A RETROSPECTIVE STUDY ON THE GEOGRAPHICAL DISTRIBUTION OF CHOLERA IN LIMPOPO PROVINCE, SOUTH AFRICA

BY

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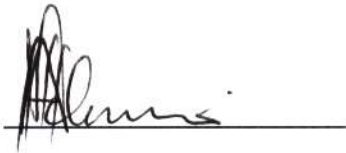SUPERVISOR: DR NJ RAMALIVHANA

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DECLARATION

"I declare that the mini-dissertation hereby submitted to the University of Limpopo, for the degree of Master of Public Health, **A retrospective study on the geographical distribution of cholera in the Limpopo Province, South Africa** has not previously been submitted by me for a degree at this university or any other university, that it is my work in design and in execution, and that all the material contained herein has been duly acknowledged"

17·05·2016

Date

DEDICATION

This study is dedicated to the families and victims of the 2008-2009 cholera outbreak in Limpopo Province. It is with their thought in mind and heart, that this study was undertaken. I hope that the study report and particularly recommendation will add value to our government's tireless endeavours to manage outbreaks of this nature. It is my wish that families of all the victims of the outbreak find comfort in the fact that their loss has touched all and sundry and laid a basis for the search of a new knowledge. May the glorious God of love enlighten the way to all of us. I further dedicate this study to a friend and brother Makoena Setati who perished as I was busy with my report, I know he so much looked forward to my completion day as the study has always been central to all our discussion. May his soul rest in peace.

With outmost love

ACKNOWLEDGEMENTS

ABSTRACT

Introduction: During mid-November 2008, eleven acute watery diarrhoea cases with the suspicion of cholera like symptoms were detected by a diarrhoea surveillance system at Musina Hospital in Vhembe district – Limpopo Province, South Africa. These cases included eight Zimbabwean and three South African citizens. Laboratory test performed on stool specimens confirmed *Vibrio cholerae serogroup 01 Ogawa* as the causative pathogen for these reported acute watery diarrhoea cases.

Within eight weeks of its onset, the outbreak spread to all the five districts of Limpopo. So far between 15 November 2008 and 01 June 2009, the cumulative number of cases of acute watery diarrhoea reported from five districts of Limpopo Province stands at 4634 including 30 confirmed cholera deaths with an overall case fatality rate of 0.65%. Of these reported cases, *Vibrio cholerae* has been laboratory confirmed in 656 samples.

Methodology: A database was received from the Limpopo Department of Health having all reported cholera cases during the 2008 and 2009 outbreak in Limpopo Province. The data was analysed using STATA statistical software version 12 for windows (STATA Corporation, College Station, Texas).

Results: The cholera affected all ages, but the geographic distribution of the disease was very heterogeneous in Limpopo Province. The highest and lowest numbers of cases were reported in Capricorn and Mopani districts, respectively. The majority of the cases 55% (N=2 542) were females. Children less than five years of age 14.2% (N=652) were less affected by the disease. About 73.8% of the cases were aged between 0 and 44 years. The first four weeks of cholera outbreak strictly included a day-to-day admixture of Zimbabweans and South Africans presenting in the health facilities. The outbreak then affected most South Africans after week five of the epidemic.

Conclusion: The cholera outbreak has affected all the five districts of Limpopo Province in South Africa, and new cases continued to be reported until first week of June 2009. There was a link between the Zimbabwean and South African cholera outbreak in Limpopo province.

DEFINITION OF TERMS

Cholera is an acute infectious disease of the small intestine, caused by the bacterium *Vibrio cholerae* and characterized by profuse watery diarrhoea, vomiting, muscle cramps, severe dehydration, and depletion of electrolytes.

Cholera case definition was categorized into three groups as illustrated in the table below:

Category	Case definition
Suspected	• In an area where the disease is not known to be present: severe dehydration or death from acute watery diarrhoea in a patient aged 5 years or more; **or** • In an area where there is a cholera epidemic: acute watery diarrhoea, with or without vomiting in a patient aged 5 years or more[1]
Probable	Not applicable
Confirmed	• A suspected case that is laboratory-confirmed.(Isolation of Vibrio cholerae O1 or O139 from stools in any patient with diarrhoea is the laboratory criteria for diagnosis)
Case counted	• Only confirmed cases for a single isolated case • All cases to be counted having epidemiological linkage[2] to a confirmed case during epidemic

Note: In a cholera-threatened area, when the number of confirmed cases rises, shift should be made to using primarily the suspected case classification.

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[1] Cholera does appear in children under 5 years; however, the inclusion of all cases of acute watery diarrhoea in the 2-4 year age group in the reporting of cholera greatly reduces the specificity of reporting. For management of cases of acute watery diarrhoea in an area where there is a cholera epidemic, cholera should be suspected in all patients.

[2] A case in which a) the patient has had contact with one or more persons who either have/had the disease or have been exposed to a point source of infection (i.e., a single source of infection, such as an event leading to a foodborne-disease outbreak, to which all confirmed case-patients were exposed) and b) transmission of the agent by the usual modes of transmission is plausible. A case may be considered epidemiologically linked to a laboratory-confirmed case if at least one case in the chain of transmission is laboratory confirmed.

V. cholerae is a gram-negative aerobic bacillus, or rod-shaped bacterium. It has two major biotypes: classic and El Tor. El Tor is the biotype responsible for most of the cholera outbreaks reported from 1961 through the early 2000s.

Outbreak in epidemiology, the occurrence of infection with a particular disease in a small, localized group, such as the population of a village. The term is sometimes used more broadly to refer to an epidemic or a pandemic

An epidemiological week: commonly referred to as an Epi-week, is simply a standardized method of counting weeks to allow for the comparison of data.

LIST OF ABBREVIATIONS

WHO - World Health Organisation

DFBMD - Division of Foodborne, Bacterial and Mycotic Diseases

CDC – Centre for Disease Control

OCV - Oral Cholera Vaccine

CWH - Community Health Worker

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CHAPTER 1: INTRODUCTION

1 INTRODUCTION

1.1. Background and motivation

Cholera is an acute form of diarrheal disease that overwhelmed human development (Ghose & Asoke, 2011) and it has caused morbidity and mortality in poorest areas of the world (Zuckerman et al., 2007; Griffith et al., 2006). There are still countries which experience the re-emergence of cholera outbreaks and the burden of this disease is underestimated or non-estimated (Zuckerman et al., 2007; Deen et al., 2008). Sub-Saharan African countries are especially affected, with 95% of reported cholera cases and 98% of deaths (WHO, 2006). Cholera emerges under poor hygiene and sanitary conditions; thus, the lack of basic services and disorganized urbanization in many Sub-Saharan African countries constitutes the perfect culture medium for cholera (Zuckerman et al., 2007).

John Snow, one of the founders of modern epidemiology, showed the importance of descriptive epidemiology in cholera epidemics, emphasizing the importance of "place", or the consideration of space, to target prevention and control activities (150th Anniversary of John Snow and the pump handle 2004). Today, although resources and tools for mapping are available, the description of place in cholera epidemics remains poor and examples of studies using spatial technologies in the medical literature are limited (Myaux et al.,1997; Ali et al., 2002b; Waldman et al., 2002; Chevallier et al., 2004; Ali et al., 2006a; Osei & Duker 2008a; Sasaki et al., 2008; Bompangue et al., 2009).

The objective of this study was to describe the cholera epidemic affecting Limpopo Province from 2008 to 2009 focusing on 'place' in order to guide prevention and control activities. This study aimed at assisting in the understanding, predicting, and controlling outbreaks of waterborne diseases as this is very crucial for informing public health policies.

1.2. Problem statement

During mid-November 2008, increase in acute watery diarrhoeal cases with the suspicion of cholera like symptoms were detected by a surveillance system at Musina Hospital in Vhembe district – Limpopo Province, South Africa. These cases included Zimbabwean and South African citizens and laboratory tests performed on

stool specimens confirmed *Vibrio cholera serogroup 01 Ogawa* as the causative pathogen for these reported acute watery diarrhoea cases.

1.3. Research question

The overall research question to be answered in this study was "How were the cholera cases during the 2008/2009 outbreak in Limpopo Province epidemiologically distributed"?

1.4. Aim of the study

The aim of the study was to review the epidemiology of cholera in Limpopo Province, South Africa.

1.5. Objectives of the study

The specific objectives of the study were:

- To describe the cholera epidemic affecting Limpopo Province from 2008 to 2009 focusing on place in order to guide prevention and control activities
- To conduct Cluster analysis in order to obtain more detailed information about the distribution of cases in the most affected area within the province.

1.6. Organisation of the dissertation

This dissertation is organized into five chapters and the details of each chapter of the study are presented as follows:

- **Chapter 1** comprises of introduction, aim of the study, the research question, objectives of the study and the organization of the dissertation.

- **Chapter 2** is the general literature review and it is sub divided into specific sections which are: the introduction about cholera, global perspective on cholera, cholera in African region, cholera in South Africa, cholera in Limpopo Province, infectivity and severity of cholera, transmission of cholera as secondary cases, public health interventions to control cholera

- **Chapter 3** presents the methodologies used for the study

- **Chapter 4** presents the findings of the study

- **Chapter 5** presents the general discussion of the findings of the overall study and their public health implications for control of cholera in rural areas.

CHAPTER 2 LITERATURE REVIEW

2.1. Introduction

Cholera is an acute, enteric diarrhoeal disease caused by infection of the intestine with the bacterial pathogen *Vibrio cholerae* serogroup O1 or O139 (DFBMD 2008; Kelly-Hope et al., 2008). The disease is transmitted via the fecal-oral route and as well as person-to-person contact (DFBMD 2008; Kelly-Hope et al., 2008; Gaffga, 2007). Cholera infection is often mild or without symptoms, but sometimes it can be severe (DFBMD, 2008; Kelly-Hope et al., 2008). About 1 in 20 infected persons will have a severe disease characterized by acute onset of watery diarrhoea, vomiting and leg cramps (Gaffga, 2007). Rapid loss of body fluids due to cholera toxin leads to dehydration, electrolyte disturbances and hypovolemic shock. If left untreated, up to 50% of patients with severe disease progress rapidly (in hours) to death (Gaffga, 2007, Nelson et al., 2007). Despite the dramatic reduction of mortality rates due to the development of oral rehydration solution, the emergence of multiple drug-resistant *V. cholerae* may reduce the efficacy of antimicrobial treatment and alter the dynamics of outbreaks (Nelson et al., 2007).

Cholera has gained both global and public health attention as it is rapidly transmitted (Osei & Duker 2008a; WHO 2009).The disease has claimed many lives throughout history and continues to be a global threat, especially in African countries (Osei & Duker 2008a; Stine et al., 2008; WHO 2009). Between 1999 and 2005, there were over 1 million reported cholera cases and over 28 000 reported deaths worldwide. Africa alone accounted for about 90% of the cases and 96% of the deaths reported globally (Osei & Duker, 2008a).The World Health Organization (WHO) reported in 2006 that 236 896 cases of cholera occurred in 52 countries, a 79% increase over 2005. The disease has therefore been listed as one of three internationally quarantinable diseases by the WHO, along with plague and yellow fever (Osei & Duker 2008a).

In addition to human suffering and lives lost, cholera outbreaks have been known to disrupt the social and economic structure of communities and obstruct development in affected areas (Osei & Duker 2008b). The causal agent of epidemic cholera can persist indefinitely in marine, estuarine and riverine environment (Nelson et al., 2007). In developing nations, transmission commonly occurs through the consumption of contaminated water (Nelson et al., 2007). The highest infection rates and outbreaks are prominent in areas where the standards of living, water supply,

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and human behaviors related to personal hygiene and food preparation are poor (Nelson et al., 2007). Ensuring universal access to safe drinking water, adequate sanitation and the practice of good hygiene is necessary to prevent widespread cholera transmission (Nelson et al., 2007).

2.2. History of Cholera

Throughout history, populations all over the world have sporadically been affected by devastating outbreaks of cholera. Medical history suggests Ganges (river) delta in Indian sub-continent is as original source of cholera, from where it spread to rest of the world time to time. Records from Hippocrates (460 377 BC) and Galen (129-216) (AD) already described an illness that might well have been cholera, and numerous hints indicate that cholera like malady was also known in the plains of the Ganges river since antiquity (WHO, 2015). Looking at what cholera has done to the mankind, a detailed accounts of the history are available (Pollitzer 1959, Barua & Burrows, 1974).

Since 1817, seven cholera pandemics have spread from Asia to much of the world. It is generally accepted that first cholera pandemic occurred in nineteenth century in 1817 (Pollitzer, 1959). Second pandemic began in 1826 and reached the many European countries including United Kingdom in 1830s where the response was important in that it led to the establishment of local Boards of Health and a "Cholera Gazette", which served as a clearing house for tracking the epidemic (Rosenberg, 1962). Cholera was rampant in the United States during the third pandemic (1852-1859). Because of the large number of sickness and deaths, the disease was considered as a major public health problem requiring USA government intervention in 1866, and cholera was declared as the first reportable disease (Duffy, 1971).

John Snow in London established the fundamental epidemiological waterborne transmission of cholera between 1847 and 1854 like during late phase of the second and early phase of the third cholera pandemic. Association of contaminated drinking water and cholera disease was established even before the discovery of bacteria (Snow et al. 1936). During 1863-1875 the fourth cholera pandemic spread mostly in Europe and Africa. It killed several thousand people (Eastern European Plagues and

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Epidemics 1300-1918).1881-1896 the fifth cholera pandemic; According to report by Wall, the pandemic cost several hundred s thousands lives in Europe and Americas. Sixth cholera pandemics (1899 -1923) killed millions of people across Europe, Africa and the Americas (WHO 2008). Vibrio cholerae, a bacteria as causative organism was identified during fifth pandemic in 1884 in Kolkata, India (Koch, 1894).

The current seventh pandemic stated in 1961 in South Asia, reached Africa in 1971 and the Americas in 1991, and has involved almost the whole world, and it is still going on. Causative agent is Vibrio cholera serogroup O1 bio type El Tor. It was first isolated in 1905 at a quarantine station in village of El Tor in Egypt (WHO, 1959). Cholera is a substantial health burden on the developing world and is endemic in many parts of Africa and Asia, and has more recently become endemic in South and Central America. Outbreaks become endemic when a large proportion of the population is immune or semi-immune to infection (Sanchez et al., 1997).

2.3. Global perspective on Cholera
2.3.1. Cholera perspective in USA

In January 1991, the cholera epidemic appeared in cases among food brought back by travellers in the United States (Sack et al, 2004). Cholera has been very rare in industrialised nations for the last 100 years, however, the disease is still common today in other parts of the world, including Indian subcontinent and Sub-Saharan Africa. Although cholera can be life threatening, it is easily prevented and treated (Newton et al, 2011). In the United States, because of advanced water and sanitation systems, cholera is not a major threat, however everyone especially travellers, should be aware of how the disease is transmitted and what can be done to prevent it. Shellfish eaten raw have been a source of cholera and a few persons in the United States have contracted cholera after eating raw undercooked shellfish from the Gulf of Mexico (King et al, 2008).

In the United States, cholera was prevalent in the 1800s but has been virtually eliminated by modern sewage and water treatment systems (Newton et al, 2011). However as a result of improved transportation more persons from United States travel to parts of Latin America, Africa or Asia where epidemic cholera may be exposed to cholera bacterium. In addition, travellers may bring contaminated

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seafood back to the United States, foodborne outbreaks have been caused by contaminated seafood brought into this country by travellers (Sack et al, 2004)

Cholera is transmitted by the faecal-oral route. In the United States and other developed countries, because of advanced water and sanitation systems, cholera is not a major threat. Nevertheless, both clinicians and members of the general public, especially travellers should be aware of how the disease is transmitted and what can be done to prevent it (King et al, 2008).

In the U.S.A., cholera has virtually been eliminated because of improved hygiene and sanitation systems. Individuals living in the United States most often acquire cholera through consumption of undercooked seafood from the Gulf Coast or foreign waters. Between January 1, 1995 and December 31, 2000, 61 cases of cholera were reported in 18 states and 2 US territories. A total of 37 were travel associated cases, the other 24 cases were acquired in the United States (Sack et al, 2004).

None of the toxigenic vibrio cholera strains associated with the US Gulf Coast have caused more than sporadic areas and small outbreaks of diarrhoea in the United States (Sack et al, 2004). In October 2005, toxogenic Vibrio cholera infection due to the consumption of contaminated and improperly cooked seafood was reported from Louisana after hurricanes Katrina and Rita (King et al, 2008). During outbreaks in countries near the U.S. such as Haiti in 2010 and Latin America in the 1990s. Cholera cases reported domestically increased. (Newton et.al, 2011).

2.3.2. Cholera perspective in European countries

The second pandemic of 1826-1837 swept across Europe starting in Russia, then moving to Poland and subsequently the rest of Europe. The disease hit Britain in October 1831 reaching London in 1832 with subsequent major outbreaks in 1841, 1854 and 1866 (Beardsley, 2000). It was through these London cases cholera has always been associated with the sea, with all of its recorded initial instances being at a seaside location. Thus the increased speed and ease of travel allowed by the industrial revolution particularly the opening of the Suez Canal and the invention of the steamboat in 1869, led to more rapid spread of the disease (Beardsley, 2000). Not only did the Industrial Revolution accelerate the disbursement of the disease around the world, but it also allowed for more rapid and devastating outbreaks when

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it reached Europe. Once in continental Europe, cholera quickly spread along major waterways and later railways (Pike, 2007). The disease subsequently reached the large and quickly growing industrial European cities and rapidly spread with the aid of the crowded and sanitary housing conditions and unhygienic water sources (Pike, 2007).

The more widespread third pandemic of 1841-1859 attacked the same regions as the second along with parts of South and Central Europe (Beardsley, 2000). Subsequently, there was another massive outbreak from 1863-1875 across the whole of Europe. The world continued to suffer the effects of cholera with a fifth pandemic in many parts of continental Europe. London was to escape the ravages of cholera during this pandemic because its water supply had been transformed by the building of Joseph Bazalgette's Sewage System (Beardsley, 2000).

Cholera deaths in the Russian Empire during a similar time period exceeded two million. Ten thousand British troops died during the first pandemic in 1816-1826. The cholera outbreak extended as far as the Caspian Sea in Europe before receding (Hayes, 2005). The second cholera pandemic reached Russia, Hungary and Germany in 1832, it killed 150,000 people in Egypt that year. In 1832, it reached London and the United Kingdom and Paris. In London, the disease claimed 6,536 victims and came to be known as "king cholera"; in Paris, 20 000 died and total deaths in France amounted to 100 000. The epidemic reached Quebec, Ontario, Nova Scotia and New York in the same year and the Pacific coast of North America by 1834 (Hayes, 2005).

Over 15 000 people died of cholera in Mecca in 1846. A two-year outbreak began in England and Wales in 1848 and claimed 52 000 lives (Kohn, 2008). In 1849, a second major outbreak occurred in Paris. In London, it was the worst outbreak in the city's history, claiming 14 137 lives, over twice as many as the 1832 outbreak. Cholera hit Ireland in 1849 and killed many of the Irish Famine survivors, already weakened by starvation and fever. In 1849, cholera claimed 5 308 lives in the major port city of Liverpool, England an embarkation point for immigrants and 1,834 in Hull, England (Kohn, 2008).

Cholera is believed to have spread from Irish immigrant ships from England, spread throughout the Mississippi river system, killing over 4.500 in St. Louis and over 3000 in New Orleans. Thousands died in New York, a major destination for Irish immigrants, cholera claimed 200.000 victims in Mexico. During this pandemic, the scientific community varied in its beliefs about the causes of cholera. In France, doctors believed cholera was associated with poverty of certain communities or poor environment. Russians believed the disease was contagious, although doctors did not understand how it spread (Wilford, 2008).

The third cholera pandemic mainly affected Russia with over one million deaths in 1852, cholera spread East to Indonesia and later was carried to China and Japan in 1854. The Phillippines were infected in 1858 and Korea in 1859. In 1859, an outbreak in Bengal contributed to transmission of the disease by travellers and troops to Iran, Iraq, Arabia and Russia. Japan suffered at least seven major outbreaks of cholera between 1858 and 1902. Between 100 000 and 200 000 people died of cholera in Tokyo in an outbreak in 1858-60 (Wilford, 2008). In 1854, an outbreak of cholera in Chicago took the lives of 5.5. % of the population. In 1853-1854 London's epidemic claimed 10,738 lives. The Soho outbreak in London ended after the physician John Snow identified a neighbourhood Broad street pump as contaminated and convinced officials to remove its handle. His study proved contaminated water was the main agent spreading cholera although he did not identify the contaminant. It would take many years for this message to be believed and acted upon. In Spain, over 236 000 died of cholera in the epidemic of 1854-1855 (Kohn, 2008).

The fourth cholera pandemic spread mostly in Europe, at least 30 000 of 90 000 Mecca pilgrims died from the disease and reached Zanzibar where 70 000 died in 1869-1870 (Byrne, 2008). Cholera claimed 90 000 lives in Russia in 1866. The epidemic of cholera that spread with the Austro-Prussian war in 1866 is estimated to have taken 165 000 lives in the Australian Empire, Hungary and Belgium each lost 30 000 people and in the Netherlands, 20 000 perished. In 1867, Italy lost 113 000 lives (Byrne, 2008).

In London, June 1866, a localised epidemic in the East end claimed 5 596 lives, just as the city was completing construction of its major sewage and water treatment systems, the East end section was not quite complete (Kohn, 2008). A minor

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outbreak occurred at Ystalyfera in South Wales caused the local water works using contaminated canal water workers associated with the company and their families were the most affected and 119 died. In the same year, more than 21 000 people died in Amsterdam, Netherlands. In the 1870s cholera spread in the United States as an epidemic from New Orleans along the Mississipi River and to parts on its tributaries, thousands of people died (Unruh, 1993).

The fifth cholera pandemic, the 1883-1887 part of the epidemic cost 250 000 lives in Europe. Cholera claimed 27 890 lives in Russia and 120 000 in Spain 90 000 in Japan and over 60 000 in Persia (Glanz and Grady, 2007). Although the city government was generally held responsible for the virulence of the epidemic, it went largely unchanged. This was the last serious European cholera outbreak, as cities improved their sanitation and water systems (Beardsley, 2000).

The sixth cholera pandemic had little effect in Western Europe because of advances in public health, but major Russian cities and the Ottoman Empire were particularly hard hit by cholera deaths. More than 500 000 people died of cholera in Russia from 1900 to 1925, which was also a time of social disruption because of revolution and warfare (Hayes, 2005). Cholera is well known in Europe and European countries are well equipped to address it. Cholera bacteria when introduced in an unsanitary environment can spread easily and the disease would not spread further if access to clean water and safe sanitation is ensured (Wilford, 2008).

2.3.3. Cholera perspective in Asia/South East Asia

First cholera pandemic (1817-24) also known as first Asiatic cholera pandemic or Asiatic cholera began near Calcutta and spread throughout South East Asia to the Middle East, Eastern Africa and Mediterranean Coast. This was the first of several cholera pandemics to sweep through Asia and Europe during the 19th and 20th centuries. The first pandemic spread over an unprecedented range of territory, affecting almost every country in Asia (Bharati et al, 2014).

Cholera was endemic to the lower Ganges River. At festival times, pilgrims frequently contracted the disease there and carried it back to other parts of India on their returns, where it would spread then subside. In 1824, transmission of the disease ended. Some of the researchers believe that may have been due to the cold winter, which would have killed the bacteria in the water supplies (Bharati et al,

2014).The movement of British Army and Navy personnel is believed to have contributed to the range of the pandemic. Hindu pilgrims carried cholera within the subcontinent as had happened many times previously, but British troops carried it overland to Nepal and Afghanistan. The Navy and merchant ships carried people with the disease to the shores of the Indian Ocean, from Africa to Indonesia, and north of China and Japan (WHO, 2005).

2.3.4. Cholera perspective in China

Epidemics and pandemics of cholera, a severe diarrhoea disease, have occurred since early 19th century and waves of epidemic disease continue today. Cholera epidemics are caused by individual genetically monomorphic lineages of vibrio cholera the on-going 7th epidemic, which has spread globally since 1961, is associated with lineage L2 of biotype EIT (Didelot et al, 2015).

Nine people were diagnosed with cholera in Hubei province in Central China. The victims of this outbreak all attended a wedding on which officials believe to be the source of the outbreak. Cholera is caused when a person becomes infected with bacterium vibrio cholera symptoms of the disease include diarrhoea vomiting, dehydration, which can lead to death. However, only 5-10 percent of people infected with the bacteria will experience symptoms (Didelot et al, 2015).

2.3.5. Cholera perspective among Islanders

Throughout history, only few pathogens have made historical impacts on human health. One of these is cholera caused by bacterium vibrio cholera, this potentially fatal disease has caused more pandemic than influenza, plague and smallpox. The most recent, the 7th, occurred in the 1960s when many parts of Asia suffered for four agonizing years (Tetro et al, 2015).

Cholera has been for the most part controlled and limited to only a few places such as Bangladesh and Haiti. In the context of cholera, changes in climate are stressors on microbes forcing them to either die off or figure out means to adapt to the conditions (Tetro et al, 2015). In Bangladesh, this has been shown through the evolution of the classical strain to one known as El T or. This particular strain relies less on seasonality and occurs more frequently.

The overall result is a year round threat of infection as opposed to only during rainy season (Tetro et al, 2015).

2.4. Cholera in African region

Africa is endemic for cholera and frequently affected by outbreaks and epidemics, but there are few molecular epidemiology studies characterizing the determinants of these episodes (Marin et.al, 2013).The African region has replaced the Indian sub-continent as the new home of *V. cholerae*. The seventh cholera pandemic that originated in Asia reached Africa in the early1970s. In 2001 there were more than 170,000 reported cases of cholera, which represented 94% of the globally reported cases. From these, 2,590 people died. Nearly all countries in Sub-Saharan Africa now regularly reported cases of cholera (Utsalo & Antia-Obong 1991).

The current millennium has seen a steep rise in the number, size and case-fatalities of cholera outbreaks in many African countries. Over 40,000 cases of cholera were reported from Nigeria in 2010. Variants of Vibrio cholerae O1 El Tor biotype have emerged but very little is known about strains causing cholera outbreaks in West Africa, which is crucial for the implementation of interventions to control epidemic cholera (Marin et.al 2013). Cholera was introduced 20 years ago to Africa, where it spread rapidly to 30 of the 46 countries of the region and by 1990 accounted for 90% of all cases reported to the World Health Organization (Glass et al., 1991).

Cholera largely eliminated from industrialized countries by water and sewerage treatment over a century ago, still remains a significant cause of illness and death in many African countries. In the 21st century, sub-Saharan Africa bore the brunt of global cholera. The region is broadly affected by many cholera cases and outbreaks that can spread across countries (Ali et al, 2012). The percent of people who die from reported cholera cases remains higher in Africa than elsewhere. This reflects the lack of access to basic health care because of cholera's simple treatment of rehydration therapy (Ali et al, 2012). Many African countries face the dual challenges of improving both cholera treatment access to basic health care, and sanitation improved water and sanitation systems. Improving global access to water, sanitation and hygiene is a critical step to reducing Africa's cholera burden.

2.4.1. Cholera in Cameroon

On the 6th May 2010, suspect cholera cases were reported from the district of Makary in the Far North region of Cameroon. By October in the Far North region, most burdened by the epidemic, 7,822 cases and 518 had been confirmed. Centers for Disease Control (CDC) was invited by Cameroon Ministry of Public Health as well as WHO to provide technical assistance during the cholera epidemic (Cartwright et al, 2013).

Cholera reached the Coast of Cameroon in February leading to 2167 cases according to reports by WHO. This was followed by a 20 year period characterised by sporadic disease clusters. Like the other countries, in Lake Chad Basin, cholera outbreaks in Cameroon occurred seasonally in specific regions and among specific populations. The cholera burden in Cameroon has increased during the past two decades, increase between 1991 and 2010 with 4026 cases in 1991, 5796 in 1996, 8005 in 2004, and 10759 in 2010 (Cartwright et al, 2013).

2.4.2. Cholera in Kenya

In 2009, multiple areas in Kenya experienced cholera outbreaks. The Kenya Ministry of Public Health and sanitation-Division of Disease Surveillance and Response requested CDC technical assistance to provide assistance with describing epidemiology of outbreaks in Kenya nationally during 2009-2010 to evaluate water quality in select Nairobi informal settlements (Mohammed et al, 2012).

New cases of cholera continue to emerge following an outbreak that was picked by surveillance system in the last week of December 2014 in Nairobi. A total of 21 countries have so far reported cases, and while some of these have successfully controlled the outbreak, a number of countries such as Kirinyaga, Embu, Baringo and Migori have reported new cases after successfully controlling the 1st wave of outbreak and declared as cholera free (Mohammed et al, 2012).

A cholera outbreak has affected 21 out of 47 countries since December 2014. With close to 7000 cases and over 100 deaths the epidemic needs to be contained, especially in light of the expected El Nino floods which can create even more favourable conditions for the bacteria to spread (Mohammed et al, 2012).

2.4.3. Cholera in Zimbabwe

The Zimbabwean cholera epidemic that originated in Zimbabwe in August 2008, swept across the country (WHO, 2008) and spread to Botswana, Mozambique, South Africa and Zambia (WHO, 2008). By 10.01.10 there had been 98,741 reported cases and 4,293 deaths making it the deadliest African cholera outbreak since 1993. The Zimbabwean government declared the outbreak a national emergency and requested international aid (WHO, 2008).

Although the epidemic was contained by late 2009, the poor condition of sanitation in Zimbabwe remains a matter of regional concern (WHO, 2008). An open drain in Kuwadzana township, Harare in 2004, by 2008 drains such as this were carrying sewage from burst sewage pipes and faeces washed out of the neighbouring areas as the urbanisation system collapsed. This contributed to the rapid spread of the cholera outbreak. This was exacerbated by collapse of the urban water supply (Thornycraft, 2008) sanitation and garbage collection (WHO, 2008). Systems along with the onset of the rainy season leading to faeces with cholera bacteria being washed into water sources, in particular public drains as well as providing readily available but contaminated water (WHO, 2008).

The disease spread to all of Zimbabwe's 10 provinces. The attack rate was highest in Beitbridge, Che gutu, Mudzi and Zvimba districts (WHO, 2008). Assistance after the 2008 outbreak was made available by numerous international agencies (WHO, 2008) and funding of water, sanitation and hygiene programmes, epidemic response and provision of essential drugs came from several government and trans-governmental organisations.

The South African government set up medical facilities and drinking water supplies at the Beitbridge border post and developed the National outbreak response Team and additional medical personnel to Musina (WHO, 2008). On 10.12.2008, the Limpopo provincial government declared Vhembe district municipality, which borders Zimbabwe at Beitbridge, Matabeleland South province a disaster area (Fletcher, 2008).

Approximately 31 (78%) of the 40 countries that reported indigenous cases of cholera to WHO were in sub-Saharan Africa in 2005. The reported incidence of indigenous cholera in sub-Saharan Africa in 2005 (166 cases/million population) was 95 times higher than the reported incidence in Asia (1.74 cases/million population) and 16,600 times higher than the reported incidence in Latin America (0.01 cases/million population). In that same year, the cholera case fatality rate in sub-Saharan Africa (1.8%) was 3 times higher than that in Asia (0.6%); no cholera deaths were reported in Latin America. The persistence or control of cholera in Africa will be a key indicator of global efforts to reach the Millennium Development Goals and of recent commitments by leaders of the G-8 countries to increase development aid to the region (Gaffga, 2007). In 2008-2009, Zimbabwe experienced an unprecedented cholera outbreak with more than 4,000 deaths. More than 60% of deaths occurred at the community level (Morof et.al. 2013).

2.4 4. Cholera in South Africa

The current cholera epidemic in the Republic of South Africa (RSA) began in October 1980 and is part of the seventh pandemic. Initial investigation of the epidemic revealed a virtually closed system of water supply, which explained the distribution of the early cases. The spread of cholera in the RSA is examined and local factors contributing to cholera transmission are discussed. Attempts are being made to prevent cholera from becoming endemic in the RSA and long-term improvements in health facilities in the susceptible areas of the country are being undertaken. (Küstner et.al., 1981)

The dynamic spread of the seventh pandemic of cholera can conveniently be subdivided into three geo-chronological periods (CH- Fung, 2014). The first stage involved the invasion of all the states of South East-Asia, the second the invasion of the states of main land Asia and the third stage the Middle East-Afro-European invasion reference. Cholera in South Africa was clearly part of the third period (Sidley, 2001). As early as 1971 South Africa was considered to be at risk. Hot, humid summers, sea-ports, overcrowded communities with a low standard of environmental sanitation and scanty, restricted and unprotected water supplies in certain areas facilitated the introduction of cholera into South Africa (Sidley, 2001).

Cholera spread to the Zimbabwean migrant worker community in Limpopo and Mpumalanga provinces of South Africa (WHO, 2008), and cholera bacteria were detected in the Limpopo river on the 3rd December 2008. By 12 December 2008, 11 deaths and 859 infections had been recorded in South Africa rising to 2100 cases and 15 deaths by 14 January 2009 and to 12 000 cases and 59 deaths by 10 March 2009 (WHO, 2008).

The South African government set up medical facilities and drinking water supplies at the Beitbridge border post and deployed the National outbreak response team and additional medical personnel to Musina (WHO, 2008). On 10 December 2008, the Limpopo Provincial Government declared Vhembe District Municipality which borders Zimbabwe at Beitbridge, Matebeleland South province a disaster area (Fletcher, 2008).

During 2000/2001 a cholera epidemic spread through the Eastern and North Eastern parts of South Africa (WHO, 2008). The first case was confirmed in KwaZulu Natal on 14th August, 2000 and is the most affected Province (WHO, 2008). Vibrio Cholerae El Tor Ogawa was isolated and by 5th April the epidemic had brought about 82,275 cases to cholera treatment centres (hospitals, clinics and Rehydration Centres) and caused 171 deaths (WHO, 2008). In addition to the suffering and loss of life, the epidemic has cost the Communities a lot of resources on treatment of cholera patients (unit cost to be worked out), significant productive work time loss and other social economic costs (WHO, 2008). Response has been organized through set up of coordination structure; inter-ministerial committee, National Task force on Cholera, Joint operations Committees (JOCs) at Provincial, Regional and District levels with Technical Support from WHO. A review was conducted in April 2001 as part of the on-going cholera control activities (Mugero & Hoque, 2001).

2.4.5. Cholera in Limpopo Province

Various studies in Limpopo Province have showed that communal standpipes were microbiologically less contaminated than borehole and unprotected spring water sources. In addition studies conducted in Vhembe District of Limpopo Province indicated that rivers and fountains used by rural communities for domestic water were all contaminated by enteric pathogens. Other studies conducted in Limpopo

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shows that enteric pathogiens such as *E. coli, Plesiomonas shigelloids, V. cholera, Enterobacter cloacae, Shigella , Salmonella, Aeromonashydrophilla, Aeromonascaviae and campylobacter* play a pivotal role in the diarrhoea (Obi et al., 2007; Ramalivhana and Obi 2009; Ramalivhana et al.,2010). On December 11,2008, Vhembe was declared a disaster zone by the Limpopo government due to the spread of cholera across the Zimbabwean border to the district (WHO, 2008).

2.5. Infectivity and Severity of cholera

About 100 million bacteria must typically be ingested to course cholera in a normal healthy adult (Sack et al. 2004). This dose however is less in those with lowered gastric acidity (Sack et al, 2004). Children are also more susceptible with 2-4 year olds having the highest rates of infection (Sack et al, 2004)). Persons with lowered immunity, such as persons with the most susceptible (Sack et al, 2004), AIDS or children who are malnourished, are more likely to experience a severe case if they become infected (WHO, 2015). Any individual even a healthy adult in middle age, can experience a severe case, and each person's case should be measured by the loss of fluids, preferably in consultation with a professional health care provider.

A person with severe dehydration due to cholera has sunken eyes, decreased skin turgor which produces wrinkled hands and skin (Typical rice water diarrhoea). The primary symptoms of cholera are profuse diarrhoea and vomiting of clear fluid (Sack et al, 2004). Severe cholera without treatment kills about half of affected individuals (Sack et al, 2004). If the severe diarrhoea is not treated it can result in life threatening dehydration and electrolyte imbalances (Sack et al, 2004). Cholera has been nicknamed the "blue death" because a person's skin may turn bluish-grey from extreme loss of fluids (Elroy &Townsend, 2009).

Fever is rare and should raise suspicion for secondary infection. Patients can have lethargic sunken eyes, dry mouth, cold clammy skin, decreased skin turgor or wrinkled hands and feet. Kussmaul breathing, a deep laboured breathing pattern can occur because of acidosis from stool bicarbonate losses and lactic acidosis associated with poor perfusion. Blood pressure drops due to dehydration, peripheral pulse is rapid and thread and urine output decrease with time. Muscle cramping and weakness, altered consciousness, seizures or even coma due to electrolyte losses and ion shifts are common especially in children (Sack et al, 2004).

2.6. Transmission of cholera as secondary cases

Cholera has been found in two animal populations; shellfish and plankton (Sack et al, 2004). Cholera is typically transmitted to humans by either contaminated food or water. Most cholera cases in developed countries are as a result of transmission by food, while in the developing world it is more often water (Sack et al, 2004). Food transmission occurs such as oysters in waters infected with sewage, as vibrio cholera accumulates in 200 plankton and the oysters eat the zooplankton (Colwell, 2013).

People infected with cholera often have diarrhoea and disease transmission may occur if this highly liquid stool colloquially referred to as "rice water" contaminates water used by others (Ryan& Ray, 2004). The source of the contamination is typically other cholera sufferers when their untreated diarrhoeal discharge is allowed to get into waterways, groundwater or drinking water supplies. Drinking any infected water and eating any foods washed in water, as well as shellfish living in the affected waterway, can cause a person to contract an infection. Cholera is rarely spread directly from person to person (Ryan & Ray, 2004).

Both toxic and nontoxic strains exist. Nontoxic strains can acquire toxicity through a temperature bacteriophage (Ryan & Ray, 2004). Coastal cholera outbreaks typically follow zooplankton blooms, thus making cholera a zoonotic disease.

Cholera transmission is closely linked to inadequate environmental management. Typical at risk areas include peri-urban slums where basic infrastructure is not available as well as camps for internally displaced persons or refugees, where minimum requirements of clean water and sanitation are not met. The consequences of a humanitarian crisis such as disruption of water and sanitation systems, or the displacement of populations to inadequate and overcrowded camps can increase the risk of cholera transmission should the bacteria be present or introduced. Dead bodies have never been reported as the source of epidemics (Ali et.al, 2012).

Cholera remains a global threat to public health and a key indicator of lack of social development. The number of cholera cases reported to WHO continues to be high. During 2013, a total of 129 064 cases were notified from 47 countries including 2102 deaths. The discrepancy between those figures and the estimated burden of disease is due to the fact that many cases are not recorded due to limitations in surveillance systems and fear of trade and travel sanctions (Ali et al, 2012).

2.7. Public health interventions to control cholera in rural areas

Among people developing symptoms, 80% of episodes are of mild or moderate severity. The remaining 10%-20% of cases develop severe watery diarrhoea with signs of dehydration. Once an outbreak is detected, the usual intervention strategy aims to reduce mortality-ideally below 1%- by ensuring access to treatment and controlling the spread of disease (WHO, 2012).

It is necessary to introduce intervention measures that address the root problems of poor sanitation and unsafe water supplies in order to prevent future cholera epidemics. The following interventions are used in rural areas to control cholera:-

2.7.1. Drinking water intervention

Cholera is transmitted by faecal-oral route i.e. a person contracts by ingesting something (water or food) that has been contaminated with faecal matter infected with vibrio cholera. Cholera can be reliably prevented and controlled by stopping this contamination cycle. Key elements of interrupting the cycle include providing safe drinking water, improving sanitation conditions and ensuring needs to be provided in sufficient quantity so the population can practice good hygiene. Ensuring a safe and

sufficient water supply should be a key element in planning a cholera prevention and control strategy (UNICEF, 2013).

2.7.2. Sanitation intervention

Proper and safe disposal of human waste (urine and faeces) is essential to preventing and controlling cholera. Improved sanitation that hygienically separates human excreta from human contact can substantially improve the health of individuals and communities. Provision of latrines in communities especially in public spaces such as schools generally will have a beneficial impact on cholera control. A ratio of one for every 20 people in crowded settings is ideal. Constructing latrines or setting up solid waste systems might not be practical in acute outbreak situations. However, a later improvement in sanitary conditions is likely to decrease future risk for outbreaks (CDC, 2013).

2.7.3. Hygiene interventions

Promoting hygiene necessarily involves a community participation in prevention and control efforts. Community ownership is essential for the successful implementation of environmental changes that will benefit cholera prevention and control. Individual and community action typically includes promotion of hand washing, use of latrines, consumption of safe water, proper disposal of dead bodies and proper food hygiene (preparation, storage and consumption) (UNICEF, 2013).

Experience has shown that a participatory approach to promoting hygiene is more effective than a message-based approach that simply raises awareness about cholera prevention and control. Mobilising the community to adhere to safe hygiene practices is the key to behaviour change. Techniques to improve community mobilisation include using social media, peer connections and participatory training. Understanding the public's perceptions about the risk of cholera and the potential for prevention and control also is important (UNICEF, 2013).

2.7.4. Use of Oral Cholera Vaccine (OCV)

Is a relatively new addition to the cholera prevention and control toolkit, can work synergistically with other interventions. The vaccine used most often in developing countries is schanchol. It works by reducing the internal colonization of vibrio cholera, thus making people less likely to spread infection. It is safe and effective, with virtually no side effects, and relatively inexpensive. Generally, two vaccine doses are given two weeks apart. In 2010, WHO recommended that OCV be used in conjunction with other prevention and control strategies in areas to which cholera is endemic (UNICEF, 2013).

2.7.5. Information, education and communication and community health worker (CHW) training

Informing and training communities and CHW is a necessary part of a cholera prevention and control plan synchronizing efforts and ensuring uniformity of message content is critical. Evidence based information, education and communication activities emphasise an approach that includes individual behaviour change or reinforcement as well as changes in social and community norm. When carefully carried out, health communication strategies can help foster health practices. Key actions include developing, implementing and monitoring a communication plan (CDC, 2013).

CHAPTER 3 METHODOLOGY

3.1. Introduction

In this chapter the researcher described the research process, design and method. The population was all suspected and confirmed cholera patients of all ages who were reported from any health facility in Limpopo Province 2008-2009. The sample was selected using purposive sampling method. Data was collected using cholera dataset collected from Limpopo Provincial Department of Health which systematically collected on patients who had diarrhoea and seen in health facilities with Limpopo Province associated with nationality, health districts, gender and age using Pearson correlations. A Chi-Square test was used to assess differences or relationships in selected variables. Data was analysed with the aid of STATA statistical software version 12 for windows (STATA Corporation college station, Texas) was used. The quality of the study was ensured through strategies which maintained reliability and validity.

3.2. Methodology

This was a quantitative, retrospective and descriptive analysis (Dalhat et al., 2014). This research was therefore designed to provide systematic information about how the outbreak has spread from one area to another in Limpopo Province. This is supported by Burns and Groove defining quantitative research as a formal, objective systemic process in which numerical data are used to obtain information about the world (Burns & Groove 2009).

3.2.1. The study area

The outbreak occurred in South Africa's northernmost province, Limpopo; which share international borders with Mozambique to the East, Zimbabwe to the North and Botswana to the West, and share provincial borders with North West Province to the West, Mpumalanga Province to the East and Gauteng Province to the South, figure 1 (StatsSA 2008). Limpopo Province occupies an area of 123 910 km^2 with an estimated total population of ~5.3 million (5 274 800) (Lehohla 2006; StatsSA 2008) distributed across five districts namely: Vhembe, Capricorn, Mopani, Sekhukhune and Waterberg (Figure 3.1) (StatsSA 2008). The province has a low level of urbanization as 89% of its population lived in non-urban areas. About 52% of the

total population is female. Limpopo had a higher proportion of women (52%) compared to men (48%) (Lehohla 2006).
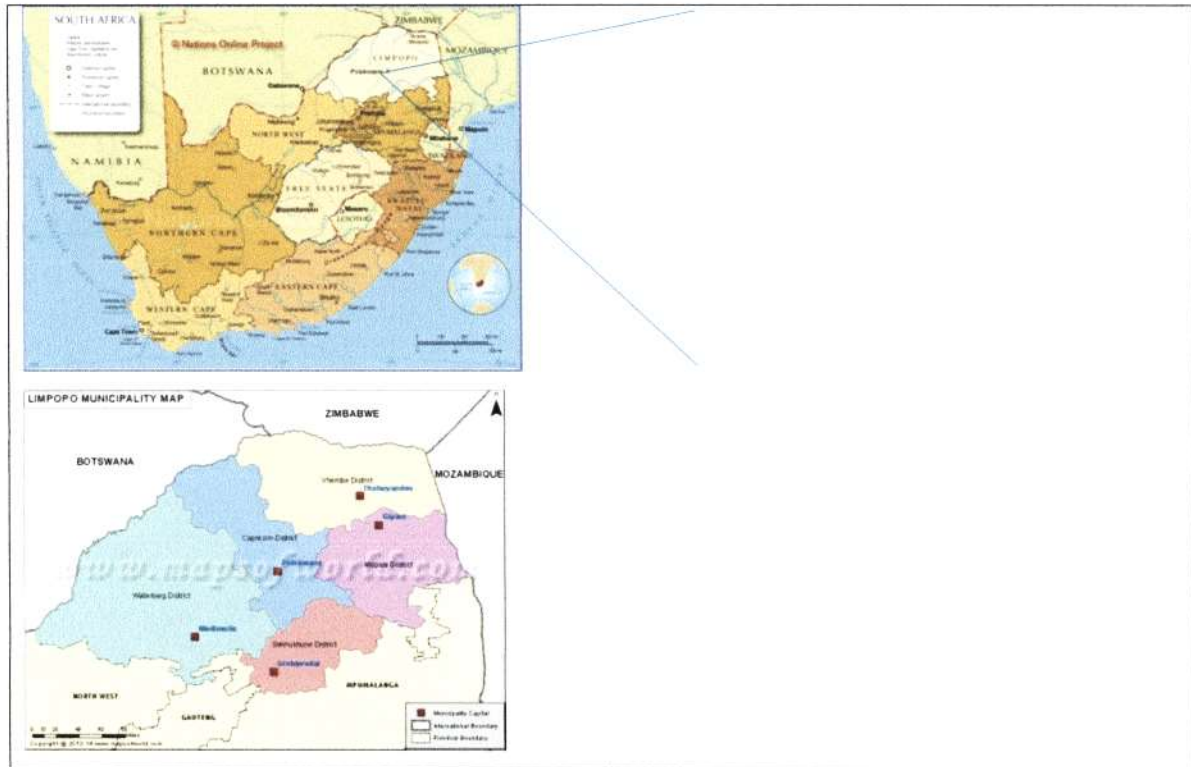
Figure 3.1: Map depicting South Africa and district health boundaries for Limpopo Province.

3.2.2. Study design

A cross sectional study design was used because the collected data was analysed from the population at one specific point in time with the aim of providing data on the entire population under study. The cross sectional study design provided a "snapshot" of outcome and the characteristics associated with it, at a specific point in time.

This was a cross-sectional study which involved analysing collected data from cholera or acute diarrhoea patients in a single time period. It followed a non-experiential descriptive research approach.

3.2.3. Study Population

Population means the entire group of persons or objects that is of interest to the researcher, in other words, that meets the criteria which the researcher is interested in studying (Brink, 2009). The study population included all suspected and confirmed cholera patients of all ages who were reported from any health facility in Limpopo Province during the 2008 and 2009 outbreak.

3.2.4. Sampling

Sampling is referred to as the researcher's process of selecting the sample from a population in order to obtain information regarding a phenomenon in a way that represents the population of interest (Brink, 2009). Purposive sampling was used in this study and the study population included all suspected and confirmed cholera patients of all ages who were reported from any health facility in Limpopo Province during the 2008 and 2009 outbreak.

3.2.5. Ethical considerations for the study

An ethical clearance was obtained from University of Limpopo high degree committee and an institutional or departmental approval to conduct the study was granted by the Provincial Research Committee, which serves as the review board for the Department of Health in Limpopo Province. As the protection of human rights is a mandate in health care research (Dresser, 1998) this research was guided by the principles of respect for people, beneficence, and justice.

3.2.6. Inclusion criteria

All suspected and confirmed cholera patients of all ages who were reported from any health facility across the five districts of Limpopo Province during the 2008 and 2009 outbreak were included in this descriptive epidemiological report.

3.2.7. Exclusion criteria

All suspected and confirmed cholera patients of all ages who were reported from any health facility outside Limpopo Province and outside the study period including cases which had duplicate entries in the dataset were excluded in this descriptive epidemiological report.

3.2.8. Data collection and analysis

The cholera dataset from the Limpopo Provincial Department of Health section which included all suspected and confirmed cholera patients of all ages who were reported from any health facility in Limpopo Province from 2008-2009 outbreak was used. According to Burns and Grove (2009), quantitative data analysis is a diverse and complex process, it become relatively easy, with clear step-by-step process and the aid of computerized data analysis software. Data analysis for this study focused on the variables which were systematically collected on patients who had acute diarrhoea and seen in health facilities within Limpopo Province. Occurrence of cholera was correlated or associated with nationality, health district, gender and age using Pearson correlations. A Chi-Square test was used to assess differences or relationships in selected variables.

Planning of data analysis was done in the planning stages of a study as an analysis plan. Firstly an effective analysis plan with an aim to establish clear analytic objectives was developed. All gathered data was double checked by biostatistician for quality assurance. STATA statistical software version 12 for windows (STATA Corporation, College Station, Texas) was used.

3.2.8.1 Frequency distributions

The frequencies were used to display distributions of the variables as they provided a good overall picture of a large set of grouped data into different classes. This was also used to determine the characteristics of the study sample, and subsequently estimated the magnitude of the problem in terms of cholera cases by age and gender.

3.2.8.2 T-test

The independent t-test was used for variables having two categories as it assesses whether the means of two groups are statistically significant. This test was performed at the 95% confidence level. The p-value ≤ 0.05 in the study results implied that there was a statistical significant difference in means between the categories.

3.2.8.3 Categorical data

The grouping of variables to describe categories of individuals was used in a form of cross-tabulation which brought the explanation of relationships between two or more categorical variables. Pearson chi-square was used to appraise the data for independence.

3.2.9. MEASURES TO ENSURE RELIABILITY AND VALIDITY

3.2.9.1. Reliability

According to De Vos et al (2011) reliability occur when an instrument measures the same thing more than once and the results in the same outcome. The trust is that the reliability was maintained during data collection by reviewing the quality assurance procedures which were used to collect the data to get good quality data (i.e. random checks by supervisors, principal investigator and re-interviewing the important questions from 10% of the respondents by different interviewer). Therefore, the data from outside the study period was excluded and cases which had duplicate entries in the dataset were also excluded in this descriptive epidemiological report.

3.2.9.2. Validity

The internal and external validity in research are the two main principles for gauging the validity of research designs examining causal propositions (Matt et al. 2010). Internal validity is the extent to which a study provides an unbiased estimate of the true value while external validity occurs if the results apply to the population identified in the study question (Arora & Schriger 2009). The internal and external validity of the study were ensured by ensuring that data management followed scientific procedures were data was edited and coded using the software EPIDATA (version 3.2) and confidentiality of the data maintained.

3.2.9.3.The process to minimize potential bias in the current study

Bias is defined as any propensity which prevents fair consideration of a request and in research it occurs when systematic error is introduced into sampling or testing by selecting or encouraging one outcome or answer over others (Pannucci & Wilkins 2010). Therefore, selection biases were minimized by using only cases which were reported within the study period

CHAPTER 4 RESULTS

4.1. Introduction

This section of the report discusses in detail the research findings in descriptive and visual form. The research results are discussed by referring to the pattern of transmission, distribution of cases, weekly progression of cholera outbreak per district, distribution of cases by age group, distribution of cases by gender, distribution of cases by nationality and cholera deaths in Limpopo Province.

4.2. Pattern of transmission in Limpopo Province

The study findings revealed that the cholera outbreak in Limpopo Province began on the 15th of November 2008. The index case was reported from Messina hospital in Vhembe District, near Zimbabwe boarder. This index case (the first case or initial patient in the population of an epidemiological investigation of cholera) was an adult male from Musina municipality had attended a funeral ceremony of a cholera – infected dead person in Beitbridge, a bordering town, in Zimbabwe. As of cholera crisis (cholera outbreak) has heightened in Zimbabwe, people from infected communities were coming to Limpopo in search of medical care and other support. The first week of the epidemic was week 46 of 2008 and during this week, eleven cases were reported from Musina hospital in Vhembe district. The number of cases dramatically increased to 156 during the second week of the epidemic. See figure 4.2. below for details.
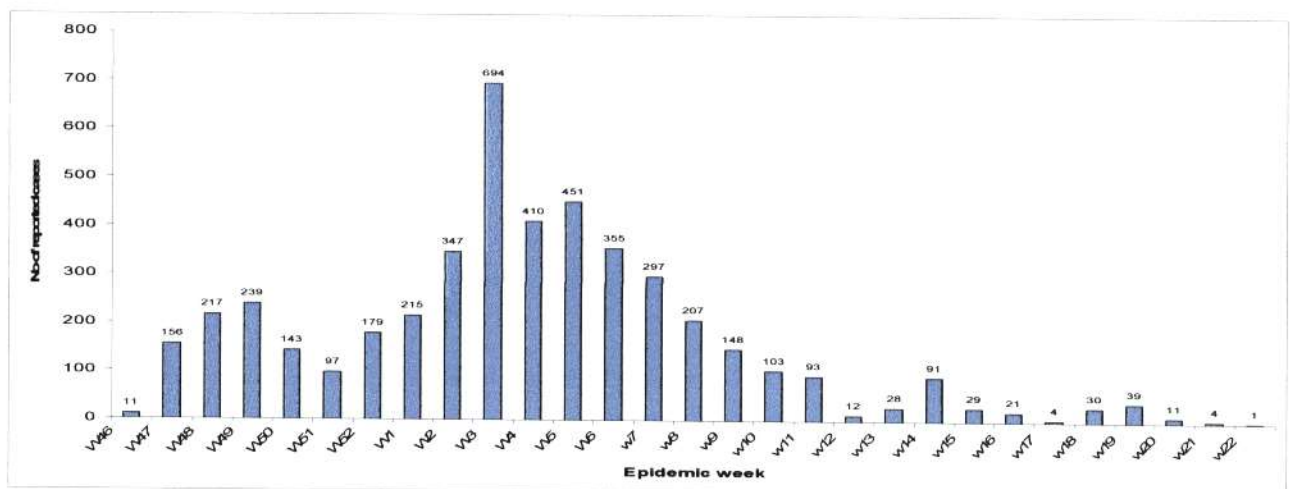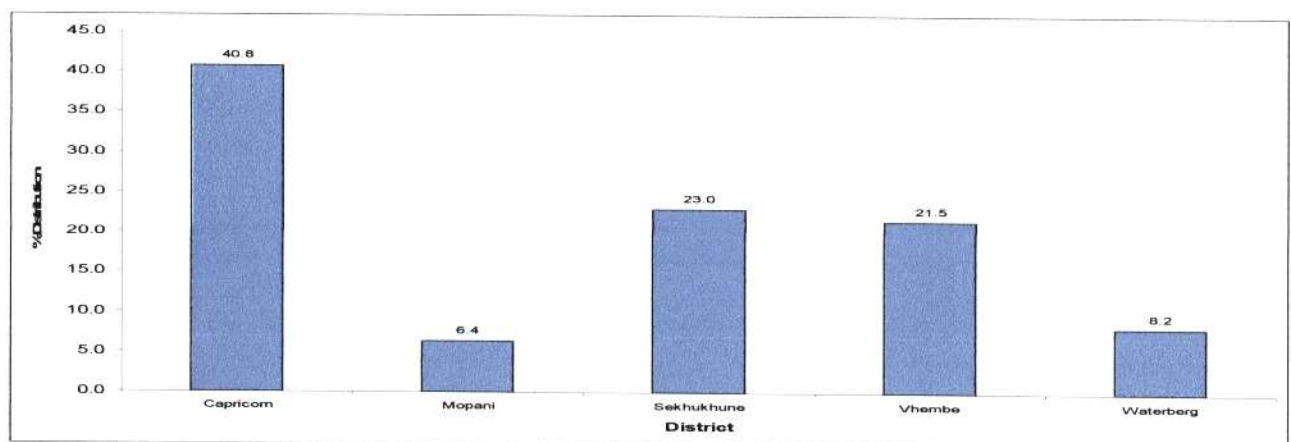

Figure 4.2: Distribution of cholera cases per epidemic week, 15 November 2008 – 01 June 2009, n=4632 CFR=0.65%

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As shown on figure 4.2 above, the cholera outbreak reached a pick during week 3 of 2009 which was the tenth week of the epidemic. During this week, a total of 694 cases were reported. The number of cases reported then dropped to 410 during week 4 which was the eleventh week of the epidemic. A slight increase in the number of cases was reported during week 5 of 2009 which was the twelfth week of the epidemic and since week 6 the number of reported cases dropped until week 12 were only twelve cases were reported. A slight increase in number of cases was reported during week 13 and 14 of 2009.

4.3. Distribution of cases by districts

Limpopo Province reported a total of 4 632 cases of cholera across its five districts from 15 November 2008 to 30 May 2009 (Fig 4.3 below).

Figure 4.3: Distribution of cholera cases per district, 15 November 2008 – 01 June 2009. n=4632 CFR=0.65%

Capricorn district reported the highest number of cases 40.8% (N=1890), followed by Sekhukhune 23% (N=1067), Vhembe 21.5% (N=998), Waterberg 8.2% (N=379) and Mopani 6.4% (N=298) district.

4.4. Weekly progression of cholera outbreak per district

The weekly progression of the cholera cases in Limpopo Province per district shows that during the first two weeks of the epidemic (week 46 and 47) a total of 167 cases

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were reported from Vhembe district. During the third week (week 47) one case was reported in Waterberg district from Mookgophong Health Centre being a 38 years Zimbabwean male. The outbreak spread to two more districts during the fourth week (week 49) of the epidemic being Mopani and Sekhukhune districts. A total of 259 cases were reported during this epidemic week were in 195 cases were from Vhembe, 42 cases from Mopani and 2 cases from Sekhukhune district. During the fifth week (week 50), the outbreak then spread to Capricorn district and a total of 143 cases were reported (96 cases from Vhembe, 23 cases from Mopani, 13 cases from Capricorn, 8 cases from Sekhukhune and 3 cases from Waterberg district.

Figure 4.4: Epidemic curve for daily progression of cholera cases reported per district, 15 Nov 2008 – 01 June 2009.
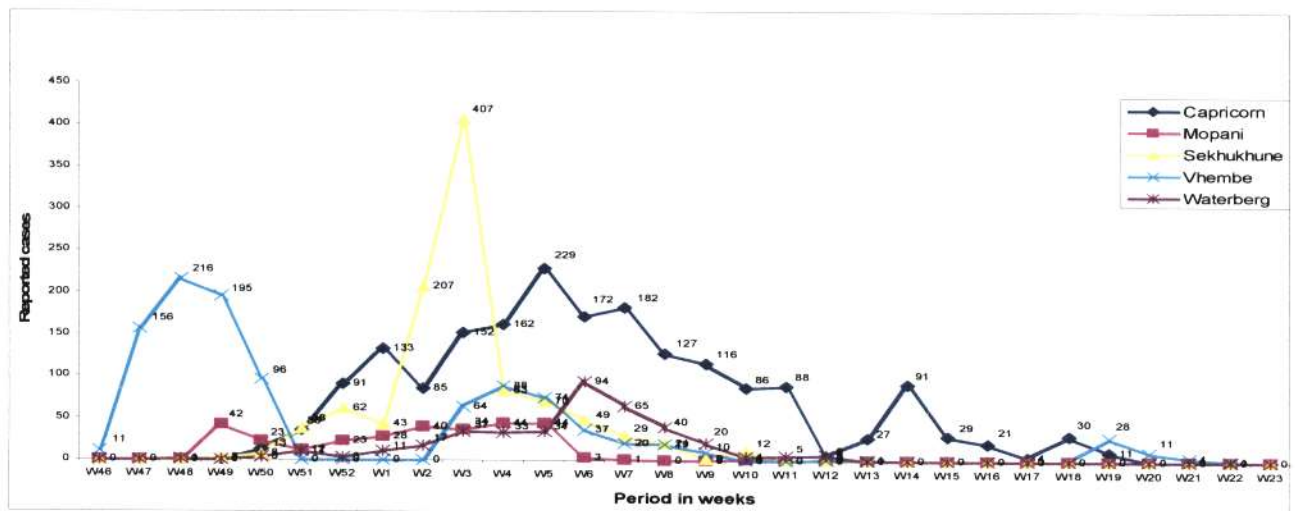
Vhembe district did not report any cholera cases during week 51 and 52 of 2008 and again during week 1 and 2 of 2009. The disease management team in Limpopo Province might have thought that cholera outbreak has been contained in Vhembe but surprisingly during the tenth week (week3 of 2009) of the epidemic a total of 64 cases were reported. Majority of these cases were from a village in Makhado municipality. The last case of cholera in Mopani district was reported during week 7 of 2009, for Vhembe district was during week 10 of 2009, for Waterberg district was reported during week 12 of 2009 and for Capricorn district was reported during week 19 of 2009. Sekhukhune district continued to report cases until week 23 0f 2009.
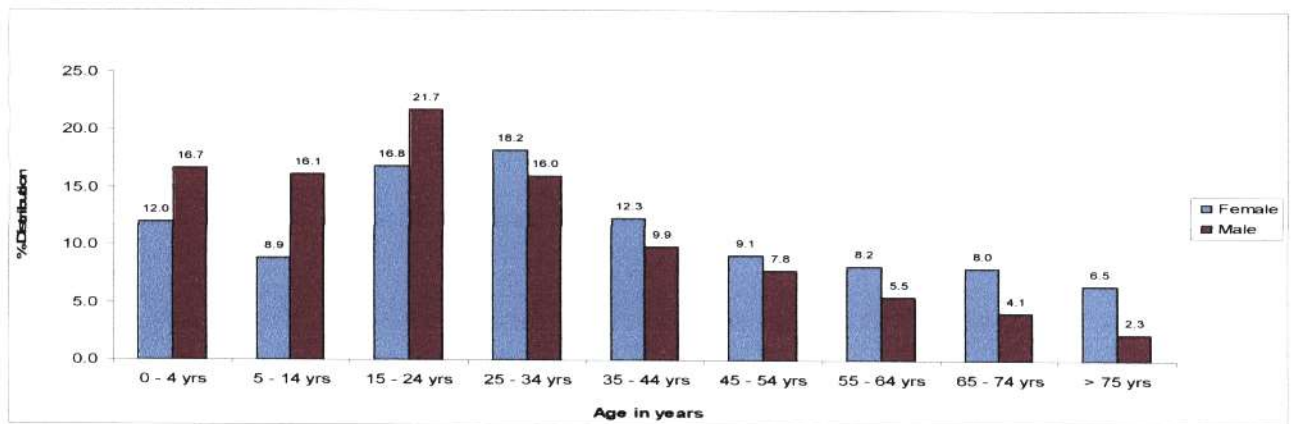
4.5. Distribution of cases by age group

Of the total (N=4 632) cholera cases reported in Limpopo, only 0.9% (N=40) had no recording of age. About 99.1% (N=4 592) of the cases had a well-documented age records. Of these, 85.8% (N=3 940) were patients more than five years of age, whilst 14.2% (N=652) were children under the age of five years. The majority of the cholera cases under the age of five 49.2% (346) were reported in Capricorn District. Table 4.1 below illustrates the age distribution of under 5 years and above 5 years per district.

Table 4.5: Distribution of cases per age group by district

Health district	<5 yrs	95% Confidence Limits	>5 yrs	95% Confidence Limits
Capricorn	53.1%	49.2 – 56.9	39.0%	37.5 – 40.5
Mopani	10.1%	8.0 – 12.8	5.7%	5.0 – 6.5
Sekhukhune	17.9%	15.1 – 21.2	23.9%	22.6 – 25.3
Vhembe	13.3%	10.9 – 6.3	22.8%	21.5 – 24.1
Waterberg	5.5%	3.9 – 7.6	8.6%	7.8 – 9.6

4.6. Distribution of cases by age group stratified by gender

The disease burden was observed generally among the children and adult population, age ranged between 0-100 years with a median age of 25 years among the reported cases. The majority 19.3% (N=872) of the cases were aged between 15-24 years, while the least 4.6% (N=211) of the cases were more than 75 years of age. Among the cases aged between 0 and 24 years, males were more frequently affected, whereas females were more affected among cases aged 25 years to more than 75 years.

Figure 4.6: Cholera outbreak case distribution by age group stratified by gender, 15 Nov 2008 – 01 June 2009.

4.7. Distribution of cases by gender

Of the total (N=4 632) cholera cases reported in Limpopo, only 0.1% (N=4) had no recording of gender. The majority 55% (N= 2 542) of these cases were females and the remaining 44.9% (N= 2 085) were males (Figure 4.7). Cholera affected more females than males across the four districts, excluding Vhembe.
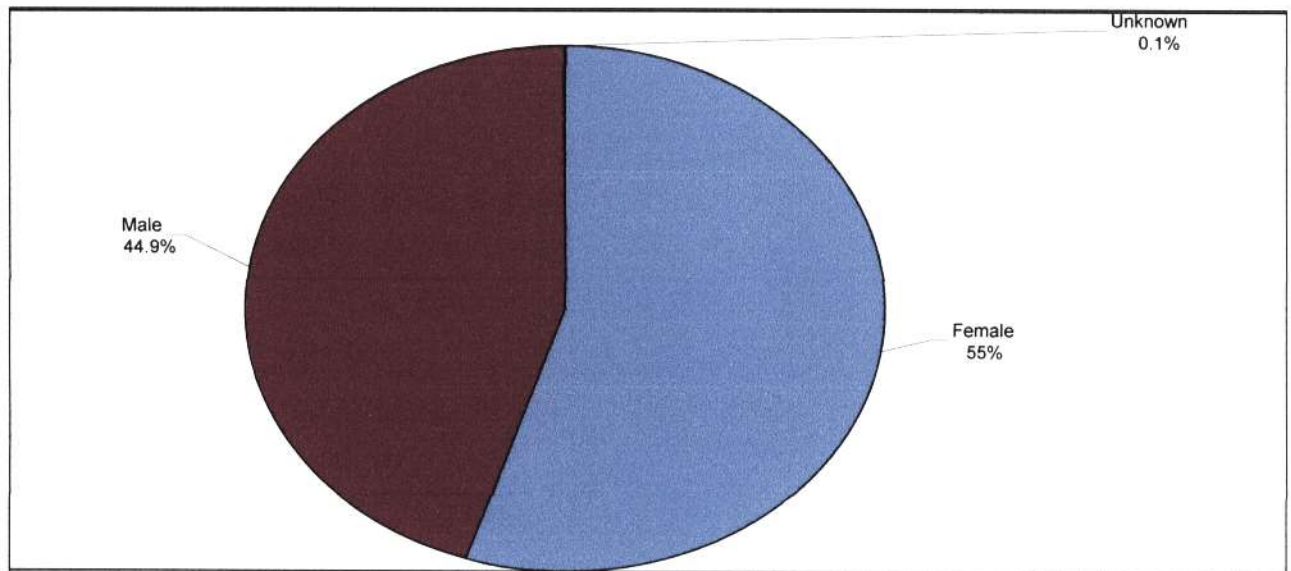
Figure 4.7.: Distribution of cholera cases by gender, 15 November 2008 – 01 June 20

4.8. Distribution of cases by nationality

The Limpopo cholera outbreak began with an amalgamation of cases from both Zimbabwe and South Africans. However, the majority of the cases during the initial stages of the outbreak were from Zimbabwe. Other nationals were reported later during the 6th day into the outbreak. Nationality was recorded for 99% (N=4 632) of the reported cases and of these, 87% (N= 4 031) were South Africans, 12.7% (N=589) Zimbabweans, % (N=) other nationals, 0.3% (N=12).
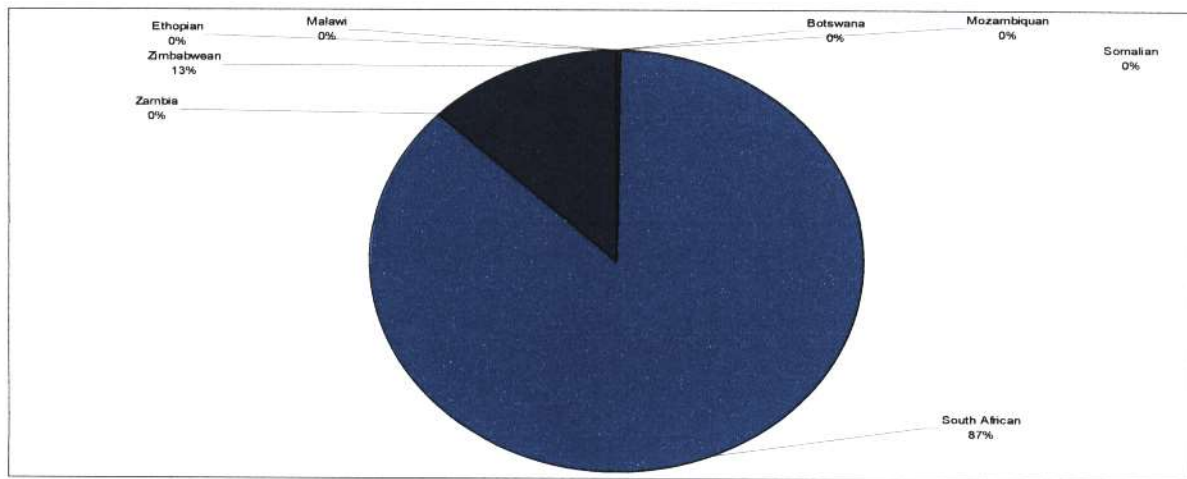
Figure 4.8 Distribution of cholera cases by nationality, 15 November 2008 – 01 June 2009.

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4.9. Cholera deaths in Limpopo Province

Cholera deaths result from severe dehydration caused by diarrhoea. Cholera is treatable and deaths are preventable. During the 2008/2009 outbreak the number of cholera deaths was only 30 giving a case fatality of 0.65% for the entire outbreak as presented in figure 4.7 below. Distributions of cholera cases and deaths differ due to differing availability of treatments.
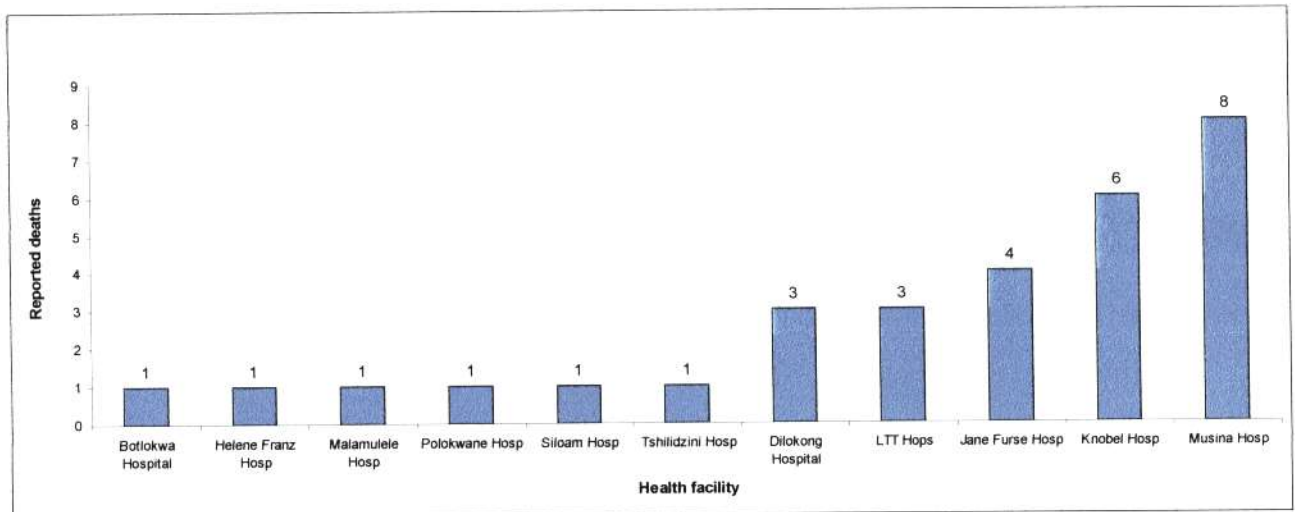
Figure 4.9: Distribution of cholera deaths per health facility, 15 November 2008 – 01 June 2009 Limpopo province (n=30)

Cholera deaths were reported in only three districts being Vhembe, Capricorn and Sekhukhune districts and for these districts the proportion of deaths were 46.7% (14), 30% (9) and 23.3% (7) respectively. The hospitals which reported high number of deaths were Musina, Knobel, Jane Furse, Louis Trichardt and Dilokong. A total of 22 deaths reported were South Africans which accounted for 73.3% of the deaths and Zimbabweans accounted for 26.7%. Males accounted for 63.3% of the deaths whereas females were 36.7%.

Chapter 5: DISCUSSION AND CONCLUSSION

5.1. Introduction

This chapter presents a discussion of the research findings, a summary and research findings related to how cholera cases were epidemiologically distributed during 2008/2009 outbreak in Limpopo Province, as well as recommendations for further research.

5.2. Discussions

Our study showed a cholera outbreak that grew in magnitude and spread to involve the most parts of Limpopo Province. This study also highlights challenges of suboptimal surveillance and response in the rural areas as well as potential endemicity of cholera (Dalhat et al., 2014). Our study shows that the provincial burden of cholera was large during the 2008 and 2009 outbreak. When considering district-specific incidence rates, it is important to note that cholera risk varied within districts of Limpopo Province and the burden of cholera was greatest in Capricorn District with a proportion of 40.8% cases, followed by Greater Sekhukhune (23%) and the least number of cases were reported from Vhembe District (6.4%).

Cholera continues to be an important public health problem among many poorer and more vulnerable communities (Jafarie et al., 2005). The recently strengthened cholera surveillance system of Limpopo Province showed that between 15 November 2008 and 01 June 2009, a total of 4 634 cases of cholera disease with 30 laboratory confirmed deaths (CFR: 0.65%) were reported across five of the five districts. A higher cholera case load was reported in Capricorn. Vhembe had more cholera cases reported from Zimbabweans [95% (N=467/493)] affected with cholera than South Africans [14% (N=232/1 634)] from the inception of the outbreak to the 12 Dec 2008.

Cholera affected all ages, but the geographic distribution of the disease was very heterogeneous in Limpopo Province as like in an outbreak which occurred in Uganda (Bwire et al., 2013). Limpopo Province is not endemic to cholera and in non-endemic areas: "a patient aged 5 years or more develops severe dehydration or dies from acute watery diarrhea" while in endemic areas: "a patient aged 2 years or more develops severe dehydration or dies from acute watery diarrhea" (Bwire et al.,

2013). During the cholera outbreak in Limpopo Province, a cholera outbreak was confirmed when Vibrio cholerae O1 or O139 was isolated from at least one stool sample. Only cases meeting the standard case definition above were investigated and included in the official cholera data (Bwire et al., 2013). The majority (83%) were above 5 years of age from our study and females were more affected than males across all five districts.

The distinctive feature of cholera among diarrhoeal diseases is the high mortality rate among patients of all ages (Ali et al., 2012). The high case fatality rate of 0.65% could have been prevented in Limpopo if some challenges were addressed such as proper home management of cases and late arrival/presentation of patients to health facilities and practice of herbal medication and advice of traditional healers are also a risk factor. The incidence within which the outbreak was spreading from one area to another signifies high level of indirect person-to-person transmission through contaminated water and food as most affected communalities were lacking safe water supply. Our study showed a relatively low level of confirmed cases which could be due to poor specimen collection, transportation or the less specific standard case definition, which tends to include severe forms of other acute watery diarrhea.

This review of cholera outbreak in Limpopo Province with specific to time, place, and person provide further insight of its likely future distribution and guide the use of cholera-specific interventions. The review raises important questions and suggestive evidence that during an outbreak communities are full of carriers. It will be interesting to determine what proportion of first case in the community got infection from funeral practices and were cluster of people infected during funeral practices? Another important question will be to find out if socio-cultural practices of funerals are a risk factor for cholera transmission? During this outbreak, it was found that prolonged and / or recurrent contact of susceptible persons with contaminated household material of the dead person's house during a funeral was a risk factor for contracting the disease. Lastly, an answer on whether is it purely an issue of poor personal / domestic hygiene, susceptibility of the individual or infectivity of the bacteria rather than funeral practices needs to be determined.

5.3. Conclusion

In conclusion, the cholera outbreak has affected all the five districts of Limpopo Province in South Africa, and cases are still being reported and continue to drop. The findings also indicate that the inception of cholera in Limpopo can be linked the outbreak in Zimbabwe. An improved surveillance system for cholera outbreak throughout Limpopo is now available with more comprehensive data on cholera, and has provided an opportunity for better recognition of the real extent of the burden of disease in the province.

5.4. Recommendations

We recommend training of infection control practitioner's at health facilities on data collection and the importance of accurate and timely reporting, especially during outbreaks such that relevant accurate information can be collected to improve case management. Furthermore, we recommend empowerment of clinicians on case management in order to reduce the case fatality rate and the duration of patient stay in hospitals.

5.5. Contribution of the study and implications for health care

The current study to review the cholera outbreak shows that proper identification of epidemic strains were successful and this led to development of cost—effective and targeted interventions to avert future epidemics and save lives.

5.6. Limitations of the study

The available dataset for cholera outbreak did not have variables which could be used to determine the risk factors for the spread on cases from one area to another. The exact contributory factors to the cause of deaths in health facilities could also not be determined from the available data

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