveillance Establish treatment management and prevention strategies</td>
</tr>
</tbody>
</table>

Table 2. *Outbreak detection for Zimbabwe and Haiti*
Table 2 presents a side-by-side comparison of the outbreak detection criteria for Zimbabwe and Haiti. In order to determine their impacts, a more thorough review of each criterion is necessary.

At the beginning, what alerted people to the possibility of an outbreak?

Prior to the 2008 outbreak in Zimbabwe, there were a few minor outbreaks (Appendix III). On August 20, 2008, 118 cholera cases were reported in the regions of the St. Mary’s and Zengeza wards (Mason, 2009). This case load alerted authorities to a potential outbreak.

In Haiti, patients with severe diarrhea were admitted to the hospital in Mirebalais on October 17, 2010. The patients were admitted to the hospital after preparing the body of a family member who had recently had a rapid onset of watery diarrhea. Days earlier, the deceased had bathed and drank water from the Latem River, which is fed by the Meye River (Ivers & Walton, 2012).

How were the first cases notified for health authorities?

The cases in Zimbabwe were reported to authorities by way of routine surveillance data reporting. Diarrheal patients presenting with diarrhea in the Artibonite and Centre Departments were reported to the Haitian Ministry of Public Health and Population on October 19, 2010. (CDC, 2011).

On what basis was it decided that it was an outbreak?

Because of inconsistent countrywide data, baseline cholera rates for Zimbabwe were indeterminate. Also, surveillance data from different districts were unreliable and infrequent. As a result, a true assessment of Zimbabwe’s outbreak status was a challenge (WHO, 2008). It also made it challenging to confirm that an outbreak was underway in August. It was not until the November to December 2008 timeframe when the number of confirmed cholera cases surpassed 11,000 that an outbreak was confirmed using surveillance data from the Ministry of
Given that cholera was not endemic to Haiti, the presence of a single case would have represented an outbreak in the country. On October 21, 2010, an analysis of the pathogen from the stool samples patients in the Artibonite region returned the presence of the *Vibrio cholerae* bacteria. On October 22, 2010, a cholera outbreak was declared in Haiti (CDC, 2011).

How long did the information take to reach decision-making level from the area where the outbreak occurred?

Because of the reporting habits of surveillance data from each district in Zimbabwe, the time it took for information to reach decision-making level varied, from two to twenty-one days. (WHO, 2008). While, in Haiti, it took approximately two days for the information to reach the decision-making level.

What were the first actions taken at the central level?

The political and economic climates in Zimbabwe were too unstable for the country to address the outbreak on its own. Through collaborative efforts of the government of Zimbabwe, United Nations International Children’s Emergency Fund (UNICEF), WHO, and support from the international community, Zimbabwe received funding and resources that were targeted to four primary actions: (1) enhance and increase cholera treatment centers and units, (2) restore the Zimbabwean national health sector, (3) provide water treatment chemicals for heavily impacted metro areas, and (4) repair dilapidated water, sanitation, and hygiene programs (WHO, 2009).

Many response actions were required in Haiti since cholera was previously unknown to the region and the nation was in such a fragile state after the earthquake. The main four actions in response to the cholera outbreak were to (1) increase access to oral and IV rehydration therapies, (2) improve access to safe water, sanitation, and hygiene supplies, (3) establish a
national surveillance system for timely case reporting, and (4) establish treatment management strategies for existing cases and prevention strategies to help prevent cholera (CDC, 2010).

An expanded view of Haiti’s outbreak detection.

Per the CDC, for a cholera outbreak to occur in Haiti, two conditions had to be met: “(1) there must be significant breaches in the water, sanitation, and hygiene infrastructure used by groups of people, permitting large-scale exposure to food or water contaminated with *Vibrio cholerae* organisms; and (2) cholera must be present in the population” (CDC, 2011). Both of these conditions were met in Haiti. In October 2010, cholera was introduced to Haiti by human activity in the form of international aid in support of earthquake recovery. Epidemiological and molecular analysis revealed the responsible strain was *Vibrio cholerae*, serogroup O1, serotype Ogawa, biotype El Tor (CDC, 2012). This strain was similar to strains found in Southeast Asia, where a cholera outbreak had recently occurred (Lantagne, D., Nair, G., Lanata, C., & Cravioto, A., 2014). Evidence suggested that Nepalese Peacekeeping soldiers introduced the bacteria to the freshwater supply at the Meye Tributary of the Artibonite River in early October. The bacteria eventually spread downstream and throughout Haiti (Appendix IV). The Artibonite served as an ideal reservoir for the growth and proliferation of *Vibrio cholerae*. (Lantagne, D., Nair, G., Lanata, C., & Cravioto, A., 2014). The need for water for cooking, drinking, dishwashing, laundry, and bathing promoted the use of cholera-contaminated water sources in and around the Artibonite River. Because of cholera’s relative short incubation period many people became infected with the disease within days of the Artibonite River being contaminated. Since cholera causes explosive diarrhea, more people used open waterways to defecate (Kean, 2014), which further exacerbated the spread of the disease (Appendix III).

Given its proximity to the source of the outbreak, the greatest number of cases occurred
in the Artibonite region. Interestingly enough, there was limited spread of the disease among individuals located in the camps for the internally displaced because these individuals had access to safe water and sanitation (WHO, 2011). Overall, from 2010 through 2013, the cholera case-fatality rates were 2.22% (2010), 0.84% (2011), 0.80% (2012), and 1.04% (2013) (WHO, 2015; The United Nations, 2014). Also, over the course of this time, 6.8% of the population has had the disease (Appendix V).

*An expanded view of Zimbabwe’s outbreak detection.*

While minor outbreaks were not uncommon in Zimbabwe, the region was not prepared for the major outbreak that started in August 2008 in the city of Harare (Youde, 2010). Unlike previous outbreaks, which had often started in rural regions of the country, the 2008 outbreak started in highly populated urban centers that previously had had maintained and protected water supplies and flushable toilets (Fournier & Whittall, 2009). One of the main sources of the outbreak was the drinking water reservoirs in Harare. Not only were the reservoirs improperly chemically treated but they were also subject to contamination from the city’s sewage works and agricultural runoff (Musemwa, 2008). Within a three-month period from August to December, the number of cases went from 18 to 26,000. Three urban centers experienced the greatest number of all cases – Mashonaland West province (23%), Harare province (20%), and Manicaland (13.6%) (Appendix VII). There were significant breakdowns in clean water supplies and sewage disposal in these urban centers (Mason, 2009). Prolonged water cutoffs became common occurrences in the suburbs of the country’s densely populated capital city of Harare (Dugger, 2008). The countrywide spread of cholera was fueled by the fact that Zimbabwe was one of few countries where 27% of the population practices open defecation (WHO and UNICEF, 2012). Due to lack of reliable water supplies and functioning sewage and sanitation,
many Zimbabweans openly defecated outdoors, where contaminated fecal matter spread the
disease through open sewage. At its peak in 2009, the reported number of cholera cases reached
over 68,000 cases (Appendix VI). The case-fatality rates for 2008 and 2009 were 4.88% and
1.38%, respectively. Over the course of the outbreak, approximately 1% of the population was
affected (Appendix V).

Discussion

Low socioeconomics and civil instability proved to be confounding factors that led to the
proliferation of cholera in both Haiti and Zimbabwe. While Haiti has had a long history of low
socioeconomics and civil instability, Zimbabwe’s was shorter in comparison. At one point,
Zimbabwe was considered a breadbasket of Africa (Orlet, 2005), an accolade Haiti has never
claimed to have in the Americas. However, economic collapse and civil instability, in any
setting, open the door for a decline in basic public health infrastructures and ultimately the
introduction of disease.

Because cholera was unintentionally introduced to Haiti by way of human activity, it was
able to quickly manifest to an outbreak level due the country’s lack of improved sanitation and
clean drinking water sources exacerbated by a natural disaster. Not only did the country lack
these resources, but also in many regions of the country, the basic infrastructure to support these
resources were not in place. The population’s strong reliance on waterways for drinking,
cooking, and bathing significantly increased exposure to the disease. More importantly, since
cholera was not endemic to the region and had not been present in more than 100 years, there
was no natural population immunity to protect against the disease.

Unlike Haiti, Zimbabwe did have improved sanitation and clean drinking water
infrastructure in place for the majority of its population in urban cities where its cholera outbreak
began. Ahmed et al. (2011) reported that the cholera outbreak in Zimbabwe served as an example of “how man-made disasters can cause degradation in the quality of life to the destruction of well-established and essential infrastructure” While more than 80% of the population had access to improved water sources, it was the lack of maintenance and breakdown of this infrastructure that led to the proliferation of cholera in a country where the disease was endemic (Ahmed et al., 2011). By definition, since the water sources were no longer protected and thusly contaminated, they were, in fact, unimproved sources. Data from Appendix VI show the country had, at a minimum of, 65 reported cases annually since 2000. Interestingly enough, the 65 cases occurred the year prior to Zimbabwe’s economic collapse. The year 2008 saw a significant spike in the number of reported cases. This suggests that even in a country where cholera is endemic and open defecation is practiced, the country was able to control the spread of cholera with proper sanitation and clean drinking water infrastructures in place.

When comparing the dynamics between each country, both countries have the same strain of cholera in its respective populations – *Vibrio cholerae*, serogroup O1, serotype Ogawa, biotype El Tor. Zimbabwe, however, has an additional strain – *Vibrio cholerae*, serogroup O1, serotype Inaba, biotype El Tor. The outbreak in Haiti has had a considerably higher impact on the Haitian population as compared to Zimbabwe. Over the span of the outbreak almost seven percent of the Haitian population has been impacted, whereas only one percent of the Zimbabwean population has been affected. Also, since Zimbabwe did have water and sanitation infrastructure in place, albeit not properly maintained, it was able to quickly gain control of the outbreak with the support of international aid which reestablished the health sector and repaired the water, sanitation, and hygiene infrastructure. On the other hand, because Haiti did not have a reliable water and sanitation program in place prior to the outbreak, stopping cholera has yet to
be achieved, despite continued aid support.

There are limitations that need to be taken into consideration with this comparative case study. The first limitation is accuracy of the actual number of cholera cases in each country. The literature reviewed reflects the number of reported cases of cholera. However, both countries have large rural populations where confirmed cases may go unreported. A second limitation of this case study is the impact open defecation had on environmental contamination and the spread of disease in Zimbabwe. Additional epidemiological research is required to determine whether or not open defecation was a major contributor to the spread of cholera in Zimbabwe. A third limitation is related to the impact of the dual strains of cholera that are endemic to Zimbabwe. Additional research would be required to determine if either of the two or both strains were introduced to the region from another cholera endemic region. Additional research would also have to be conducted to determine which strain contributed to more cases.

**Conclusion**

Even though both outbreaks caused significant morbidity and mortality, the epidemiology of the disease in each country revealed different risks that influenced the way each outbreak occurred. Each country also had different outbreak detection methods. However, both outbreaks were significantly impacted by disaster and compromised water and sanitation, which occurred in each country. Zimbabwe’s disaster was manmade due to political and economic instability. Haiti’s disaster was a natural one, the result of a catastrophic earthquake, which led to an influx of foreign aid workers, some of whom were unintentional reservoirs and vectors of cholera.

Zimbabwe’s cholera has since been controlled, but Haiti’s continues. It can therefore be suggested that what separates Zimbabwe’s ability to recover and Haiti’s inability is the fact that, though inefficient, Zimbabwe did have sufficient sanitation and clean water infrastructure in
place. Haiti did not. There was also the degree of population immunity in Zimbabwe, which Haiti is just now developing, especially in children under the age of five years. Through the support of international aid, Zimbabwe was able to control its cholera outbreak by treating and repairing water supplies and improving its health sector. In order for Haiti to experience similar success, it will need to rapidly improve access to clean drinking water to its population. It will also need to improve, and in many cases, implement improved sanitation sources throughout the country.

**Leadership reflection**

Having had the opportunity to visit Haiti immediately after the earthquake, I can attest to the uphill climb the nation has to battle to get the country back on track to realize its reformation agenda to improve water and sanitation. The country still has to address corrupt leadership practices in order for the people of Haiti to reap the benefits of all of the international aid that is coming into the country. There have been significant improvements through programs launched and maintained through NGO’s such as CARE, Partners in Health (PIH), and Family Health Ministries. However, these organizations cannot meet the population needs of the entire country. It would be recommended that the newly seated Haitian president, Michel Martelly, partner with international governments and humanitarian aid organizations to design and implement programs to lift and sustain the Haitian population. Such programs should include:

- Improving access to clean drinking water and sanitation
- Implementing monitoring and surveillance programs to detect communicable diseases
- Educating and retaining Haitian health professionals to meet the country’s overall health needs
- Educate the population on the importance of keeping waterways free of human waste and
debris

- Promoting the use of good hygiene practices, such as hand washing and using clean water for food preparation and drinking

If I were partnering with the government of Haiti to implement some of these recommendations, one of the first things that I would do is improve my cultural competence (Suarez & Steffen, 2013). Improving my cultural competence would be very important in understanding cultural practices that may impede program implementation. Another challenge I would take on would involve altering my leadership style and approach, which are polar opposite than most I encountered while in Haiti. In general, my leadership style is very direct and highly goal oriented. I also have the tendency to disregard the emotional aspects of leadership. In Haiti, I learned that personal relationships are highly valued. It also appeared that personal relationships needed to be established before any business relationship could be established. In order for me to make any gains in on any of these recommendations, I would have to strategically modify my leadership style and significantly improve my emotional and cultural intelligence (Fernandez, 2013).


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