ENVIRONMENTAL HEALTH WORK METHODS AND PROCEDURES FOR THE SURVEILLANCE AND CONTROL OF CHOLERA IN THE KWAZULU-NATAL PROVINCE, SOUTH AFRICA

by

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In accordance with Rule G4.6., I hereby declare that the above-mentioned dissertation is my own work and that it has not previously been submitted for assessment to another University or for another qualification.

SIGNATURE: ……

DATE: 06 October 2012

DEDICATION

My sincerest gratitude and appreciation are extended to:

- all the Environmental Health Practitioners in KwaZulu-Natal who enhance the quality and practice of Environmental Health within their respective communities; and
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ABSTRACT

The aim of this study was to develop a standardised set of Environmental-Health work methods and procedures, with the purpose of contributing to the effective surveillance and control of Cholera in the KwaZulu-Natal province, South Africa. The researcher followed a qualitative research design, which was explorative, descriptive, inductive and deductive by nature. The methods of data collection were documentary research and focus-group interviews.

A documentary research approach was employed as the primary method of data collection for the study. The researcher has used semi-structured questions to obtain relevant information from the participants in the focus groups.

The purpose of using semi-structured questions in the focus groups was to draw on their knowledge and experience of communicable disease surveillance and control in relation to Cholera, as well as to ascertain their views on the role of the Environmental-Health Practitioners in the Communicable-Disease Outbreak-Response Teams at the three different spheres of government.

The process of qualitative data analysis was followed. This was based on data reduction and interpretation; and it was conducted as an activity simultaneously with data collection, data interpretation (coding) and narrative writing. The information obtained from the analysed data assisted in the development of the environmental-health work methods and procedures for the surveillance and control of Cholera in the KwaZulu-Natal province, South Africa.

In this study, firstly, the epidemiology of Cholera was described and analysed against the background of its manifestation in South Africa. Secondly, the national health care system, with specific reference to the place and role of environmental health practitioners at national, provincial and municipal spheres – in relation to Cholera surveillance and control – was analysed.

Thirdly, the relevant research that has been done globally has been analysed against the background of the findings of the above, together with work methods and procedures to be used by environmental-health practitioners during the surveillance and control of Cholera in the KwaZulu-Natal Province, South Africa. These include, inter alia:

- Work methods and procedures for Cholera case investigation;
- Work methods and procedures for sanitary investigations; and
- Work methods and procedures for identifying the sources of contamination in environmental waters.

Finally, the conclusion and limitations was presented, and appropriate recommendations were made. These include:

- The need to educate all role-players, on the recent developments in the identification of *Vibrio cholerae* from environmental surface waters;
- Communication systems should be developed that allow the Director: Environmental Health to communicate urgent environmental health information directly to the Minister of Health;
- The training of environmental-health practitioners on detailed work methods and procedures for the surveillance and control of Cholera; and
- The existing national Cholera control guidelines need to be updated to include relevant environmental health situations when emergencies arise.

KEY WORDS

- Cholera
- Surveillance
- Control
- Work methods
- Work procedures

CHAPTER ONE

INTRODUCTION

1.1. Introduction

Chapter One serves as an introduction to the research study. Firstly, the chapter contains a literature review. In qualitative research, a literature review shows that the researcher has identified some gaps in previous research, and that the proposed study could serve to fill a demonstrated need. Secondly, the problem and sub-problem statements of the study are also presented.

To date, none of the provinces and municipalities have developed detailed environmental health-work methods and procedures for the surveillance and control of Cholera within their areas of jurisdiction. In order to effectively address the above, three sub-problems have been identified as follows:

- **The epidemiology of Cholera:** The surveillance and control of a disease is dependent on its epidemiology. It is, therefore, important, when attempts are made to develop or improve existing work methods and procedures, to have a thorough knowledge of the epidemiology of the disease – especially as it manifests itself within the KwaZulu-Natal province.

- **The organizational arrangements for Cholera surveillance and control in South Africa:** Cholera surveillance and control can be regarded as functions of environmental health practitioners in the municipal sphere of government. Since there are a number of role-players in national, provincial and municipal spheres whose decisions may influence the efficiency and / or effectiveness of Cholera surveillance and control, it has become necessary to critically analyse the current organizational arrangements for Cholera surveillance and control from the national, provincial and municipal perspectives.

- **Work methods and procedures for the surveillance and control of**

Cholera: From the above, it may be deduced that the work procedures and methods for Cholera surveillance and control must be exactly the same within each municipality of a province – in order for the data to be integrated, and for valid decisions to be made.

The aim of this study is to develop a standardised set of environmental health-work methods and procedures, which would contribute to the effective surveillance and control of Cholera in the KwaZulu-Natal province, South Africa. More specifically, the objective of this study is to:

- Firstly, analyse and describe the epidemiology of Cholera – with the focus on the distribution and characteristics of the disease in South Africa – and specifically in the KwaZulu-Natal province. This is a prerequisite for the development of formal work methods and procedures for the surveillance and control of the disease. The methods of data collection in this part of the study will comprise a documentary review;

- Secondly, analyse the national health-care system with specific reference to the place, role and current work methods and procedures of environmental health practitioners at national, provincial and municipal spheres – in relation to Cholera surveillance and control – for the purpose of identifying any inadequacies, and for making appropriate recommendations. The method of data collection will consist of a documentary review, as well as focus group interviews;

- Thirdly, against the background of the findings of the above, to develop a formal set of work methods and procedures to be used by environmental health practitioners during the surveillance and control of Cholera in the KwaZulu-Natal Province, South Africa. The method of data collection will be a documentary review, as well as focus group interviews. The research design and methodology to be adopted for the study will be explained and motivated in the following paragraphs.

The proposed research design has a qualitative, explorative, descriptive and contextual research approach. In this proposed study, the researcher will describe the experience of the environmental health practitioners within the municipal and provincial spheres of government in the KwaZulu-Natal province, with regard to their functional and administrative activities in relation to Cholera surveillance and control.

The results of the data analysis will assist in the development of the work methods and procedures for the surveillance and control of Cholera in the KwaZulu-Natal province. Finally, the format of the research and the clarification of concepts are to be presented in this chapter.

In qualitative research, a literature review shows that the researcher has identified some gaps in the previous research, and that the proposed study would probably fill a demonstrated need. Against the background of what has been said above, the researcher in this study will conduct a thorough search of relevant information pertaining to the topic, with the aim of gaining knowledge, insight and ideas for the study.

In the next section the literature review is presented.

1.2. The literature review

According to Cooper (1998:3), literature reviews typically appear as detailed independent works, or as a brief introduction to reports of new primary data. Literature reviews can attempt to integrate what others have done and said – to criticise previous scholarly works, to build bridges between related topic areas, to identify the central issues in a field, or all these issues. Cresswell (2003:30) states that a literature review provides a framework for establishing the importance of the study, as well as a benchmark for comparing the results of a study with other findings.

In qualitative research, a literature review shows that the researcher has identified some gaps in previous research, and that the proposed study will

probably fill a demonstrated need (De Vos, Strydom, Fouché & Delport, 2002: 263). Against the background of what has been said above, the researcher in this study will conduct a search of relevant information pertaining to the topic, with the aim of gaining knowledge, insight and ideas for this study in the sections that follow.

Cholera is an acute diarrhoeal infection caused by the ingestion of food or water contaminated with the bacterium *Vibrio cholerae.* Two of the distinctive epidemiologic features of Cholera are: its tendency to appear in explosive outbreaks, often starting in several distinct foci simultaneously, and its propensity to cause true pandemics that progressively affect many countries in numerous continents over the course of many years (Kaper et al., 1995).

It is generally accepted that seven distinct pandemics of Cholera have occurred since the first pandemic was recognized in the early 19th century (Kaper et al., 1995). In each instance, Cholera spread from Asia to reach other continents in pandemics that affected many countries and extended over many years. Except for the seventh pandemic, which originated on the island of Sulawesi in Indonesia (Faruque et al., 1998), the other six pandemics arose from the Indian subcontinent, usually from the Ganges delta in Bengal (Kaper et al., 1995).

Since 1961, the world has been experiencing the seventh pandemic of Cholera, the causative organism of which is *Vibrio cholerae* O1 of the El Tor biotype. The final decade of the 20th century has been a hallmark epoch for Cholera (Kaper et al., 1997).

In 1991, the seventh pandemic reached South America. This marked the return of Cholera to this continent after a century of absence. This last extension of the El Tor pandemic resulted in the single largest and most rapidly spreading of all epidemics recorded. Abruptly and unexpectedly, 23 months later, there appeared in the Indian sub-continent a new variant of *Vibrio cholerae,* which was found to express surface antigens of a new O serogroup. This variant was named *Vibrio cholera* O139 (Kaper et al., 1995).

In Africa, the year of 1997 marked a dramatic Cholera epidemic affecting the countries in the Horn of Africa. Although South Africa had experienced seasonal Cholera peaks between 1980 and 1985, in August 2000 South Africa experienced the start of one of the worst outbreaks in the country's recent history. The total number of cases was well over 100 000, but the case fatality rate was relatively low (0.22%), which is below the World Health Organisation reported figure of 1%. This low fatality rate may be attributed to good preparedness and the implementation of control strategies.

This indicated that, despite poor provision of safe drinking water and adequate sanitation, the case management was nevertheless good (Mudzanani et al., 2004). The epidemic resulted in 105 000 cases of cholera, as well as 220 deaths in KwaZulu-Natal between August 2000 and July 2001 (Mugero & Hoque, 2001).

In 2008, a raw sewage spill from Beit Bridge into the Limpopo River, and a total breakdown in that Zimbabwean town's water treatment, caused the worst of the recent outbreaks in Southern Africa (Bateman, 2009).

During 2010, *Vibrio cholerae* was introduced into Haiti. The explosive spread of the outbreak was linked to the lack of immunity against *Vibrio cholerae,* as well as to the limited access to safe drinking water, basic sanitation, and the internal migration that followed the earthquake in January 2010 (Centre for Communicable Diseases, 2011:331).

Cholera is now considered to be endemic in many countries (World Health Organisation, 2012). The endemicity of Cholera carries the potential of epidemic flare-ups; and such pandemicity is always a threat, especially in developing countries with unsafe water supplies and poor sanitation (Colewell, 1996).

Cholera, an epidemic-prone diarrhoeal disease, is a major public health problem, and it should be recognised and addressed accordingly. It is important that environmental management in developing countries, in particular improvement in

water supplies, access to hygiene and sanitation is effected (World Health Organisation, 2008a).

Cholera surveillance should be part of an integrated surveillance system; and there should be combined efforts to implement efficient control measures – particularly given the emergence of new strains. Extraordinary advances have been made in recent years in unravelling the molecular pathogenesis of the infection of Cholera and the persistence of the micro-organism in environmental surface waters (Kaper et al., 1995). These developments need to be incorporated into the development of environmental health-work methods and procedures for the surveillance and control of Cholera.

Vibrio cholerae is a well-defined species, on the basis of biochemical tests and DNA homology studies (Bauman et al., 1984). The important distinctions within the species are made on the basis of the production of Cholera enterotoxin (Cholera toxin [CT]), serogroup and potential for epidemic spread (Faruque et al., 1998; Kaper et al., 1995). Two serogroups: O1 and O139 have been associated with epidemic disease, but there are also strains of these serogroups, which are not pathogenic; and they are known as non-O1/O139 (Kaper et al., 1995). Although, non-O1/O139 have been implicated as etiologic agents of moderate to severe human gastroenteritis, the vast majority of the non-O1, non-O139 strains are presumed to be non-pathogenic (Rahman et al., 2008).

Vibrio cholerae O1 serogroup consists of two biotypes: classical and El Tor, which can be further divided into two serotypes: Ogawa and Inaba (Kaper et al., 1995; Faruque et al., 1998). Genetic studies point to the possibility that the seventh pandemic El Tor strain could have given rise to the O139 strain by genetic shuffling. One cluster of genes did not react with any of the existing serogroups, suggesting that this fragment may have originated from another bacterium (Uma et al., 2003).

The natural habitat of the gram-negative bacterium *Vibrio cholerae* is the aquatic ecosystems (Faruque et al., 1998, 2004). Recent studies have established that

Vibrio cholerae is naturally occurring in both marine and fresh water environments; and it exists in association with plankton (Alum et al., 2007). Several studies have confirmed that in environmental waters *Vibrio cholerae* attaches to surfaces provided by plants, filamentous green algae, copepods (zooplankton), crustaceans and insects. Furthermore, algal and zooplankton blooms can promote the proliferation of *Vibrio cholerae* (Lipp et al., 2002; Vezzulli et al., 2008).

Various biological and physicochemical factors influence the growth, survival and distribution of *Vibrio cholerae* in aquatic environments (Alum et al., 2007). *Vibrio cholerae* O1 becomes coccoid and enters into a non-culturable state in the environment when conditions are not conducive for its active growth. Biofilms formed in situ in the aquatic environment, for most of the year, could contain Cholera bacteria in the non-culturable state of ‘‘conditionally viable environmental cells’’ (CVEC). These CVEC cells are well adapted to the aquatic ecosystem. These viable non-culturable state (VNC) bacteria do not grow on conventional culture media, but remain intact and retain their metabolic activity and respiration.

In general, *Vibrio cholerae* can be isolated from only 1% of water samples collected during epidemic periods – and rarely if ever between epidemics (Alum et al., 2006). However, the use of direct immunofluorescence of *Vibrio cholerae* O1 (DFA-DVC) technique, polymerase chain reaction (PCR) and improved culture methods has isolated both O1 and non-O1 strains, even in the absence of traditional indicator bacteria, such as *Eschericia coli* and faecal streptococci (World Health Organisation, 2002:246).

According to Sedas (2007), the numbers of *Vibrio cholerae* suspended in water are generally low, and usually approximately 10^3 cfu/l for *Vibrio cholerae* non-O1s, and less than, 50 cfu/l for *Vibrio cholerae* O1. However, the organism may be found in large numbers when associated with aquatic species, such as algae (blue green algae such as *Anabaena*), water hyacinth, duck weed, cyanobacteria, zooplankton and crustaceans. While counts of free organisms in

water may be low, copepods found in the same water may have 10^5 cfu/l organisms attached to their surface (Sedas, 2007; Emch, 2008).

Stools of Cholera patients contain high concentrations of *Cholerae vibrios* (up to 10^8 bacteria per gram), and they are highly infectious. When passed into the environment, they can contaminate water sources and food; and they may seed an environmental reservoir (Sack et al., 2004).

In a country where Cholera is endemic, the ingestion of water from ponds and rivers, when plankton blooms, can provide the requisite infectious dose for clinical Cholera to manifest (Colewell, 1996). Cholera is dose-dependent and the infective dose has been shown to be 10^3 to 10^6 *Vibrio cholerae* cells. Ingestion of this dose causes clinical symptoms (Huq et al., 2010). The likelihood of consuming an infectious dose is higher when a bloom of plankton occurs in the water (Ahmed et al., 2007).

People develop Cholera when they ingest an infective dose of *Vibrio cholerae* O1 or O139. The disease is characterised by a short incubation period (8 to 72 hours). Approximately 75% or more of initial infections with *Vibrio cholerae* O1 or O139 may be asymptomatic, depending on the infecting dose (Sack, et al., 2004). Of the 25% of persons with symptomatic infections, most have mild symptoms. Approximately 5% of patients have moderate illness symptoms that require medical attention, but not hospitalisation (World Health Organisation, 1999:38). Only about 2% of patients have severe disease symptoms, characterized by profuse watery diarrhoea, vomiting, and leg cramps. In such persons, the rapid loss of body fluids leads to dehydration, electrolyte disturbances, and hypovolemic shock. Without treatment, death can occur within hours (Sack et al., 2004).

According to the World Health Organisation (1999:39; 2008c), rehydration is the mainstay of Cholera treatment. The successful treatment of patients with symptoms depends on the rapid replacement of fluid and electrolyte losses. With proper treatment, mortality occurs in less than 1% of the reported cases

(National Department of Health, 2002:4).

The management of Cholera patients should focus on the recognition of Cholera cases; and health workers should start rehydration as soon as possible – to reduce the potential contamination of the environment and death. Given the spread of the disease, a well-coordinated strategy for preparedness is required at provincial and health district level for robust response, and to mitigate the impact of an epidemic (National Department of Health, 2002:4).

Cholera was the first disease for which modern public health surveillance and reporting was carried out in an organised way (World Health Organisation, 2001.1). The International Health Regulations, 2005 (IHR), require weekly notification of Cholera cases and deaths to the World Health Organisation. The World Health Assembly (WHA) has the legal authority to implement regulations concerning the prevention of, and the international spread of the disease.

The said International Health Regulations, 2005, emphasize the commitment of member states to the goal of global health security. This requires all member states to develop and maintain a functional and effective surveillance and response system that is able to detect, investigate and respond to public health emergencies of national and international concern (Revised International Health Regulations, 2005, World Health Organisation, 2006:3).

Since 2000, the incidence of Cholera has increased steadily, culminating in 317 534 reported cases worldwide, including 7543 deaths in 2010, with a case fatality rate (CFR) of 2.38% (World Health Organisation, 2011). Cholera remains a global threat to public health and one of the key indicators of social development. While the disease is no longer an issue in countries where minimum hygiene standards are met, it remains a threat in almost every developing country (Centre for Communicable Diseases, 2011:325).

In the South African context, according to Section 21(k) of the National Health Act, 2004 (Act 61 of 2003), the National Department of Health must facilitate and

promote the provision of the management, prevention and control of communicable diseases. In doing so, the National Department of Health has developed national guidelines for the control of Cholera in South Africa (National Department of Health, 2002). These are based on the guidelines provided by the World Health Organisation.

The Cholera control guidelines developed by the National Department of Health are intended to be used by the nine provincial Health Departments – to develop their Cholera surveillance and control strategies that must be implemented and executed by the municipalities within their areas of jurisdiction (S.A. Health Review, 2002:104).

The KwaZulu-Natal Provincial Health Department developed their Cholera Control guidelines in terms of the said national guidelines (KwaZulu-Natal Health Department, 2001). However, none of the guidelines provided by the World Health Organisation, the National Department of Health and the KwaZulu-Natal Provincial Health Department have detailed work methods and procedures on how to conduct Cholera surveys – nor do they provide details on functional and practical control strategies or activities to be performed once an outbreak of Cholera occurs.

The implications are that each municipality within the KwaZulu-Natal province will tend to follow its own work methods and procedures during surveillance and control strategies. As a result, it would be impossible to integrate data generated by the municipalities of the province, because the work methods and procedures followed during the collection of the data would not be the same.

The term “work procedure” is defined by Robbins, (1982: 72) as “… a series of interrelated sequential steps established for the accomplishing of a task”. Work procedures have been extensively used in organisations since time immemorial. According to Cheminais, Bayat, Van Der Waldt and Fox (1998:49), work procedures obviate a trial-and-error system – by providing novices with tried and tested ways of executing their duties. They also promote the concept of public

accountability by providing norms for acceptable behaviour on the part of public officials. Well-conceived and proven work procedures are essential for the efficient functioning of any organisation.

They offer the following advantages (Cheminais, Bayat, Van Der Waldt and Fox, 1998:49):

- They serve as the basis for sound induction and training;
- They promote safety, effectiveness and efficiency;
- They prevent ambiguity and misunderstanding – by providing standardised, uniform norms for the behaviour of public sector personnel;
- They provide a basis for assessing the performance of individuals and sections; and
- They are useful in the investigation of any mishaps or wrongdoings.

Andrews (1988: 10) pointed out that because of the need to continually adjust procedures to cope with technological developments, legislation does not normally prescribe any procedures in detail. They are set out in procedure manuals, which can be amended more easily and faster than changing legislation.

In terms of Section 1 of the National Health Act, 2004 (Act 61 of 2003), Cholera surveillance and control can be regarded as functions of environmental health practitioners in the municipal sphere of government. Environmental health services play a pivotal role in health-service delivery; and they concentrate on preventive and promotive health that is vital for the alleviation of current pressures on curative health services. The World Health Organization's definition (Basset, 1992: xxi) that was developed during a Consultation Meeting in Sofia, Bulgaria in 1993, defined Environmental Health from an international perspective. It states that it "…comprises those aspects of human health, including quality of life, that are determined by physical, chemical, biological, social, and psychosocial factors in the environment".

It also refers to the theory and practice of assessing, correcting, controlling, and preventing those factors in the environment that could potentially adversely affect the health of present and future generations (Agius, 2010). “Health” in this context is said to mean “…a state of complete physical, mental and social wellbeing, and not merely the absence of disease or infirmity” (World Health Organization, 1986).

According to Maarschalk (2003), there is a perception that a major contributing factor that negatively affects the environmental health profession in South Africa is the non-existence of a standard set of formal work procedures and methods. With this study, an attempt will be made to develop a standardised set of environmental health-work methods and procedures for Cholera surveillance and control in the KwaZulu-Natal Province, South Africa. Other provinces and municipalities should be able to use the results of this study during the development of their own work methods and procedures.

The next section presents the problem statement.

1.3. The problem statement

The National Department of Health has developed guidelines for the control of Cholera in South Africa (National Department of Health, 2002). These guidelines are based on the guidelines provided by the World Health Organisation; and they must be used by the provincial Health Departments and municipalities to develop their surveillance and control strategies. To date, no province or municipality have developed detailed environmental health-work methods and procedures for the surveillance and control of Cholera within their areas of jurisdiction. This study will attempt to develop the said work methods and procedures to be used by Environmental Health Practitioners within the municipal sphere of government in the KwaZulu-Natal Province.

1.3.1. Sub-problems

In order to effectively address the above, three sub-problems have been identified. These are explained below.

1.3.1.1. The epidemiology of Cholera

The surveillance and control of a disease is dependent on its epidemiology (Walley and Wright, 2010:239). It is therefore, important, when attempts are made to develop or improve existing work methods and procedures, to have a thorough knowledge of the epidemiology of the disease – especially as it manifests itself within the KwaZulu-Natal province. A thorough literature study on Cholera as a disease entity will therefore be done; and the findings utilised during the development of the said work procedures and methods.

1.3.1.2. The organizational arrangements for Cholera surveillance and control in South Africa

In terms of Section 1 of the National Health Act, 2004 (Act 61 of 2003), Cholera surveillance and control can be regarded as functions of environmental health practitioners in the municipal sphere of government. Since there are a number of role-players in national, provincial and municipal spheres whose decisions may influence the efficiency and / or effectiveness of Cholera surveillance and control, it has become necessary to critically analyse the current organizational arrangements for Cholera surveillance and control from a national, provincial and municipal perspective.

This analysis would enable the identification of inadequacies/weaknesses within the three spheres of government, as well as the identification of functional activities for which work procedures and methods must be developed.

1.3.1.3. Work methods and procedures for the surveillance and control of Cholera

From the above, it may be deduced that the work procedures and methods for Cholera surveillance and control must be exactly the same within each municipality of a province, in order for the data to be integrated, and for valid decisions to be made. With this study an attempt will be made to develop a standardised set of environmental health-work methods and procedures for the surveillance and control of Cholera in the KwaZulu-Natal province, South Africa.

1.4. Purpose of the study

The general purpose of this study is to develop a standardised set of environmental health-work methods and procedures, which would contribute to effective Cholera surveillance and control in the KwaZulu-Natal province, South Africa. More specifically, the purpose of this study is to:

- Firstly, analyse and describe the epidemiology of Cholera with the focus on the distribution and characteristics of the disease in South Africa – and specifically in the KwaZulu-Natal province – as a prerequisite for the development of formal work methods and procedures for the surveillance and control of the disease in the country as a whole. The methods of data collection of this part of the study will comprise a documentary review;

- Secondly, analyse the national health care system with specific reference to the place, role and current work methods and procedures of environmental-health practitioners at national, provincial and municipal spheres – in relation to Cholera surveillance and control – with the purpose of identifying inadequacies, and for making appropriate recommendations. The method of data collection will be a documentary review, as well as focus group interviews; and

- Thirdly, against the background of the findings of the above, to develop a formal set of work methods and procedures to be used by environmental-health practitioners during the surveillance and control of Cholera in the KwaZulu-Natal Province, South Africa. The method of data collection will comprise a documentary review, as well as focus group interviews. In the next section the significance of the study will be addressed.

1.5. The significance of the study

The development of formal work methods and procedures for Cholera surveillance and control by environmental-health practitioners is important because it gives legality and legitimacy to the actions of environmental-health practitioners. The particular work methods and procedures to be developed should compel environmental health practitioners to unite their efforts to work in

an organised manner. It should also ensure that everyone cooperates in attaining the set objectives (Maarschalk, 2003:10).

The formal work methods and procedures to be developed should make the actions of environmental health practitioners legal. This would also eliminate confusion amongst future Cholera surveillance and control personnel, and make the actions of environmental health practitioners more purposeful – and facilitate goal-directed training (Maarschalk, 2003; Botes et al., 1996; Cloete, 1996).

Formal work methods and procedures would enable the different spheres of government to integrate their data and to make information available from local, municipal, health sub-district, and health district, provincial and national perspectives. The results of this study could also contribute to a comprehensive knowledge of Cholera surveillance and control in South Africa.

1.6. Research design

The proposed research design has a qualitative, explorative, descriptive and contextual research approach. In the next sections these issues will be discussed.

1.6.1. Qualitative research design

A qualitative research design is defined as an inquiry process for understanding a social or human problem; and this must be conducted in a natural context (Creswell, 1994:2). Qualitative research is a form of social inquiry that focuses on the way people interpret and make sense of their experiences and the world in which they live. Qualitative researchers explore the behaviour, the perspectives, feelings and experiences of people – and what lies at the core of their lives.

Qualitative methodology is also useful in the exploration of change or conflict (Holloway and Wheeler, 2002:3). Qualitative research involves field work and going out to record the experiences of people and observing their behaviour in their natural settings. Qualitative methods focus on qualitative aspects (meaning,

experience and understanding), and they study human experience from the viewpoint of the research subject in the context where the action takes place (Brink, 1996:119).

A qualitative research design would assist in revealing how environmental health practitioners in the municipal and provincial spheres of government in the Kwa-Zulu Natal province are dealing with Cholera surveillance and control.

1.6.2. Explorative research approach

An explorative research approach provides more insight into the nature of the phenomena. With an explorative research approach the researcher would be able to see what is going on and what the nature of the phenomenon is (Brink, 2000:11). During the study the researcher will examine the experiences of the environmental-health practitioners working within the municipal and provincial spheres of government in the KwaZulu-Natal province regarding their functional and administrative activities in relation to Cholera surveillance and control.

1.6.3. Descriptive research approach

The purpose of this approach is to accurately portray individuals or real life situations for the purpose of discovering new meaning, and describing what exists – by categorising any information generated from the study (Creswell, 1998:145). In this proposed study, the researcher will describe the experience of the environmental-health practitioners within the municipal and provincial spheres of government in the KwaZulu-Natal province – with regard to their functional and administrative activities in relation to Cholera surveillance and control.

1.6.4. The contextual research approach

A contextual research approach involves the immediate environment and physical location of the people being studied (Holloway and Wheeler, 1998:192). The context is specific to municipalities within the KwaZulu-Natal province, and the phenomenon to be studied is specific: i.e. functional and administrative activities in relation to Cholera surveillance and control.

1.7. Research method

The research method describes how the researcher plans to go about collecting and making sense of the data collected (Hansen, 2006: 60). In the sections that follow, the research method for conducting this study will be further discussed.

1.7.1. The research population

A study population is that aggregate of elements from which the sample is actually selected (Babbie & Mouton, 2001:174; Brink, 1996:132). When doing a study, it is important to clearly define the group from which you want to gather the information, and about which you want to make conclusions (Katzenellenbogen et al., 2002:74). The research population for this study will include all the environmental health practitioners within the provincial and municipal spheres of government in the KwaZulu-Natal Province.

1.7.2. Sampling method

The primary goal of sampling is to get a representative sample or a small collection of units or cases from a much larger collection or population, such that the researcher can study the smaller group and produce accurate generalisations about the larger group (Neuman, 2000:195). According to Neuman (2000:196), the primary purpose of sampling is to collect specific cases, events, or actions that can clarify and deepen one's understanding of the phenomena.

The researcher will use a purposive, criterion-based focus group. With purposive sampling, the researcher gets all possible cases that fit the particular criteria by using various methods. This requires the judgement of the expert in selecting cases with a specific purpose in mind (Neuman, 2000:198). Purposive sampling is selected for a specific purpose – on which the researcher decides; therefore, the term purposive, or purposeful sampling is used (Holloway and Wheeler, 2002:123).

According to Barbour (cited in Hansen, 2006:52), purposive (or theoretical)

sampling offers a degree of control rather than being at the mercy of any selection bias.

A focus group may be defined as a carefully planned discussion designed to obtain perceptions on a defined area of interest in a permissive, non-threatening environment (de Vos et al., 2005:300).

The sample criteria for inclusion in the focus group will be as follows:

- Subjects must be registered as environmental-health practitioners with the Health Professionals Council of South Africa;
- Subjects must have at least 1 year of experience in communicable disease surveillance and control; and
- Subjects must be willing to participate in the study.

1.7.3. The sample size

Focus groups rely on purposive sampling and homogeneity. This is important. This homogeneity should be determined by the purpose of the group (Neuman, 2000:196), which in this case is the identification of the perceptions and practices of environmental-health practitioners with reference to Cholera surveillance and control in KwaZulu-Natal.

A sample size should neither be too large or too small, in order to address the research questions. An overly small sample could indicate premature stopping of sampling by the researcher (Hansen, 2006: 52). For the purpose of this study, at least one subject from each of the following authorities should be part of the focus group:

- Ugu District Municipality;
- uMgungundlovu District Municipality;
- uThukela District Municipality;
- uMzinyathi District Municipality;
- Amajuba District Municipality;

- Zululand District Municipality;
- uMkhanyakude District Municipality;
- uThungulu District Municipality;
- ILembe District Municipality;
- Sisonke District Municipality;
- eThekwini Municipality (Metro);
- Environmental Health Division – Provincial Department of Health – KwaZulu-Natal;
- Communicable Disease Coordinator – Provincial Department of Health – KwaZulu-Natal.

Interviews with the focus group will be repeated until data saturation occurs; thus when the researcher is observing respective themes or stories from the participants, even if it means that the researcher needs to interview more, or less than the abovementioned numbers. The power of purposive sampling lies in the quality of the information obtained, as opposed to a number per se (Hansen, 2006: 52).

1.7.4. Data collection

The primary methods of data collection for this study will be documentary research and focus-group interviews. The following paragraphs describe these methods.

1.7.4.1. Documentary research

Documentary research is a basic method for data collection (Creswell, 2003:188). Documentary studies refer to documents that are being studied and analysed for the purpose of scientific research (De Vos, et al., 2002:322). When documents are studied, it is of cardinal importance that the researcher evaluates the validity and reliability of the documents (De Vos, et al., 2002:324). During the documentary research, the researcher will collect the data from relevant government legislation and publications, official statistics and other national and international publications (Daly, Kellehear & Gliksman, 1997:132 – 134).

1.7.4.2. Focus group interviews

As a second means of collecting data, the researcher will conduct focus-group interviews, as discussed above.

The focus group involves persons specially selected, owing to their particular interest, expertise or position in the community – in an attempt to collect information on a number of issues, as well as brainstorming a variety of solutions, and facilitating group discussion as a tool of data collection and possibly policy construction. Focus groups are used as a form of data collection that employs discussion in a non-standardised form, with observation as its source (Sarantakos, 1997:181).

The focus-group discussions include more than one person at a time. Although this is conducted in a group environment, its main aim is not to analyse the group; it is primarily a way of gaining information in a short period of time about the breadth or varieties of opinions, and of establishing a mechanism for ascertaining information on the various opinions (Sarantakos, 1997:181).

The basic assumption that underlies this method is that the group environment would, through mutual stimulation, encourage discussion related to topical issues; it should increase the motivation to address social and especially critical issues; it should also enable the discussion leader to lead the discussion towards focal points and topical issues; and it should thereby allow significant points of view to be presented. This is expected to occur when: (1) Addressing, describing or explaining an issue introduced by the leader or group member; (2) comparing different points of view, evaluating views and discussion outcomes, and judging relevant arguments; or (3) making decisions or drawing conclusions by presenting alternative points of view, trying to achieve or suggesting a possible consensus of opinions (Sarantakos, 1997:181).

Focus-group interviews are a method of data collection in which an interviewer obtains responses from participants in a face-to-face encounter (Brink, 1996:

157). It also allows the researcher to investigate a multitude of perceptions in a definite area of interest (Nyamathi and Shuler, 1990; 1282, as cited in De Vos et al., 2005: 300). These interviews can be classified as structured, semi-structured, unstructured, in-depth or informal (Hansen, 2006: 98-102).

Semi-structured interviews will be conducted in this research study. The interviewer will use this method of data collection to ascertain the participants' experiences on the implementation of Cholera surveillance and control strategies (see Annexure 3 Permission to conduct Research). The interviews during the group sessions will be recorded by using an audiotape recorder; and these will be transcribed verbatim and analysed.

The interviews will be conducted at an appropriate facility. The topics to be covered are as follows:

- The organisational structure (including the lines of communication) of Cholera surveillance and control in the province;
- The role (functional activities) of the environmental-health practitioner in Cholera surveillance and control;
- Lessons learnt during previous Cholera surveillance and control strategies; and
- Any recommendations.

Additionally, questions may be asked to gain clarity. New lines of questioning may develop during the focus-group sessions. There needs to be a rapport with the participants; and the interviewer needs to listen very carefully, allowing pauses and time for the participants to think (Hansen, 2006: 99-100). Open-ended questions will be asked to elicit the participants' experiences. The participants will be given freedom to discuss issues beyond the confines of the questions.

1.7.4.3. Field notes

An assistant facilitator will take detailed field notes during the focus-group sessions. After the group sessions, the researcher will take notes as well. Both the researcher and the assistant facilitator will then discuss their notes. It is important that this be done as soon as possible after each focus group session. The notes will include (De Vos, et al., 2005: 311):

- Seating arrangements;
- The order in which participants speak, to aid voice recognition;
- Non-verbal behaviour, such as eye contact, posture, gestures between group members, crying and fidgeting;
- Themes that are striking; and
- Highlighting as much of the conversation as possible.

Attention will also be given to the dynamics that took place in the group. Field and Morse (1985) prescribed field notes as a written account of the things the researcher hears, sees, experiences and thinks in the course of collecting or reflecting on the data obtained during the study.

1.7.4.4. Data analysis

Data analysis is a process which brings order, structure and meaning to the mass of data collected (Cresswell, 1994:153). During the course of this study several simultaneous activities will engage the attention of the researcher: Collecting information from the field; sorting the information into categories; formatting the information into a story; and then actually writing the text (Cresswell, 1994:153). The process of data analysis will be based on data reduction and the interpretation (Creswell, 1994:143-144).

The researcher takes voluminous quantities of information (see Creswell, 2003:215) and reduces this into patterns, categories, or themes; and s/he then interprets this information by using schema (Cresswell, 1994:154).

Cresswell (1994:142-165) believed that the process of data analysis and

interpretation could best be presented in the form of a spiral image, rather than by using the fixed linear approach. One enters with data made up of text or visuals; and one exits with an account or narrative. In between, the researcher touches on several facets of the analysis, circling around and “upwards” towards the completion of the process (De Vos et al., 2002:340).

Miles and Huberman developed an interactive-data analysis model, which comprises three main components, namely: data reduction, data display and the drawing and verifying of conclusions. These three components are interwoven and concurrent throughout the entire data-analysis process, which involves three main operations: coding, memoing, and the developing of propositions (Punch, 2005:197-199).

The coding process and data analysis will be conducted, according to the steps suggested by Tesch (1990) in Cresswell (2003:192). These steps are as follows:

- Get a sense of the whole. Read through all the transcripts carefully. Make short notes;
- Pick one document (interview) at a time. Go through it, and try to make sense of it. Write notes in the margin;
- When this action has been completed for several documents, make a list of all the topics. Group similar ones together, and list them in columns that can be arranged as: a major topic, unique topics and leftovers;
- Take this list and go back to the data. Abbreviate the topics as codes and write the codes next to the appropriate segments of the text, to see whether new categories and codes emerge;
- Find the most descriptive wording for the topics and turn them into categories. Look for reducing total lists of categories by grouping related topics. Indicate interrelationships between categories;
- Make a final decision on abbreviations for each category in one place; and then perform a preliminary analysis; and
- If necessary, recode the existing data.

Transcripts of the audiotaped interviews will be made, and sent to an independent coder with a data analysis guide to be used. The independent coder will use the data-analysis guide provided to analyse the data from the transcribed interviews. This action by the independent coder will assist in excluding biases by the researcher, and also to control any haphazardness in the data coding analysis (Kvale, 1996:208).

A discussion between the researcher and the coder will then follow, in order to finalise the findings of the study. The results of the data analysis will assist with the development of the work methods and procedures for the surveillance and control of Cholera in the KwaZulu-Natal province (see Annexure 4 Data analysis: research focus group interviews).

1.7.4.5. Literature control

A literature control is a process that involves finding, reading, understanding and forming conclusions about the published research and theory on a particular topic (Brink, 1996: 76). A literature control will be done to determine what is already known about the topic being researched. The literature control would also be done to refine certain parts of the study, and to form a basis for comparison when interpreting the findings of the current study (Brink, 1996: 76). The results will, subsequently, be re-contextualised within the framework for scholarly literature linked to the focus of the study.

1.8. Pilot study

Although pilot testing is a cardinal rule of research, it presents special problems with focus groups. The questions used with focus group interviews are hard to separate from the environment of the focus group. The true pilot test is the first focus group with the participants (De Vos *et al*., 2005: 309). De Vos (2005: 309) and Krueger (Morgan & Krueger, 1998: 58) both suggested pilot testing with research team members, experts and potential participants. With this study, a pilot study will be done with two of the thirteen participants that have been identified and included in the focus group.

1.9. Trustworthiness

The key principle of good qualitative research is found in the notion of trustworthiness: That is, the neutrality of its findings or decisions (Babbie and Mouton, 2001: 276). Lincoln and Guba (1985): 290) used the trustworthiness model to refer to the essential criteria of high-quality research. Lincoln and Guba's model comprised four aspects that reflect the assumptions of qualitative research, namely: credibility, transferability, dependability and conformability.

The trustworthiness of this study in terms of Lincoln and Guba's model is discussed below.

1.9.1. Credibility

Credibility is the quality whose goal it is to demonstrate that the inquiry was conducted in such a manner as to ensure that the subject was accurately identified and described (De Vos, et al., 2002:351). In this study, this will be ensured by exploring the experiences of the subjects in the focus group, which will be accurately recorded and transcribed without distortion in language and context, to ensure that the data conform to the reality of what the participants describe.

According to Babbie and Mouton (2001: 277), credibility is achieved through the following "procedures":

- **Prolonged engagement:** Stay in the field until data saturation occurs;
- **Persistent observation:** Consistently pursue interpretations in different ways, in conjunction with a process of constant tentative analysis. Search for what counts and what does not count;
- **Triangulation:** The best way to elicit the various and divergent constructions of reality that exist within the context of a study is to collect information about different points of view;
- **Referential adequacy:** This refers to the materials available to document the findings, such as audio-taping etc;
- **Peer debriefing:** This is done with a colleague of similar status who is

outside the context of the study, who has a general understanding of the nature of the study, and with whom you can review perceptions, insights and analyses; and

- **Member checks:** Go to the source of the information and check both the data and the interpretation. The aim is to assess the intentionality of the respondents, to correct for obvious errors, and to provide additional volunteer information.

To enhance credibility, triangulation will be recognised by using multiple sources of authoritative research and other literature to cross-check the facts, and by offering the transcripts to participants during follow-up group sessions to corroborate their transcripts or to clarify them.

1.9.2. Transferability

Transferability refers to the degree or extent to which the findings of research data can be applied in other contexts or with other respondents (De Vos et al., 2002: 352). All observations are defined by the specific contexts in which they occur. The researcher, therefore, does not maintain or claim that knowledge gained from one context would necessarily have relevance in other contexts, or to the same context in another timeframe. The obligation for demonstrating transferability rests on those who wish to apply it to the receiving context (Babbie and Mouton, 2001: 277).

Guba and Lincoln (as cited in Babbie & Mouton, 2001: 278) discuss the following strategies for transferability:

- **Thick description:** Because transferability depends on similarity between the sending and receiving contexts, the researcher collects sufficiently detailed descriptions of data in context, and then reports on them with sufficient detail and precision to allow judgements about transferability to be made by the reader; and

- **Purposive sampling:** By purposely selecting locations and informants that differ from one another, qualitative research seeks to maximise the range of specific information that can be obtained from and about that context.

The strategy of triangulating multiple sources of data can enhance a study's transferability (De Vos et al*.,* 2002:352). This means that designing a research in which multiple cases, multiple informants, or more than one data-collecting method are employed, could strengthen the study's usefulness for other settings. In this research, the strategy of triangulating multiple sources of data (literature control and focus-group interviews) will be used to strengthen their transferability (Marshall and Rossman, 1995: 144).

1.9.3. Dependability

An inquiry must provide its audience with evidence that if it were to be repeated with the same or a similar subject in the same (or in a similar) context, its findings would be similar. Since there can be no validity without reliability, a demonstration of the former is sufficient to establish the existence of the latter. If it is possible, by using the techniques outlined in relation to credibility, to show that a study has the necessary quality, it ought not to be necessary to demonstrate dependability separately (Babbie and Mouton, 2001: 278).

In effect, overlapping methods represent triangulation, which is typically undertaken to establish validity, not reliability; although demonstration of the former is equivalent to demonstration of the latter, these points have been contested as being sufficient to establish dependability. Guba and Lincoln, as cited in Babbie and Mouton (2001: 278), introduced the notion of an *inquiry audit,* whereby the auditor examines the documentation of critical incidents and gives a running account of the process of inquiry.

The auditor, in determining its acceptability, attests to the dependability of the inquiry; and then examines the product – data, findings, interpretations and recommendations supported by the data – to determine whether it is internally

coherent, so that the “bottom line” can be accepted. This process establishes the conformability of the inquiry. Thus, a single audit, properly managed, can be used to determine dependability and conformability simultaneously.

Dependability is the criterion for consistency. This refers to the researcher attempting to account for the changing conditions of the chosen research phenomenon and the changes in design (De Vos et al., 2003:352). The strategies used to ensure dependability in this study will be a dense description of the research methods together with triangulation (Krefting, 1991:217).

1.9.4. Conformability

This is the degree to which the findings are the product of the focus of the inquiry, rather than the biases of the researcher. Conformability refers to the objectivity or neutrality of the research (De Vos et al., 2002: 352; Lincoln & Guba, 1985: 209). This means that no prejudice is evident in the research process and results. Lincoln and Guba (cited in Babbie & Mouton, 2001: 278) refer to a conformability audit trail, i.e. an adequate trail that should be left to enable the auditor to determine whether the conclusions, interpretations and recommendations can be traced to their sources, and if they are supported by the inquiry. In conducting the trail, the data need to be reviewed as follows:

- **Raw data:** Tape-recorded focus-group interviews, written notes, documents and survey results;
- **Data reduction and analysis products:** Write-ups of field notes, and theoretical notes, such as concepts and hunches;
- **Data reconstruction and synthesis products:** Themes that are developed, findings and conclusions, as well as a final report;
- **Process notes:** Methodological trustworthiness and audit-trail notes;
- **Material relating to intentions and dispositions:** Inquiry proposal, personal notes and expectations; and
- **Instrument-development information:** Pilots, forms and preliminary schedules, observation formats and surveys.

According to Krefting (1991:217), strategies to ensure conformability include a conformability audit, triangulation and reflexivity. Both the research process and the research results will be audited by the supervisor and experts in this field, to ensure the conformability of the study.

1.10. Ethical considerations

Anyone involved in research needs to be aware of general agreements about what is proper, and what is improper in scientific research (Babbie, 2001: 470, as cited in De Vos et al., 2002:62). According to Botha (1993: 3), ethical guidelines serve as standards, and as the basis whereby each researcher ought to evaluate his/her own conduct. Ethical principles should be internalized in the personality of the researcher – to such an extent that ethically guided decision-making becomes part of one's total lifestyle.

Respondents should be well informed beforehand about the potential impact of the investigation. A researcher is ethically obliged to change the nature of his research rather than to expose the respondents to the faintest possibility of physical and/or emotional harm, of which he may know/be aware (De Vos et al., 2002: 65). Respondents must be fully informed as to what is going to happen to the information after recording.

The study will not harm the environment, humans or animals, because no experiments or trials are involved. Informed consent will be obtained from the participants prior to the start of the study (see Annexure 1 and 2). The participants will be informed as to what will happen with the results throughout the study. The ethics approval of the Nelson Mandela Metropolitan University Ethics Committee will be obtained before commencement of the study.

1.11. Format of the research report

The study will be divided into six chapters, namely:

Chapter 1: Introduction

Chapter 2: The epidemiology of Cholera.

Chapter 3: Cholera: The place and role of Environmental Health in the national, provincial and municipal spheres of government.

Chapter 4: Work methods and procedures for the surveillance of Cholera.

Chapter 5: Work methods and procedures for the control of Cholera.

Chapter 6: Conclusion /Limitations and Recommendations

In **Chapter One** a thorough literature review of the study is presented. The problem and sub-problem statements of the study are also presented in this chapter. This is followed by an explanation of the purpose, significance and contextual research approach of the study. Furthermore, the research design and methodology to be adopted for the study are explained and motivated here. Also identified and discussed are the measures for trustworthiness, and the ethical considerations.

Chapter Two explains the historical background of Cholera, with the emphasis on the seven epidemics that have occurred throughout the years. The incidence of cholera in South Africa is highlighted, as well as the history of all the various Cholera outbreaks. Recent studies of the aquatic environment have shown that *Vibrio cholerae*, including serogroups 01 and 0139, are normal inhabitants of surface water, particularly brackish waters, and survive and multiply in association with zooplankton and phytoplankton – quite independently of human beings. It is, therefore, important to give an account of the environmental factors influencing the survival and proliferation of *Vibrio cholerae*. Cholera, usually begins with the ingestion of an infectious dose of *Vibrio cholerae* O1/O139; the clinical manifestations, the diagnosis and the treatment of cholera are also discussed in this chapter.

In **Chapter Three**, environmental health is defined, to identify the functional areas of the environmental-health profession, and to identify the professional regulatory framework and requirements of the profession. Furthermore, the national health-care system in South Africa is analysed, with specific reference to the place and role of environmental health, as well as that of the other role-players within the health-care system, whose decisions may have an influence on the effectiveness of environmental health-service delivery.

The said organisational structure is discussed from a national, provincial and municipal perspective. Regulatory documentation relevant to Cholera surveillance and control are also introduced and discussed.

Chapter Four deals with the work methods and the procedures for Cholera surveillance. The concept of work methods and the specific procedures are described here. The basic principles of Cholera surveillance are explained from a public-health perspective. In this chapter, the work methods and procedures for human-case surveillance are discussed from four perspectives, namely: case detection, notifiable disease reporting; the investigation of a Cholera outbreak and case confirmation. Also discussed in this chapter are work methods and procedures for environmental surveillance of Cholera from three perspectives, namely: identifying those communities in high-risk areas, sanitary surveillance and water quality surveillance.

Chapter Five focuses on the work methods and procedures for the control of Cholera. In this chapter, Cholera control is discussed from four perspectives, namely: basic strategies for Cholera control; control strategies for Cholera in humans; control strategies for the environmental transmission of Cholera, and the role of the Cholera Outbreak Response Teams.

This chapter also focuses on the place and role of environmental health-practitioners in the national, provincial, district and sub-district communicable disease-outbreak response teams.

Chapter Six presents the conclusion, with a particular emphasis on the findings of the study. The limitations of the study are discussed and appropriate recommendations are made.

1.12. Clarification of concepts

Various attempts have been made by social scientists to formulate universally acceptable definitions for the different phenomena found in the specific field of study. These attempts have failed, mainly due to a semantic confusion of words and expressions in their definitions. To prevent confusion, the meanings of important terms and functions used in this study will be adequately clarified.

- **Municipal health services**

  In terms of section 1 of the National Health Act, 2004 (Act 61 of 2003), municipal health services include the following, but exclude, port health, malaria control and the control of hazardous substances:

  - Water quality monitoring;
  - Food control;
  - Waste management;
  - Health surveillance of premises;
  - Surveillance and prevention of communicable diseases, excluding immunisations;
  - Vector control;
  - Environmental pollution control;
  - Disposal of the dead; and
  - Chemical safety.

  Cholera surveillance and control are activities under the service: Surveillance and prevention of communicable diseases (see bullet five above).

- **Cholera**

  Cholera is an infection of the small intestine caused by the bacterium *Vibrio Cholerae*. It causes a large amount of watery diarrhoea (World Health Organisation, 2004:11).

- **Cholera outbreak (epidemic)**

  A (Cholera) outbreak or epidemic is an increase in the number of cases, above the expected incidence of the specific disease, or abnormal conditions in a specific geographical area within a defined period of time (Connolly, 2005:107).

The surveillance and control of a disease is dependent on its epidemiology. It is therefore important, when attempts are made to develop or improve existing work methods and procedures, to have a thorough knowledge of the epidemiology of the disease – especially as it manifests itself within the KwaZulu-Natal province. A thorough literature study on Cholera as a disease entity will therefore be done and the findings will be utilised during the development of the said work procedures and methods. In the next chapter the epidemiology of Cholera will be described.

CHAPTER TWO

THE EPIDEMIOLOGY OF CHOLERA

2.1 Introduction

Epidemiology is the foundation for the surveillance and control of a disease. It is, therefore, necessary to study the epidemiology of cholera, in order to develop formal work methods and procedures for cholera surveillance and control. This chapter focuses on the epidemiology of cholera as a disease entity.

Firstly, the historical background of cholera is explained with the emphasis on the seven worldwide pandemics that have occurred over the years. The incidence of cholera in South Africa is highlighted, as well as the history of the cholera outbreaks. Secondly, a description of the classification, as well as the toxigenicity of *Vibrio cholerae,* is presented. Thirdly, recent studies of the aquatic environment have shown that *Vibrio cholerae*, including serogroups 01 and 0139, are normal inhabitants of surface water, particularly brackish waters; and they survive and multiply in association with zooplankton and phytoplankton quite independently of human beings. It is therefore important to give an account of the environmental factors that influence the survival and proliferation of *Vibrio cholerae*.

Fourthly, it is impossible to maintain cholera surveillance and control effectively if the relevant personnel do not have a thorough knowledge of the disease. The clinical manifestations, together with the diagnosis and the treatment of cholera, must therefore also be discussed. The historical background of the disease is firstly presented in the section that follows.

2.2 Historical background of Cholera

The term Cholera is said to derive from either the Greek, meaning “bilious” or from Hebrew, meaning “bad disease” (Kaper et al., 1995). Cholera is an acute diarrhoeal infection caused by the ingestion of food or water contaminated with the bacterium *Vibrio cholerae.* The short incubation period of two hours to five

days, enhances the potentially explosive pattern of outbreaks (World Health Organisation, 2008a).

Two distinctive epidemiologic features of Cholera are: its tendency to appear in explosive outbreaks – often starting in several distinct foci simultaneously, and its propensity to cause true pandemics that progressively affect many countries in various continents over the course of many years (Kaper et al., 1995).

It is generally accepted that seven distinct pandemics of Cholera have occurred since the first pandemic was recognized in the early 19th century (Kaper et al, 1995). In each instance, Cholera spread from Asia to reach other continents in pandemics that affected many countries and extended over many years. Except for the seventh pandemic, which originated on the island of Sulawesi in Indonesia (204), the other six pandemics arose from the Indian subcontinent, usually from the Ganges delta in Bengal (Kaper et al., 1995).

Since 1961, the world has been experiencing the seventh pandemic of Cholera, the causative organism of which is *Vibrio cholerae* O1 of the El Tor biotype (Kaper et al., 1995). The final decade of the 20th century has been a hallmark epoch for Cholera.

In 1991, the seventh pandemic reached South America. This marked the return of Cholera to this continent after a century of absence. This last extension of the El Tor pandemic resulted in the single largest and most rapidly spreading of all epidemics recorded during the history of the seventh pandemic. Abruptly and unexpectedly, 23 months later there appeared in the Indian sub-continent a new variant of *Vibrio cholerae,* which was found to express surface antigens of a new O serogroup, this variant was named *Vibrio cholera* O139 (Faruque et al., 1998).

South Africa experienced seasonal Cholera peaks between 1980 and 1985. However, in Africa the year of 1997 marked a dramatic Cholera epidemic – affecting all the countries in the Horn of Africa.

In August 2000, South Africa experienced the start of one of the worst outbreaks in the country's recent history. In 2008, a raw sewage spill from Beit Bridge into the Limpopo River, and a total breakdown in that Zimbabwean town's water treatment, caused the worst of the recent outbreaks in Southern Africa (Bateman, 2009).

During 2010, *Vibrio cholerae* was introduced into Haiti; and on 26 October 2010, the explosive spread of the outbreak was linked to the lack of immunity against *Vibrio cholerae,* as well as to the limited access to safe drinking water and basic sanitation, in addition to the internal migration that followed the earthquake in January 2010 (Centre for Communicable Diseases, 2011: 331).

According to the Centre for Communicable Diseases (2011: 331), Cholera is now endemic in many countries. The endemicity of Cholera carries the potential of epidemic flare-ups and pandemicity is always a threat, especially in developing countries having unsafe water supplies and poor sanitation (Colewell, 1996). In the next section the timeline of Cholera will be presented.

2.2.1. The Cholera timeline

There are descriptions of a disease resembling cholera in Sushruta Samshita from India, written in Sanskrit during 500 to 400 before Christ (B.C). Hippocrates, the father of medicine and a famous physician in the Age of Pericles (448 BC), gives considerable detail concerning the history and symptoms of the disease (Beard, 1936). According to Mosley (1970:23), Cholera has been endemic in the delta of the Ganges and Brahmaputra in eastern India and East Pakistan since the beginning of recorded history.

The first recorded pandemic of Cholera started in 1817. The source of the outbreak was the Ganges River, which is considered to be the lifeblood of India. The Ganges flows the length of the country and supplies its people with water for drinking, washing irrigation, and waste removal. Scientists think that Cholera was endemic in the Ganges River, and that low levels of bacteria had been present

as far back as 499 B.C (Bjorklund, 2003:24). In the next section, the Cholera pandemics will be presented:

- **First Pandemic 1817-1823**

  The disease started in the Ganges River region and spread to Kolkata, India (Bjorklund, 2003:24). The deaths in India between 1817 and 1860 are estimated to have exceeded 15 million people (Garfield, 1986; Wikipedia, 2009). The soldiers and traders carried it to South-east central Asia, the Middle East, eastern Africa, and the Mediterranean. At Basra, Iraq, as many as 18 000 people died during a three-week period in 1821 (Cholera: Encyclopedia Britannica, 2009).

- **Second Pandemic 1829 -1849**

  This pandemic began in India, and was taken by traders and merchants to Russia, Finland, Poland, and in 1831, to England, causing 140 000 deaths. Irish immigrants carried the disease to Quebec, Canada in 1832; and then it entered the United States through Detroit, Michigan, and New York. By 1832, Cholera had reached New Orleans; and by 1833 it had journeyed to Mexico (Bjorklund, 2003:24). In 1831, the cholera pandemic killed 150 000 people in Egypt; and in 1846 cholera struck Mecca, killing 15 000 people (Cholera: Wikipedia, 2009).

  In 1832, the two year outbreak in England and Wales claimed 52 000 lives (Cholera: Wikipedia, 2009). The response to this outbreak 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 pandemic (Sack et al., 2004). The fundamental epidemiological observations by John Snow on the waterborne transmission of cholera were made in London between 1847 and 1854 – during the late second and the third pandemics (Snow, 1855, as cited in Faruque et al., 1998).

- **Third Pandemic 1852 -1859**

  From India, British troops carried Cholera to Afghanistan, and then it spread into China, Iran, Asia, Africa, and Europe. Europeans carried the bacteria to the east coast of the United States. In 1849, in California, gold-rush miners carried the disease from the east coast to the Pacific coast, and then to Mexico. *Vibrio cholerae* reached Central America in 1856 (Bjorklund, 2003:25).

  The third pandemic (1852 to 1860) erupted in India (Colwell, 1996). This pandemic is generally considered to have been the most deadly pandemic of all (Encyclopedia Britannica, 2009). The pandemic mainly affected Russia (with over one million deaths); from there it spread through Persia (present-day Iran) to Europe, the United States, and then to the rest of the world. Africa was severely affected, with the disease spreading from its eastern coast into Ethiopia and Uganda (Cholera: Encyclopedia Britannica, 2009).

- **Fourth Pandemic 1863- 1879**

  As they travelled to their holy land, Muslim pilgrims took Cholera from the Ganges Delta to Mecca, Saudi Arabia. From there, the disease spread to the Middle East, Africa, Western Europe, Russia, and the Americas (Bjorklund, 2003:25). The cholera pandemic in New York led to the formation of the first Board of Health in the United States of America in 1866; and Cholera became the first notifiable disease (Sack et al., 2004). Cholera failed to get into New York from any infected ships; but it arrived there in 1887, and again in 1892 (Swaroop & Pollitzer, 1955).

- **Fifth Pandemic 1881-1896**

  During this pandemic, *Vibrio cholerae* spread from the Kolkata region of India to Asia, Africa, South America, France, Russia, Germany, and Japan. Generally considered less severe than the previous epidemics, however in some areas, extraordinary outbreaks were recorded, such as for example, 5 000 inhabitants of Naples died in 1884; 60 000 in Spain in 1885, and

another 200 000 in Russia from 1893-95 (Cholera: Encyclopaedia Britannica, 2009).

- **Sixth Pandemic**

  Once again, the outbreak started in the Ganges River region. Then it reached the Middle East, North Africa, and Russia. This pandemic was essentially the last outbreak of cholera in the West. It caused 4 000 deaths in Mecca and Egypt, but it failed to reach the Americas (Colwell 1996; Cholera: Encyclopaedia Britannica, 2009). In the first half of the 20th century, the disease seemed to rest. It was still present in Asia, but aside from a devastating epidemic in Egypt in 1947, where 32 978 cases (with 20 472 deaths) were reported, it did not appear in epidemic proportions anywhere else in the world (Swaroop & Pollitzer, 1955).

- **Seventh Pandemic 1961-present**

  Originating in Indonesia, the cholera bacteria known as El Tor spread across Asia, reached Europe; it then hit the Middle East and Africa. In 1991, it reappeared in Peru, after an absence of 100 years in the American continent (Kaper et al., 1995).

  The seventh pandemic of Cholera is notable for several reasons (Kaper et al., 1995). Firstly, this pandemic which is still ongoing is the most extensive in geographic spread and in time. Secondly, the causative agent is *Vibrio cholerae* O1 of the El Tor biotype. The sixth pandemic, and probably the fifth as well, were caused by *Vibrio cholerae* O1 of the classical type. Thirdly, all previous pandemics originated in the Indian subcontinent, whereas the seventh pandemic came from the island of Sulawesi, in the Indonesian archipelago (Kaper et al., 1995).

Several features have undoubtedly contributed to allow the extensive geographic spread of El Tor during the seventh pandemic. These will be discussed in the following section.

2.2.2. Features contributing to the spread of Cholera

An important determinant of the epidemiology of the seventh pandemic is caused by the differences in the *Vibrio cholerae* biotypes. Although *Vibrio cholerae* O1 El Tor serotype Ibana is a less virulent strain than *Vibrio cholerae* O1 classical, it causes a higher proportion of asymptomatic infections (1:30-100 compared with 1:2-4); and thus it allows carriers to spread the disease unknowingly through contamination of food or water (Sack et al., 2004).

The duration of carriage after infection is longer for El Tor. The organism grows in many foods; it survives longer in the natural environment (it is one of the most resistant to adverse environmental conditions); and it shows a greater resistance to antibiotics and chlorine (Lee, 2001). The disease has now become endemic in many places, particularly in South Asia and in parts of Africa (Sack et al., 2004).

The clinical case/invisible infection ratio is skewed for El Tor, such that for each of Cholera gravis there are many more individuals with mild or invisible infections than is seen with the classical biotype Cholera (Kaper et al., 1995). As a consequence, in communities affected by El Tor Cholera, there are many individuals circulating who are asymptomatic excretors, and who, depending on local water supply and sanitary conditions, can thereby spread the infection (Kaper et al., 1995).

Modern transport, particularly air travel, is increasingly utilized by individuals of all socio-economic levels in developing countries. Thus, an individual asymptomatically excreting El Tor Cholera or incubating the infection prior to the onset of the clinical illness can be whisked from one continent to another within hours (Kaper et al., 1995).

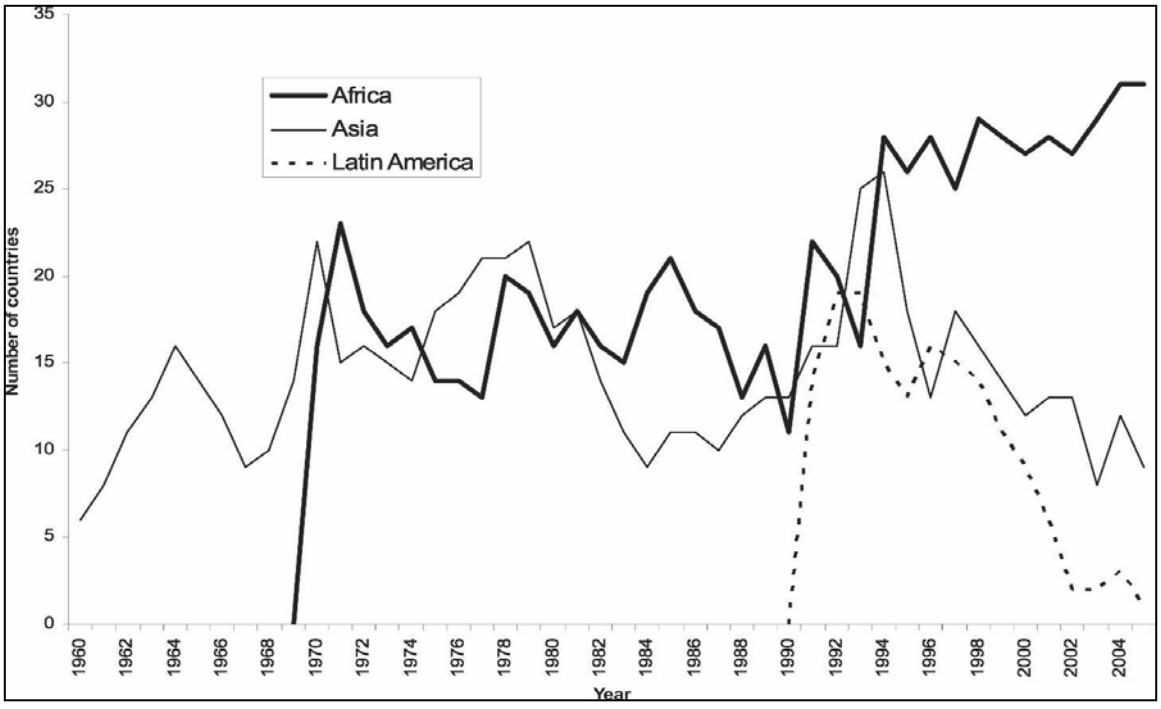
The incidence of Cholera will be discussed in terms of the discovery of the Cholera organism and the incidence of cases during the seventh ongoing pandemic. Firstly, it will be presented from an international perspective, and secondly, from the South African perspective.

2.2.3. The worldwide incidence of Cholera

The aetiological agent responsible for cholera was identified during the 19th century. In 1883, Robert Koch demonstrated that cholera is produced by a bacterium that he referred to as a "comma-(shaped) bacteria" (Koch, 1884, as cited in Reidl & Klose, 2002). He later designated this organism as *Vibrio cholerae* (Reidl & Klose, 2002).

The early pandemics preceded Koch's discovery of the infectious cause of cholera; and consequently, have never been associated with a specific variant. The fifth and sixth pandemics, however, were shown to have been caused by the *Vibrio cholerae* serogroup O1 of biotype "classical"; while the seventh pandemic was caused by the serogroup O1, biotype "El Tor" (Barua & Greenough, 1992:21).

Figure 1: The number of countries that reported Cholera cases to the WHO by region (Africa, Asia, Latin America) during the years 1960-2005.



Source: Adapted from Gaffga et al., (2007)

In 1992, a newly described non-O1 serogroup of *Vibrio cholerae* designated O139 Bengal, caused unusual outbreaks in India and Bangladesh (Sack et al.,

2004). The number of cases caused by this serogroup remains only a small proportion of the total number of cholera cases worldwide (World Health Organisation, 2008a & Zuckerman, 2007). This seventh pandemic led to the re-emergence of Cholera in Africa in the 1970s; 11 086 cases (with 747 deaths) and, in southern Europe 726 cases (with 1 death) were reported (see Figure 1).

In 1970, an epidemic of Cholera struck West Africa. This area had not experienced the disease for more than 100 years. The disease quickly spread to more than 30 countries (Sack et al., 2001); and it eventually became endemic in most parts of the African continent (World Health Organisation, 2000; Zuckerman et al., 2007). As the pandemic moved into Africa, there were two main epidemic foci: in Southern and Eastern Africa (Zambia, Mozambique, Malawi and Angola), and in West Africa (Barua & Greenough, 1992: 21; Isaäcson, 1986).

Internationally, Cholera incidences generally remained relatively low in the 1980s, and were confined to Asia and Africa (Isaäcson et al., 1974). In 1991, the pandemic of Cholera El Tor, which started in 1961 in Indonesia, finally completed its encircling of the globe. The pandemic reached the Americas in 1991, causing nearly 400 000 cases that year. The Pan American Health Organisation estimates that in 1991 and 1992 there were 750 000 cases of Cholera in the Americas and 6 500 deaths (Kaper et al., 1995).

According to the World Health Organisation, (1997) 85 809 cases and 845 deaths were reported in 1995; and 24 643 cases and 351 deaths were reported in 1996, indicating that Cholera was on the decrease in Latin America. The number of cases reported has since diminished sharply; and in 2005, only one Latin American country, i.e. Brazil, reported five cases of Cholera (World Health Organisation, 2006).

The number of Asian countries reporting Cholera cases (indigenous or imported) decreased from a mean of 18 during the period 1970–1979 to a mean of only 11 during the period 2000–2005. In 2005, nine Asian countries reported a total of

just 6 824 indigenous or imported Cholera cases to the World Health Organisation (Gaffga et al., 2007).

The incidence of Cholera and the number of countries reporting Cholera have decreased in Asia and Latin America over the past decade. The number of countries in sub-Saharan Africa reporting Cholera has increased; and the incidence has remained largely unchanged (Gaffga et al., 2007).

The political instability during July 1994 in Rwanda led to one of the most noteworthy cholera outbreaks of the decade; thousands of refugees fled Rwanda into Zaire. The case-fatality rate was 22% at its peak; and 40 000 people were at one time dying of cholera. The epidemic strain of 01 El Tor was resistant to tetracycline and several other drugs generally used for its treatment (Sack et al., 2001).

The year of 1997 was marked by a dramatic Cholera epidemic, affecting the countries in the Horn of Africa. A total of 147 425 cases (6 274 deaths) with a case fatality rate of 4.3% were reported in 1997 to the World Health Organisation. With a total of 118 349 cases, Africa accounted for 80% of the global total. The countries accounting for the highest numbers of cases were the United Republic of Tanzania (40 249), Guinea-Bissau (20 555), Kenya (17 200), Chad (8 801) and Mozambique (8 739) (World Health Organisation, 1998).

In Africa in 1998, eleven countries reported outbreaks of Cholera, with 21 748 cases. This was the highest number of cases ever reported, and accounted for 72% of the global total. Most of the Cholera outbreaks followed heavy rainfalls, which in some countries resulted in huge floods. The El Niño phenomenon is considered to be related to the heavy rain falls and floods in the Horn of Africa; and these floods destroyed lands and displaced populations in several countries, such as Djibouti, Ethiopia, Kenya, Somalia and Sudan (World Health Organisation, 1999).

During 2003, 45 countries officially reported to the World Health Organisation a total of 111 575 cases and 1 894 deaths due to cholera. The overall number of

cases and deaths declined compared with those in previous years. The number of cases notified by Africa still greatly exceeds the number reported from other continents. Africa reported a total of 108 067 cases, accounting for 96% of the globally notified cholera cases (World Health Organisation, 2004).

The World Health Organization reports that the actual number of cases is considered to be much higher, because of poor surveillance systems, under-reporting and the increased size of vulnerable populations. Estimates of the officially reported cases represent around 5-10% only of the actual number of cases worldwide (World Health Organisation, 2003).

The number of Cholera cases reported to the World Health Organisation during 2006 rose dramatically, reaching the level of the late 1990s. Globally, the number of deaths rose from 2 272 to 6 306, a three-fold increase compared with 2005. The overall case fatality rate rose from 1.72% in 2005 to 2.66% in 2006. A total of 236 896 cases (with 6311 deaths) and a case fatality rate of 2.66%, were notified from 52 countries. This amounted to an overall increase of 79% compared with the number of cases reported in 2005. Almost all the deaths were reported from the African continent. Africa reported a total of 234 349 cases, an increase of 87%, compared with 2005, representing 99% of the global total of officially notified Cholera cases (World Health Organisation, 2007).

This increased number of cases was the result of several major outbreaks that occurred in countries where cases had not been reported for several years. Most countries reported an overall Case Fatality Rate of >1%, but not exceeding 9%. However, high case fatality rates reaching up to 30% occurred among vulnerable groups living in high-risk areas (World Health Organisation, 2007).

In 2007, the World Health Organisation recorded a total of 177 963 cases, with as many as 4 031 deaths, and a case fatality rate of 2.3%. This represents a 25% decrease in the number of officially notified cases compared with 2006, but an increase of 46% in the mean number of cases reported during 2002–2005. Africa reported a total of 166 583 cases, representing a 29% decrease from

2006, but a 19% increase compared with the mean number of cases reported in the previous five years (World Health Organisation, 2008b).

In 2007, Africa accounted for 93.6% of the global total of reported cases of Cholera, compared with 99% in 2006. Asia, for the first time since 2000, reported 11 325 cases, or 6.4% of the global total. North America notified both imported and local cases. Europe and Oceania reported imported cases only (World Health Organisation, 2008b).

In 2008, a raw sewage spill from Beit Bridge into the Limpopo River, and a total breakdown in that Zimbabwean town's water treatment, caused the worst of the recent outbreaks in Southern Africa (Bateman, 2009). The outbreak started in mid-August 2008 and caused 98 591, cases including 4 288 deaths (CFR, 4.39%). The outbreak was a consequence of the deterioration in the infrastructure, the weakened health-care system, and critical shortages of essential drugs and skilled personnel (World Health Organisation, 2010: 298).

During 2010, *Vibrio cholerae* was introduced into Haiti; and on 26 October 2010, the Ministry of Health of Haiti reported 3 342 cases of Cholera, including 259 fatalities. The explosive spread of the outbreak was linked to the lack of immunity against *Vibrio cholerae,* as well as to the limited access to safe drinking water and basic sanitation, and the internal migration that followed the earthquake in January 2010 (Centre of Communicable Diseases, 2011: 331).

In the next section, the incidence of Cholera in South Africa from 1970 to the present will be discussed.

2.2.4. Incidence of Cholera in South Africa

Cholera outbreaks made their mark in South Africa in the 1970s, about the same time as the disease was considered to be endemic in neighbouring Angola, Malawi, Mozambique and Zimbabwe; and these outbreaks were fast spreading southwards through the African continent (Isaäcson, 1986). It was inevitable that Cholera outbreaks would cross into South Africa, considering the numbers of

migrant labourers seeking employment, especially in the South African mining industry (Isaäcson, 1986).

Cholera, being endemic in these southern neighbouring countries, warranted the establishment of a surveillance system to follow up on all reported Cholera cases in South Africa (Isaäcson et al., 1974). The asymptomatic Cholera cases identified in a Transvaal (Gauteng) gold mine, after the introduction of a large-scale surveillance programme in 1974, constituted the earliest official record of Cholera cases in South Africa, since the onset of the seventh pandemic in 1961 (Isaäcson et al., 1974).

During March 1974, two coal mines and one gold mine in the eastern Transvaal (Mpumalanga) yielded Cholera-positive sewer pads. The reported cases could, however, hardly be considered to be an epidemic; at best, this constituted an outbreak that was quickly contained. Consequently, within two months, the source of the Cholera outbreaks was recognised and swiftly contained by the administration of Oxytetracycline, with the mass vaccination of all mineworkers in 1978, and also by instituting a sewage-surveillance system using Moore pads, thus containing the outbreak (Isaäcson et al., 1974).

Internationally, Cholera incidents generally remained relatively low in the 1980s, and were confined to Asia and Africa. There were seasonal Cholera peaks documented in South Africa between 1980 and 1985. This Cholera seasonality showed a pattern, which became familiar in other Cholera-endemic areas of the world, whereby Cholera was expected to wane, only to be followed by a subsequent recrudescence (Isaäcson, 1986).

The first case of Cholera in South Africa in an open community was diagnosed on 2 October 1980 at Shongwe Hospital in KaNqwane, eastern Transvaal (Mpumalanga), (Küstner et al., 1981). An epidemiological investigation was launched on 8 October 1980. The one common factor found among all the patients was that they lived on farms at Malelane, and had drunk water from the Crocodile-Malelane irrigation canal (Küstner et al., 1981). Cholera, subsequently, spread to Lebowa, Natal (KwaZulu-Natal) and the Free State (Küstner et al.,

1981). South Africa reported the largest number of cholera cases to the World Health Organization in 1982 (12 000), followed closely by Zaire (10 000), then Indonesia (8 200) and India (4 600) (Chapman & Collocott, 1985).

The first major outbreak of Cholera in KwaZulu-Natal was in 1982, with a total of 12 263 reported cases and 24 deaths. In KwaZulu-Natal, the total number of reported Cholera cases in the period 1980 to 1995 was 22 415 (with 78 deaths) (Cottle & Deedat, 2002). During the Cholera epidemic in South Africa, 1980-1987, 25 251 cases of cholera were bacteriologically proven with a case-fatality rate of 1.4% (Küstner & Du Plessis, 1991).

In South Africa, the Department of Health (DOH) released a communiqué in November 1997, warning of the spread of Cholera southwards in Africa, and the possibility of outbreaks in South Africa if precautionary measures were not taken timeously. As such, provincial health facilities throughout South Africa were placed on alert, and the necessary guidelines for managing a potential Cholera outbreak were widely distributed.

Bacteriological surveillance was carried out on the sewers of major cities – to detect Cholera bacteria, and laboratory facilities were prepared for confirming any clinical diagnoses of the disease. Extensive public awareness campaigns to those communities most at-risk were also intensified (National Department of Health, 1997).

Mozambique was hit by *Vibrio cholerae* O1 biotype El Tor in August 1997; and the number of cases totalled 10 000 by the end of that year. Cholera was introduced into South Africa in 1998 by migrant workers from Mozambique, mainly into Gauteng and Mpumalanga. Although all the cases in Gauteng were identified in migrant labourers, many of those in Mpumalanga were acquired in South Africa (Dalsgaard et al., 2001). Subsequently, Mpumalanga had an outbreak recorded early in 1998; and the use of surface water for drinking was quoted as the probable route for Cholera transmission (Athan et al., 1998).

The Department of Health in 2000 reported a total of 30 4645 cases of Cholera from 1980 to 2000 (see Table 1).

Table 1: Reported cases of Cholera from 1980 to 2000

(Department of Health, 2000)

YEAR	Eastern Cape Province	Free State Province	Gauteng	KwaZulu -Natal Province	Mpumalanga	Northern Province	North West Province	Western Cape Province	X X	TOTAL
1980	-	-	68	1	1 238	96	15	-	-	1 418
1981	-	22	205	943	1 275	2 458	633	-	-	5 536
1982	125	1	140	12 263	462	858	51	-	-	13 900
1983	30	15	156	6 427	142	107	2	-	-	6 879
1984	7	1	12	1 663	1	1	-	-	-	1 685
1985	-	-	-	699	1	1	-	-	-	701
1986-1990	-	-	6	330	-	-	-	1	-	337
1991- 1995	1	-	9	89	15	-	3	-	2	119
1996- 2000	1	-	3	37	21	-	4	-	4	70
TOTAL FOR SA	164	39	599	22 452	31 55	3 521	708	1	6	30 645
XX: Number of cases of Cholera acquired outside South Africa - : No of case(s) of Cholera that were reported.										

Source: Adapted from Department of Health (2000).

In August 2000, South Africa experienced the start of one of the worst Cholera epidemics in the country's recent history. The outbreak was first reported from the rural area of Ndabayanake in the health district of Lower Umfolozi on 20 August 2000. Thereafter, it spread to the other five health districts of KwaZulu-Natal, namely Eshowe, Lower Umfolosi, Ulundi, Stanger and Port Shepstone [see Table 2]. In 2001/02, the epidemic spread to all the other provinces in South Africa. Most cases and deaths were in KwaZulu-Natal and the Eastern Cape Province (Mudzanani et al., 2004).

Table 2: The spread of Cholera cases in KwaZulu-Natal Province, August 10th 2000 to April 5th 2001

	CONFIRMED CASES	TOTAL DEATHS	CASE FATALITY RATE (CFR) %
Lower Umfolosi	18 436	22	0.12
Eshowe	24 575	29	0.12
Durban	1 138	15	1.32
Stanger	6 566	14	0.21
Port Shepstone	8 032	19	0.24
PMB Ndlovu	3 797	17	0.45
Ladysmith	231	1	0.43
Newcastle	937	10	1.07
Ulundi	18 414	37	0.20
Jozini	153	7	4.58
Total	82 275	171	0.21

Source: Adapted from Mugero and Hoque (2001)

In South Africa, the total number of cases was well over 100 000; but the case fatality rate was relatively low (0.22%), which is below the World Health Organisation's reported figure of 1%. This low fatality rate may be attributed to good preparedness, and the implementation of control strategies. This indicated that despite poor provision of safe drinking water and adequate sanitation, case management was nevertheless good (Mudzanani et al., 2004).

The epidemic resulted in 105 000 cases of Cholera, as well as 220 deaths in KwaZulu-Natal between August 2000 and July 2001 (Mugero & Hoque, 2001).

Of all the reported cases, 97% were from KwaZulu-Natal, and the case fatality rate of the epidemic in the province was 0.22%. Half of the health districts of KwaZulu-Natal were affected with Cholera up to July 2001. Those health districts that were affected by the Cholera epidemic were Lower Umfolozi,

Eshowe/Nkandla, Ulundi, Stanger and Port Shepstone (Mugero & Hoque, 2001; Mudzanani et al., 2004).

Systematic biological examinations carried out during the pandemic showed high levels of *Vibrio cholerae* carriers in the population. A number of environmental surveys undertaken established the fact that many rivers were infected with the bacterium (Department of Health, 2000). Effluent from the nearby township of Ngwelezane pours into the Empangeni Lake. There was evidence that water seepage occurs from the lake into the Umhlatuze River (Hemson & Dube, 2004).

The Council for Scientific and Industrial Research (CSIR) conducted research in 1998 – 2000 and showed that there were traces of Cholera bacteria in raw sewage from rural hospitals in KwaZulu-Natal. Communities were utilising water from sources close to these hospitals. The study also showed that the sewage treatment works in the areas' health facilities had broken down (Scarce, 2006).

The number of cases and deaths had, however, decreased since the 2000/2001 epidemic. By December 2003, a total of 3 901 cases and 45 deaths (case fatality rate of 1.15%) were reported to the Department of Health (National Department of Health, 2000).

The total number of Cholera cases and deaths in South Africa had, by June 2004, decreased to 2 778 cases and 35 deaths respectively, with a case fatality rate of only 1.26%. However, Mpumalanga continued to experience outbreaks; and this time they reported the highest number of cases (National Department of Health, 2004). In February 2004, a Cholera outbreak was declared in the Nkomazi area, Mpumalanga, with 179 cases and five deaths (case fatality rate of 2.79%); and by June in the same year, the number of Cholera cases had risen to 1 773, with 29 deaths (Department of Health, 2004).

In 2008, a raw sewage spill from Beit Bridge into the Limpopo River, epitomized an infrastructural breakdown in Zimbabwe that cost at least 3 037 lives and infected 65 700 people there; and in Southern Africa, over the ensuing three months, the respective cholera tallies between early November 2008 and 28

January 2009 were: Zimbabwe – 60 000 cases with 3 000 deaths; and South Africa – 57 000 cases with 37 deaths (Bateman, 2009). Zimbabwe's Cholera death toll has now exceeded the number of people who have died from the disease in the entire African continent over several years, according to the World Health Organisation (Bateman, 2009).

By 23 March 2009, the Cholera outbreak in Zimbabwe had shown signs of abating. The 2076 cases reported as of 14 March 2009, although still high, represent a reduction from the 3812 cases reported in the preceding week and the >8000 cases reported weekly at the beginning of February. The weekly case-fatality rate also decreased from its peak of almost 6% in January, to 2.3% for the week ending 14 March 2009 (World Health Organisation, 2009).

Cholera illustrates many of the increased health risks associated with the global changes taking place around us: A large-scale movement of people, changes to ecosystems with heavy pollution, human-induced climate changes, rapid technological change, economic and political instability. Furthermore, widening socio-economic inequalities within and between countries leave over one billion people without access to clean water, and 1.7 billion people with no access to sanitation services (World Health Organisation, 2008a).

It may be deduced that Cholera is an epidemic-prone diarrhoeal disease; and that it is a major public health problem; and it should be recognised and addressed accordingly. It is important that environmental management in developing countries, in particular improvement in water supplies, access to hygiene and sanitation, be effected.

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It may be deduced that Cholera as an epidemic-prone diarrhoeal disease is a major public health problem; and it should be recognised and addressed accordingly. It is important that environmental management in developing countries, in particular improvement in water supplies, access to hygiene and sanitation be effected (World Health Organisation, 2008a). Cholera surveillance should be part of an integrated surveillance system; and there should be combined efforts by all the role-players to implement efficient control measures, particularly, given the emergence of new strains.

Extraordinary advances have been made in recent years in unravelling the molecular pathogenesis of the infection of Cholera (Kaper et al., 1995). The clinical, microbiological, epidemiological, pathogenic, and clinical features of Cholera will be presented next. First to be described is the isolation and identification of *Vibrio cholerae*.

2.3. The isolation of *Vibrio cholerae*

The agent responsible for cholera was first described in 1854 in Italy by Pacini (Kaper et al., 1995). This initial discovery was overshadowed by the work of Robert Koch, who studied Cholera in Egypt; and he demonstrated in 1883 that Cholera was caused by a comma-shaped organism (Pollitzer, 1959). Koch named the organism Kommabazillen, and the subsequent name *Vibrio* comma was used for several decades before the pioneering work of Pacini was recognised, and the name was changed to *Vibrio cholerae* (Kaper et al., 1995).

Vibrio cholerae is a well-defined species on the basis of biochemical tests and DNA homology studies (Bauman et al., 1984:525). The important distinctions within the species are made on the basis of the production of Cholera enterotoxin (Cholera toxin [CT]), serogroup and its potential for epidemic spread: Faruque et al., 1998; Kaper et al., 1995).

There are two serogroups, O1 and O139, that have been associated with the epidemic disease; but there are also strains of these serogroups, which are not pathogenic. In assessing the public health significance of an isolate of *Vibrio*

cholerae, there are two critical properties to be determined. The first of these properties is the production of CT, which is responsible for severe Cholera-like disease in epidemic and in sporadic forms. The second property is the possession of the O1 or O139 antigen, which has been referred to as a marker of potential Cholera epidemic and sporadic outbreaks (Kaper et al., 1995). The major serogroups of Cholera are discussed below:

2.3.1. *Vibrio cholerae* O1

Vibrio cholerae O1 has been associated with epidemic and pandemic Cholera. However, some isolates of *Vibrio cholerae* O1 do not produce CT, and do not possess the genes encoding CT (Faruque et al., 1998). Environmental strains are usually CT negative; however CT negative *Vibrio cholerae* strains have been isolated from occasional cases of diarrhoea or extraintestinal infections (Kaper, et al., 1995).

Vibrio cholerae O1 serogroup can be further divided into various serotypes of the O1 serogroup called Ogawa and Inaba; and a third serotype that is rarely isolated is Hikojima (Kaper, et al 1995). *Vibrio cholera O1* can also be divided into two biotypes: classical and El Tor. All combinations can be found, such as classical strains, which are Inaba or Ogawa, and El Tor strains, which are Inaba or Ogawa.

2.3.2. *Vibrio cholerae* non-O1/non-O139

Until the emergence of the O139 serogroups, all isolates that were identified as *Vibrio cholerae* on the basis of biochemical tests that were negative for the O1 serogroup were referred to as “non-O1 *Vibrio cholerae* or non-agglutinable (NAG) *Vibrios* (Kaper et al., 1995). Generally, these strains do not produce CT and are not associated with epidemic diarrhea (Faruque et al., 1998).

These strains are occasionally isolated from cases of diarrhoea (usually associated with the consumption of shell fish) and have been isolated from extraintestinal infections, including wounds (Kaper et al., 1995). These strains are regularly found in estuarine environments, and infections due to these strains

are commonly of environmental origin. While the majority of these strains do not produce CT, some strains may produce other toxins (Faruque et al., 1998).

In 1992, an epidemic of Cholera in India was unexpectedly caused by a non-O1 strain (Uma et al., 2003). This strain did not agglutinate with any of the existing antisera to 138 sero groups of *Vibrio cholerae* known at the time. Consequently, the strain was designated to a new sero group O139 (Uma et al., 2003).

2.3.3. *Vibrio cholerae* O139

This organism appears to be a hybrid of the O1 strains and the non-O1 strain. In important virulence characteristics, specifically enterotoxin and toxin-co-regulated pilus (TCP), *Vibrio cholerae* O139 is indistinguishable from typical El Tor *Vibrio cholerae* (Kaper et al., 1995). However, the O139 strain is capsulated, unlike the O1 strains, and has significant dissimilarities in the “O” antigen component of the bacterial lipopolysaccharide (Uma et al., 2003).

Genetic studies point to the possibility that the seventh pandemic El Tor strain could have given rise to the O139 strain by genetic shuffling. One cluster of genes did not react with any of the existing serogroups, suggesting that this fragment may have originated from another bacterium (Uma et al., 2003).

Later studies involving the screening of the 300 non-O1, non-O139 isolates for the presence of virulent genes established that non-O1, non-O139 *Vibrio cholerae* strains with pathogenic potential could emerge by the exchange of O-antigen biosynthesis genes (Uma et al., 2003). It may be deduced that the *Vibrio cholerae* genome has a large gamut of genes that can encode proteins with a wide range of substrate specificities.

The organism is greatly benefited by these, as it thrives in the varied environments of the human gut and in the environment. From a public health perspective, in order to control the spread of the disease, it is important that toxigenic *Vibrio cholerae* be timeously isolated and correctly identified (Faruque et al., 2004; Wang et al., 2010). In the next section, the isolation and detection of *Vibrio cholerae* will be presented.

2.4. The identification of *Vibrio cholerae*

The minimum identification criterion for *Vibrio cholerae* O1 requires only serologic confirmation of the presence of O1 serotype antigens with suspect isolates. However, a more complete characterization of the organism may be necessary; and this may include various biochemical tests, as well as the determination of other characteristics, such as hemolysis, biotyping, molecular subtyping and anti-microbial sensitivity (World Health Organisation, 1999: 27). The first to be described is the identification of *Vibrio cholerae* O1 in stool specimens.

2.4.1. Stool specimens

The initiation of treatment for severe, dehydrating diarrhea need not and should not wait for identification of the etiologic agent; subsequent clinical and public health decisions can be greatly influenced by the identification of *Vibrio cholerae* O1 (or o139) in a clinical specimen. Stools should be collected early in the illness and preferably before the start of antibiotic therapy (Kaper, et al., 1995; National Department of Health, 2002: 24).

In many specimens, the concentration of *Vibrio cholerae* is high (107 to 108 per ml of liquid faeces) so that enrichment is unnecessary. However, alkaline peptone water is an enrichment broth that can be used to recover low levels of *vibrios*, particularly from formed stools (Kaper et al., 1995).

The series of biochemical tests commonly used to identify *Vibrio cholerae* was originally designed for clinical samples, in order to specifically detect pathogenic *vibrios* (Choopan et al., 2002). These methods have generally been used to test for *Vibrio cholerae* O1 in food, environmental water and sewage (Kaper et al., 1995).

2.4.2. Water and sewage samples

According to Alum et al., (2007); and Huq et al., (2005), *Vibrio cholerae* is naturally occurring in both marine and fresh water environments, and exists in association with plankton. In general, it can be isolated from only 1% of water

samples collected during epidemic periods, and rarely if ever between epidemics.

According to Sedas (2007), the numbers of *Vibrio cholerae micro-organisms* suspended in water are generally low, and usually approximate 10^3 cfu/l for *Vibrio cholerae* non-O1s, and less than, 50 cfu/l for *Vibrio cholerae* O1. However, the organism may be found in large numbers when associated with aquatic species, such as algae (blue green algae, such as *Anabaena*), water hyacinth, duck weed, cyanobacteria, zooplankton and crustaceans. While counts of free organisms in water may be low, copepods found in the same water may have 10^5 cfu/l organisms attached to their surface (Sedas, 2007; Emch, 2008).

Various biological and physicochemical factors influence the growth, survival and distribution of *Vibrio cholerae* in aquatic environments. The presence of *Vibrio cholerae* O1 in aquatic environments is not limited to estuaries, because the salinity requirements can be met through adequate nutrient concentrations in fresh water environments. It has been reported that the micro-organism can survive in fresh water for prolonged periods (Wang et al., 2010).

Extensive studies have shown that *Vibrio cholerae* O1 becomes coccoid and enters into a non-culturable state in the environment, when conditions are not conducive for active growth (Alam et al., 2007). According to Wang et al., (2010) *Vibrio cholerae* requires salt for growth; and it can revert to a viable but non-culturable state (VNC) in response to adverse environmental conditions.

These viable non-culturable state (VNC) bacteria do not grow on conventional culture media, but remain intact and retain metabolic activity and respiration. This depends on the physicochemical properties of the water or the physiological state of *Vibrio cholerae* O1, itself – either with growing cells or cells in a latent or dormant state (Wang et al., 2010). It may therefore be deduced that the isolation of the micro-organism with classical culture methods may fail.

However, fluorescent anti-body-based studies show that *Vibrio cholerae* O1 is present in aquatic environments throughout the year (Alam et al., 2007).

Techniques employing microscopy, with either direct or indirect fluorescent antibody staining, have been developed; and they provide important data on the occurrence of viable but non-culturable *Vibrio cholerae* O1 (Wang et al., 2010).

The recently developed real-time PCR technique has high sensitivity in detecting *Vibrio cholerae*, although it also detects nucleic acids, and it still requires isolation and culture of the sample after PCR detection. The fluorescent labelling technique uses antibodies to specifically identify pathogens; and some studies have applied this method to the detection of *Vibrio cholerae* in environmental water samples (Wang et al., 2010).

The fluorescent-antibody (FA) direct viable count (FA-DVC) assay can rapidly and easily detect culturable and non-culturable *Vibrio cholerae* O1. Huq et al., (2005) isolated *Vibrio cholerae* O1 from fresh water environments, using immunofluorescence, but were unable to isolate culturable forms with conventional culture methods in Bangladesh (Wang et al., 2010).

The direct fluorescent antibody (DFA) assay has also been applied to detect viable but non-culturable *Vibrio cholerae* O1 in environmental water and in studies on the role of *Vibrio cholerae* biofilm in the transmission of Cholera (Wang et al., 2010).

Using the direct immunofluorescence of *Vibrio cholerae* O1 (DFA-DVC) technique, the study of Wang et al., (2010) for the first time provided evidence of the isolation of *Vibrio cholerae* non-O1, non-O139, and the presence of viable non-culturable *Vibrio cholerae* O1 all the year round, in rivers in Tucaman, Argentina. The World Health Organisation, (2002:126) confirmed that more advanced techniques, using immunoflorescence microscopy, PCR and improved culture methods have isolated both O1 and non-O1 strains, even in the absence of traditional indicator bacteria, such as *Eschericia coli* and faecal streptococci. This suggests that *Vibrio cholerae* can survive longer in the environment. In the next section the pathogenesis and virulence of *vibrio* cholera will be described.

2.5. Pathogenesis and virulence factors

The natural habitat of the gram-negative bacterium, *Vibrio cholerae,* is the aquatic ecosystems, although some strains of this species are associated with severe enteric infection in humans (Faruque et al., 1998, 2004). Toxigenic strains of *Vibrio cholerae* belonging to the O1 and O139 serogroups cause Cholera, a severe diarrhoeal disease that occurs frequently as epidemics in many developing countries (Rahman et al., 2008).

Strains belonging to other serogroups, collectively referred to as non-O1, non-O139, have also been implicated as etiologic agents of moderate to severe human gastro-enteritis although the vast majority of the non-O1, non-O139 strains are presumed to be non-pathogenic bacteria, constituting part of the normal aquatic flora (Rahman et al., 2008).

Vibrio cholerae O1 and O139 strains are commonly known to carry a set of virulence genes necessary for pathogenesis in humans (Kaper et al., 1995; Faruque et al., 1998, 2004). The major virulence factors of *Vibrio cholerae* include Cholera toxin (CT), which is responsible for the profuse watery diarrhoea, and a pilus colonization factor known as toxin co-regulated pilus (TCP). In addition to CT and TCP, Cholera pathogenesis is presumed to depend on the synergetic effect of a number of putative accessory virulence factors. These factors include the mannose-sensitive hemaglutin (MSHA) pilus, the RTX toxin, as well as a few other accessory toxins (Kaper et al., 1995; Faruque et al., 1998, 2004).

The roles of the accessory virulence factors in Cholera pathogenesis are not well established, and recent studies are beginning to reveal that at least some of these factors also play a role in the environmental fitness of the pathogen (Rahman et al., 2008). The pathogenic strains of *Vibrio cholerae* have evolved from non-pathogenic environmental strains, and the horizontal gene transfer of virulence gene clusters plays a major role in the process (Faruque et al., 1998; Faruque and Mekalanos, 1996).

In order to track the evolutionary events in the origination of pathogenic *Vibrio cholerae* from their non-pathogenic progenitors, it is important to identify intermediate strains that are likely to carry some of the virulence-related genes, but fall short of the complete set of genes required for pathogenesis and epidemic spread (Rahman et al., 2008). For example, occasionally environmental non-O1, non-O139 *vibrios* have been found to carry one or a few of the virulence-associated genes or their homologues (Faruque et al., 2004).

The study of Rahman et al., (2008) indicates that although the prevalence of major virulence genes is quite asymmetric among *Vibrio cholerae* non-O1, non-O139 and O1 or 0139 serogroup strains, the accessory virulence genes that now appear to have functions in the environment are uniformly distributed among both pathogenic and non-pathogenic strains.

According to Rahman et al. (2008), the aquatic environment of Cholera endemic area harbours strains with various virulence gene profiles, and thus constitutes a reservoir of diverse virulence genes. The ecological settings presumably favour extensive interactions among *Vibrio cholerae* mediated by phages and mobile genetic elements (Faruque and Mekalanos, 2003) as well as the selection of pathogenic clones – leading to the clustering of critical combinations of genes required for the emergence of an epidemiologically thriving pathogenic strain.

Matson et al. (2007) mention that multiple quorum-sensing systems in *Vibrio cholerae* act in parallel to regulate virulence-gene expression, biofilm formation and protease production. The ability of *Vibrio cholerae* to switch between two different phase variants, termed smooth and rugose, is thought to play a role in the survival of the organism in the host and in the environment.

Phenotypic traits associated with the rugose phenotype include the increased ability to form biofilms. Rugose variants produce VPS (for *Vibrio* polysaccharide), which enables them to form well-developed biofilms, and to resist a variety of environmental stresses (Matson et al., 2007).

Higgens et al. (2007) mention that in the process called quorum sensing, bacterial communities track changes in their population densities by producing, releasing and detecting, diffusible signalling molecules called auto-inducers. The accumulation of auto-inducers shape group behaviours, such as the formation of biofilms and the expression of virulence factors.

According to the study of Higgens et al. (2007), at low density in the absence of auto-inducers, *Vibrio cholerae* expresses virulence factors and forms biofilms. This pattern of gene expression enables host colonization, and contributes to the persistence of the organism in the environment.

In the presence of auto-inducers, at high cell density, quorum sensing represses both the expression of virulence factors and the formation of biofilms. Matson et al. (2007) agree that the modulation of virulence gene expression in *Vibrio cholerae* is intimately tied to whether or not the microbe is growing at high cell density or low cell density.

Vibrio cholerae is capable of growing to high levels during the course of an infection, after which it exits very efficiently and in large numbers (Matson et al., (2007). According to Faruque et al., (2004) it has recently been shown that human colonization creates a hyper-infectious bacterial state that is maintained after dissemination, and that may contribute to the epidemic spread of Cholera.

These events are proposed to allow *Vibrio cholerae* to leave the host, to re-enter the environment in large numbers, and to initiate a new cycle of infection (Higgins et al., 2007). However, the study of Alum et al., (2007) confirmed that the aggregates of cells in biofilms in Cholera stools that were present immediately after release to the environment contained cells that remained infective only for a short period, thereby having temporal limitation with respect to contributing to the intensity of cholera epidemics; except where conditions of poor sewage treatment expedite the faecal-oral mode of transmission.

According to Kaper et al., (1995), non-O1 strains are much more commonly isolated from the environment than the O1 strains, even in epidemic settings in

which faecal contamination of the environment might be expected. Outside epidemic areas (and away from areas that may have been contaminated by Cholera patients), O1 environmental isolates are almost always CT negative. However, it is clear that CT-producing *Vibrio cholerae* O1 can persist in the environment in the absence of known human disease (Faruque et al., 2004).

Vibrio cholerae micro-organisms are able to build up large multi-cellular structures on solid surfaces; these structures are known as biofilms. The biofilm provides a micro-environment that favours survival and persistence, due to increased resistance to various stresses, such as chlorine and antibiotics (Reidl & Klose, 2002). Biofilm formation can be viewed as a survival mechanism for bacteria; biofilm can provide protection from toxic compounds, such as antibiotics, thermal stress and predation (Huq et al., 2008).

The number of cells in a biofilm may reach as high as 1.0×10^9 cells per clump, which, in most cases, can comprise an infectious dose of a pathogen (Huq et al., 2008). Several studies have shown that biofilms form in situ in the aquatic environment, and that such biofilms for most of the year would contain cholera bacteria in the non-culturable state of ‘‘conditionally viable environmental cells’’ (CVEC) (Faruque et al., 2006). These are better adapted to the aquatic ecosystem, compared with *Vibrio cholerae* shed in cholera stools (Alam et al., 2007). The persistence of *Vibrio cholerae* within the environment may be attributed to environmental factors; and this will be explained in the next section.

2.6. Environmental factors influencing the survival or proliferation of *Vibrio Cholerae*

Vibrio cholerae is a chemoheterotrophic bacterium capable of both respiratory and fermentative metabolism, starting from a variety of organic substrates (Kaper et al., 1995). It is a halo-tolerant micro-organism, mostly isolated from environmental sites, where NaCl concentrations are between 0.2% and 3%. The optimal temperature for growth ranges from 30°C to 40°C, and the optimal pH is 8 (Vezzulli et al., 2010).

Environmental conditions and resources that *Vibrio cholerae* exploit in nature and interactions with other living organisms and abiotic substrates shape the ecological niche of the species. The persistence of *Vibrio cholerae* within the environment may be facilitated by the ability to assume survival forms (Kaper et al., 1995).

Vibrio cholerae produces a chitinase, and is able to bind to chitin, which is the principal component of crustacean shells (Kaper et al., 1995). *Vibrio cholerae* is often found in the aquatic environment attached to the chitinous exoskeleton of zooplankton. This attachment is likely to enhance the survival of *Vibrio cholerae* by providing a source of carbon and nitrogen, as well as a surface for the formation of biofilms (Matson et al., 2007). Furthermore, TCP production contributes to the colonization of chitinous surfaces, due to the fact that *Vibrio cholerae* TCP mutants are not able to form biofilms on chitin or to form micro-colonies. It may be said that *Vibrio cholerae*-producing TCP may have a fitness advantage in the environmental over those that do not (Matson et al., 2007).

The interaction of *Vibrio cholerae* with chitin provides the micro-organism with food availability, adaptation to environmental stresses, and protection from predators (Pruzzo et al., 2008; Vezulli, et al., 2010). *Vibrio cholerae* have a selective advantage in their ability to enter a dormant stage, termed viable, but non-culturable (VBNC) (Lipp et al., 2002). During inter-epidemic periods, non-culturable cholera is detectable in water only when molecular and immunochemical methods are used. That is to say, culturable *Vibrio cholerae* O1 can rarely be isolated (Alam et al., 2007).

Molecular methods have clearly demonstrated the presence of toxigenic *Vibrio cholerae* O1 in the aquatic environment during inter-epidemic periods in a viable but non-culturable state, and as aggregates of structured biofilms (Alam et al., 2007). Carbon, which is abundant in marine and brackish water systems, plays an important role in the formation of biofilms, by directly stabilizing intercellular interactions (Huq et al., 2008).

Vibrio cholerae strains possess multiple strategies for surface colonisation (Reidl & Klose, 2002). The presence of pili is associated with the ability of bacterial cells to colonise surfaces (Pruzzo et al., 2008). Once attached, *Vibrio cholerae* cells are able to use chitin as a source of carbon and nitrogen. *Vibrio cholerae* multiplies efficiently on chitinous fauna, including crabs, shrimps and zooplankton (Pruzzo, et al., 2008). Notably, chitinous organisms, such as copepods, amphipods, and other crustaceans, have been shown to support a large population of *vibrios*, including pathogenic species like *Vibrio cholerae*, representing the largest reservoir of these bacteria in sea water.

Vibrios are often found in association with the guts and skin of marine animals, phytoplankton, sediments and suspended detritus. Algal and zooplankton blooms can promote the proliferation of associated bacterial communities by providing micro-environments favouring growth, and by exuding nutrients into the water (Lipp et al., 2002). Plankton attachment to chitinous organisms, such as copepods and their eggs, which are dispersed in the water, or other aquatic living organisms, for example, flying chironomids, ultimately provides the main mechanism for the dissemination and extended geographic distribution of pathogenic *vibrio* spp. in nature (Vezzulli et al., 2008).

Furthermore, correlations of the dynamics of attached pathogenic *Vibrio* species to seasonal algal and zooplankton blooms have been established (Colwell, 1996). The incidence of epidemic cholera in Bangladesh has also been correlated with seasonal algal and zooplankton blooms, suggesting a link between the abundance of marine indigenous pathogens and outbreaks of the disease in humans (Colwell, 1996).

It may be deduced that environmental reservoirs can act as disseminators of the pathogen across large geographic areas, and also as vectors of infection. It has been suggested that they can be responsible for the start of an epidemic, and are thus critical to disease endemicity (Vezzulli et al., 2010).

Environmental reservoir contribution to Cholera transmission during epidemics is considered low. However, in a country where Cholera is endemic, ingestion of

water from ponds and rivers during plankton blooms provides the requisite infectious dose for clinical Cholera (Colewell, 1996).

Cholera has also been associated with bathing in contaminated river water. Consequently, rivers contaminated with Cholera bacteria tend to transmit the disease from one community to another, contributing thereby to the spread of the disease. However, sudden large outbreaks are usually caused by contaminated public water supplies. Thus, water plays an important role in the transmission and epidemiology of cholera, be it surface water, waste water or sea water (Acosta et al., 2001).

The practice of the direct discharge of effluent into receiving water bodies is of major concern, as this could result, amongst other things, in a substantial increase in the organic load, and consequently to the depletion of the dissolved oxygen content of the receiving water body (Igbinosa & Okoh, 2009). In rural and suburban settings of most developing nations, the use of sewage and waste water is often the only source of water for irrigation in such areas. Eating fruit and vegetables that have been irrigated with contaminated water and are normally eaten raw, is one possible way that toxigenic *Vibrio cholerae* can be ingested (Igbinosa & Okoh, 2008).

Vibrio cholerae, an autochthonous microbial inhabitant of brackish water, estuarine ecosystems, and coastal areas, can remain in the non-culturable state in the marine environment for years (Sedas, 2007). This long-lasting persistence reduces pathogen dependence on host-to-host contact for transmission and propagation, enabling it to reach higher virulence levels (i.e. forms capable of producing a larger number of infectious particles per infected host in a short period of time) (Vezzulli et al., 2010). This may account for violent epidemics followed by long non-host phases.

Vibrio cholerae micro-organisms are able to build up large multi-cellular structures on solid surfaces (Huq et al., 2008). The number of cells in a biofilm may reach as high as 1.0×10^9 cells per clump, which in most cases, can comprise an infectious dose of a pathogen (Huq et al., 2008).

Faruque et al. (2006) have shown that environmental water that is apparently negative for virulent *Vibrio cholerae* by conventional enrichment methods, but contains conditionally viable environmental cells (CVEC), can be introduced into rabbit ileal loops and yield virulent *Vibrio cholerae* strains after 18 hours of *in vivo* incubation. Similarly, humans who ingest clumps of conditionally viable environmental cells (CVEC) may resuscitate *Vibrio cholerae,* and even amplify the strain. Such individuals could become index cholera cases that could start a cholera epidemic.

It may be deduced that the disease begins with the ingestion of the causal bacterium *Vibrio cholerae* via contaminated water or food. The microbe makes its way to the small intestine, where it attaches and begins to produce cholera toxin (CT) (Cottingham, 2003). The clinical manifestation of Cholera will be discussed in the following section.

2.7. Clinical manifestation

People develop contract Cholera when they ingest an infective dose of *Vibrio cholerae* O1 or O139. The disease is characterised by a short incubation period (8 to 72 hours) (Sack et al., 2001, 2004).

Cholera infection can be asymptomatic, mild, or severe (Sack et al, 2004). Approximately 75% or more of initial infections with *Vibrio cholerae* O1 or O139 may be asymptomatic, depending on the infecting dose (World Health Organisation, 1999:38).

Of the 25% of persons with symptomatic infections, most have mild illness. Approximately 5% of patients have moderate illness that requires medical attention, but not hospitalisation (World Health Organisation, 1999:38). Only about 2% of patients have severe disease symptoms characterized by profuse watery diarrhoea, vomiting, and leg cramps. In such persons, the rapid loss of body fluids leads to dehydration, electrolyte disturbances, and hypovolemic shock. Without treatment, death can occur within hours (Sack et al., 2004).

The successful treatment of patients depends on the rapid replacement of fluid and electrolyte losses. With proper treatment, mortality is less than 1% of reported cases (World Health Organisation, 1999:39). In the next section the treatment of Cholera patients will be discussed.

2.8. Treatment

Rehydration is the mainstay of Cholera treatment. The treatment of dehydrated patients should not be delayed (World Health Organisation, 2008c). In a Cholera outbreak, the best control measures are early detection and the treatment of patients (National Department of Health, 2002: 4).

According to the World Health Organisation, the case definition for cholera cases is as follows: A case of cholera should be suspected when (World Health Organisation (1999: 15; 2004: 15) :

- In an area where the disease is not known to be present, a patient aged five years or more develops severe dehydration or dies from acute watery diarrhoea;
- In an area where there is a cholera epidemic, a patient aged five years or more develops acute watery diarrhoea, with or without vomiting.

Clinicians should suspect cholera, whilst attending to any case that involves massive, shock-producing diarrhoea, especially if the patient has recently travelled to a cholera-affected country or region (World Health Organisation (1999: 15; 2004: 15). Signs of dehydration are not clinically apparent until the patient has already lost about 5% of his/her body weight. Efficient treatment resides in the prompt rehydration through the administration of oral rehydration salts (ORS) or intravenous fluids, depending on the severity of the case (Prevention and control of Cholera, World Health Organisation, 2008c).

Up to 80% of patients can be treated adequately through the administration of oral rehydration salts (ORS), (WHO/UNICEF ORS standard sachet) (World Health Organisation, 2008c). Very severely dehydrated patients are treated

through the administration of intravenous fluids, preferably Ringer's lactate. Appropriate antibiotics can be given to severe cases to diminish the duration of the diarrhoea, to reduce the volume of rehydration fluids needed, and to shorten the duration of *Vibrio cholerae* excretion (World Health Organisation, 2008c). Tetracycline is the usual antibiotic of choice, but resistance to it is increasing; thus, its administration is not recommended (Said, 2006: 18). For children up to 5 years, supplementary administration of Zinc has been proven effective in reducing the duration of the diarrhoea, as well as a reduction in successive diarrhoeal episodes (World Health Organisation, 2008c).

The global application of oral rehydration treatment (ORT) has decreased the death rates from diarrhoeal diseases by more than half in the last 30 years (Said, 2006: 18). It may be said that the management of Cholera patients should focus on the recognition of Cholera cases; and health workers should start rehydration as soon as possible, in order to reduce potential contamination of the environment and death.

It may be concluded that a strong programme for the control of diarrhoeal diseases is the best preparation for a Cholera epidemic. The key to an effective outbreak control is rapid response, before the outbreak develops into an epidemic.

2.9. Conclusion

The modern history of cholera began in 1817; there were six epidemics up until 1923. After almost 40 years, the seventh pandemic started in Indonesia in 1961 and is still ongoing worldwide. This pandemic spread to the Indian subcontinent, the Middle East, reaching Africa in the 1970s and South America in the early 1990s.

In 1992, a newly described, non-O1 serogroup of *Vibrio cholerae* designated O139 Bengal, caused unusual outbreaks in India and Bangladesh. It has not so far been isolated in Africa or in the Americas. Cholera outbreaks made their mark in South Africa in the 1970s; these were swiftly contained by instituting a sewage-surveillance system.

Cholera seasonal peaks in South Africa were documented between 1980 and 1985. This Cholera seasonality showed a pattern, which became familiar in other cholera-endemic areas of the world, whereby Cholera was expected to wane, only to be followed by a recrudescence. In August 2000, South Africa experienced the start of one of the worst cholera epidemics in the country's recent history, with the number of cases being over 100 000, with a 0.22% case fatality rate being reported.

The low case fatality rate can be attributed to good preparedness and the implementation of control strategies. This indicated good case management, despite the poor provision of safe drinking water and inadequate sanitation. The Council of Scientific and Industrial Research conducted research (1998-2000), which showed that there were traces of cholera in raw sewage from rural hospitals in KwaZulu-Natal. Communities in these areas were utilising water from sources close to these hospitals. The sewage-treatment plants in many of the areas' health facilities had regrettably broken down.

In 2008, a raw sewage spill from Beit Bridge into the Limpopo River, and a total breakdown in that Zimbabwean town's water-treatment system, caused the worst of the recent outbreaks in Southern Africa. Zimbabwe's cholera death toll has now exceeded the number of people who have died from the disease in the entire African continent over the last few years.

With over one billion people without access to clean water, and 1.7 billion people with no access to sanitation services, Cholera an epidemic-prone diarrhoeal disease, is a major public health problem, and it should be recognised and addressed accordingly. It is important that environmental management in developing countries, in particular improvement in water supplies, access to hygiene and sanitation, be effected.

Cholera surveillance should be part of an integrated surveillance system; and there should be combined efforts to implement efficient control measures –

particularly given the emergence of new strains. Extraordinary advances have been made in recent years in unravelling the molecular pathogenesis of the infection of Cholera.

Two serogroups, O1 and O139 have been associated with epidemic disease, but there are also strains of these serogroups which are not pathogenic; and these are known as non-O1/O139. *Vibrio cholerae* O1 serogroup consists of two biotypes, classical and El Tor, which can be further divided into two serotypes: Ogawa and Inaba. In 1992, an outbreak in India was caused by a new strain designated to a new serogroup, O139.

The seventh pandemic El Tor strain could have given rise to the O139 strain by genetic shuffling. It has been established that non-O1, non-O139 *Vibrio cholerae* strains with pathogenic potential could have emerged by the exchange of O-antigen biosynthesis genes.

Vibrio cholerae is identified through a series of biochemical tests originally designed for clinical samples, in order to specifically detect pathogenic *vibrios*. These methods have generally been used to test for *Vibrio cholerae* O1 in food, environmental water and sewage.

Recent studies have established that *Vibrio cholerae* is naturally occurring in both marine and fresh-water environments, and that it exists in association with plankton. In general, it can be isolated from only 1% of water samples collected during epidemic periods, and rarely if ever between epidemics.

Various biological and physico-chemical factors influence the growth, survival and distribution of *Vibrio cholerae* in aquatic environments. *Vibrio cholerae* O1 becomes coccoid, and enters into a non-culturable state in the environment when conditions are not conducive for its active growth. These viable non-culturable state (VNC) bacteria do not grow on conventional culture media, but remain intact and retain metabolic activity and respiration. The World Health Organisation has confirmed that by using immunoflorescence microscopy, PCR and improved culture methods, they have isolated both O1 and non-O1 strains,

even in the absence of traditional indicator bacteria, such as *Eschericia coli* and faecal streptococci.

Toxigenic strains of *Vibrio cholerae* belonging to the O1 and O139 serogroups are commonly known to carry a set of virulence genes necessary for pathogenesis in humans. The pathogenic strains of *Vibrio cholerae* have evolved from non-pathogenic environmental strains, and the horizontal gene transfer of virulence-gene clusters is believed to play a major role in the process.

Multiple-quorum sensing systems in *Vibrio cholerae* act in parallel to regulate virulence-gene expression, biofilm formation and protease production. The ability of *Vibrio cholerae* to switch between two different phase variants, termed smooth and rugose, is thought to play a role in the survival of the organism in the host and in the environment.

Vibrio cholerae is capable of growing to high levels during the course of an infection, after which it exits very efficiently and in large numbers. It has recently been shown that human colonization creates a hyper-infectious bacterial state that is maintained after dissemination and which may contribute to the epidemic spread of Cholera.

Aggregates of cells in biofilms in Cholera stool released into the environment contained cells that remained infective only for a short period, except where conditions of poor sewage treatment expedite the faecal oral mode of transmission. The *Vibrio cholerae* non-O1 strains are much more commonly isolated from the environment than the O1 strains, even in epidemic settings in which faecal contamination of the environment might be expected.

Biofilms formed in situ in the aquatic environment, for most of the year, would usually contain cholera bacteria in the non-culturable state of ‘‘conditionally viable environmental cells’’ (CVEC). These CVEC cells are better adapted to the aquatic ecosystem, compared with *Vibrio cholerae* shed in Cholera stools.

In environmental waters, *Vibrio cholerae* attaches to the surfaces provided by plants, filamentous green algae, copepods (zooplankton), crustaceans and insects. Cholera is an acute dehydrating diarrhoea caused by the potent cholera toxin (CT). The disease is contracted upon ingestion of an infective dose of *Vibrio cholerae* from contaminated water or food.

The interaction of *Vibrio cholerae* with chitin provides the micro-organism with food availability, adaptation to environmental stresses, and protection from predators. *Vibrios* are often found in association with the guts and skin of marine animals, phytoplankton, sediments and suspended detritus.

Algal and zooplankton blooms can promote the proliferation of associated bacterial communities by providing micro-environments favouring growth and by exuding nutrients into the water. Plankton attachment to chitinous organisms, such as copepods and their eggs, which are dispersed in the water, or other aquatic living organisms, for example, flying chironomids, ultimately provides the main mechanisms for the dissemination and extended geographic distribution of pathogenic *vibrio* spp. in nature.

People develop Cholera when they ingest an infective dose of *Vibrio cholerae* O1 or O139. The disease is characterised by a short incubation period (8 to 72 hours). Approximately 75% or more of initial infections with *Vibrio cholerae* O1 or O139 may be asymptomatic, depending on the infecting dose.

The successful treatment of patients with symptoms depends on the rapid replacement of fluid and electrolyte losses. With proper treatment, mortality is less than 1% of reported cases. Rehydration is the mainstay of Cholera treatment. The treatment of dehydrated patients should not be delayed.

In a Cholera outbreak, the best control measures are early detection and treatment of the patients. A case of Cholera should be suspected when a patient five years or older develops acute watery diarrhoea.

Signs of dehydration are not clinically apparent until the patient has already lost about 5% of his/her body weight. Efficient treatment resides in prompt rehydration through the administration of oral rehydration salts (ORS) or intravenous fluids, depending on the severity of the case. Up to 80% of patients can be treated adequately through the administration of oral rehydration salts (ORS).

The global application of oral-rehydration treatment (ORT) has decreased the death rates from diarrhoeal diseases by more than half in the last 30 years. The management of Cholera patients should focus on the recognition of Cholera cases; and health workers should start rehydration as soon as possible, to reduce the potential contamination of the environment and death.

Extraordinary advances have been made in recent years in unravelling the molecular pathogenesis of the infection of Cholera and the persistence of the micro-organism in environmental surface waters. These developments need to be incorporated into the development of environmental health-work methods and procedures for the surveillance of Cholera.

Cholera was the first disease for which modern public health surveillance and reporting was carried out in an organised way. The International Health Regulations, 2005 (IHR), require weekly notification of any Cholera cases and deaths to the World Health Organisation. The World Health Assembly (WHA) has the legal authority to adopt regulations concerning the prevention of, and the international spread of the disease.

The said International Health Regulations, 2005, emphasize the commitment of member states to the goal of global health security. This requires all member states to develop and maintain a functional and effective surveillance and response system that is able to detect, investigate and respond to public health emergencies of national and international concern.

In the South African context, according to Section 21(k) of the National Health Act, 2004 (Act 61 of 2003), the National Department of Health must facilitate and

promote the provision of the management, prevention and control of communicable diseases. In doing so, the National Department of Health has developed national guidelines for the control of Cholera in South Africa. These are based on guidelines provided by the World Health Organisation. The Cholera control guidelines developed by the National Department of Health are intended to be used by the nine provincial Health Departments to develop their Cholera surveillance and control strategies. These control measures must be implemented/executed by the municipalities within their areas of jurisdiction.

The next chapter will discuss the place and role of Environmental Health in the national, provincial and municipal spheres of government.

CHAPTER THREE

CHOLERA – THE PLACE AND ROLE OF ENVIRONMENTAL HEALTH WITHIN THE ORGANISATIONAL STRUCTURE OF THE HEALTH-CARE SYSTEM IN SOUTH AFRICA

3.1 Introduction

The aim of this study is to develop a standardised set of environmental-health work methods and procedures, which will contribute to the effective surveillance and control of Cholera in the KwaZulu-Natal province of South Africa. In order to develop effective work methods and procedures, it is necessary to have a clear understanding of the environmental health profession itself, including its place and role in the organisational structure within which it functions. It is also important to identify the place and the roles of all the relevant decision-makers, whose decisions may have a direct or indirect influence on the execution of their functional activities.

In this chapter, first to be discussed is the environmental health profession and the definition of environmental health from an international and national perspective. Secondly, environmental health is a wide-ranging discipline that relies on intersectoral co-operation and action; thus, the fields of activity of the environmental health profession, as they apply internationally, as well as in South Africa, will be discussed.

Thirdly, the place and role of environmental health, as well as that of other role-players within the health care system, whose decisions may have an influence on the effectiveness of environmental health-service delivery, will be identified and discussed. In the next section, the environmental health profession will be introduced.

3.2. The Environmental Health profession

This discussion includes a definition of environmental health, from an international and national perspective; the functional areas of environmental health-service delivery and the professional regulatory framework.

3.2.1. Environmental Health defined

The term Environmental Health is difficult to define, as its meaning is so wide; and in many respects, there is unease and misunderstanding when one attempts to define it (MacArthur, 1999: 1). It has been said that environmental health is everything, and that everything is environmental health (MacArthur, 1999: 1). While this may capture the enormity of the subject, it does not serve as a meaningful definition.

From an international perspective, environmental health has been defined in many ways, as follows (Frumkin, 2005: xxxi):

- Environmental Health is the branch of public health that protects people against the effects of environmental hazards that could adversely affect health or the ecological balances essential to human health and environmental quality (Agency for Toxic Substances and Disease Registry, cited in U.S. Department of Health and Human Services [DHHS], 1998);

- “Environmental health comprises those aspects of human health and disease that are determined by factors in the environment. It also refers to the theory and practice of assessing and controlling factors in the environment that [could] potentially affect health. It includes both the direct pathological effects of chemicals, radiation and some biological agents, and the effects (often indirect) on [the] health and wellbeing of the broad physical, psychological, social and aesthetic environment, which includes housing, urban developmental land use and transport” (European Charter on Environment and Health; see WHO Regional Office for Europe, 1990); and

- “Environmental health is the discipline that focuses, on the interrelationships between people and their environment, promotes human health and well-being, and fosters a safe and healthful environment” (National Center for Environmental Health, cited in DHHS, 1998).

- The National Institute of Environmental Health Sciences (NIEH, 2001) states that Environmental Health is the field of science that studies how the environment influences human health and disease. “Environment,” in this context, means things in the natural environment – like air, water and soil, and also all the physical, chemical, biological and social features of our surroundings. Moeller (2005:1) concurs by stating that in its broadest sense; environmental health is the segment of public health that is concerned with assessing, understanding and controlling the impacts of people on their environment and the impacts of the environment on them.

  Even so, this field is defined more by the problems it faces than by the approaches it uses. These problems include the purification of drinking water supplies and the provision of food supplies that are adequate and safe (Moeller, 2005:1).

- The World Health Organisation (2009b) states that Environmental Health addresses all physical, chemical, and biological factors external to a person, and all the related factors impacting behaviours. It encompasses the assessment and control of those environmental factors that could potentially affect health. It is targeted towards preventing disease and creating health-supportive environments. This definition excludes behaviour not related to the environment, as well as behaviour related to the social and cultural environment, and genetics.

According to the South African National Department of Health (2011:15), Environmental Health encompasses those aspects of human health, including quality of life, that are determined by the physical, chemical, biological, social and psychosocial factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling and preventing those factors in the environment that could potentially affect adversely the health of present and future generations.

From the definitions presented above, it may be deduced that environmental health is about the protection and promotion of human health by the mitigation and prevention of those environmental factors that could have an adverse effect on human health. The said factors are limited to the physical, chemical, biological and social factors in the environment. Furthermore, environmental health may be regarded as a facet of public health that involves the analysis (assessing and identification) of the said factors in the environment and the introduction of strategies (correcting, controlling and preventing), in order to rectify or prevent the occurrence of those factors that could potentially adversely affect the state of human wellbeing.

3.2.2. The functional areas of environmental health service delivery

Environmental health services are defined by the World Health Organisation (2009b) as: "… those services which implement environmental health policies through monitoring and control activities. They carry out that role by promoting the improvement of environmental parameters and by encouraging the use of environmentally friendly and healthy technologies and behaviours. They also have a leading role in developing and suggesting new policy areas." The primary and principal step deemed imperative in the effort to deliver environmental health services is the development and formulation of comprehensive and sound policy in the sector (World Health Organisation, 2009b).

According to MacArthur (2002:17), by applying the seven principles on which the environmental health approach is founded, namely:

1. Focus on people;
2. Redressing imbalances;
3. Co-operation and partnership;
4. Participatory democracy;
5. Putting safety first;
6. International co-operation; and
7. Sustainable futures.

Policy-makers and decision-makers should strive to ensure that a proposed policy or strategy would have a positive impact in creating supportive environments (MacArthur, 2002:17).

There is a need for environmental health services to be appropriately targeted and sympathetic to public needs, while at the same time representing the views of any relevant authorities, be they local, regional or national (MacArthur and Bonnefoy, 1998: 9). This requires the development of a wide range of competencies in organisational management, which encompass policy development, strategic and contingency planning, applied management sciences and the evaluation of services (Fitzpatrick & Bonnefoy, 1998: 24).

In this regard the following are the fields of knowledge relevant to the core areas of environmental health (Fitzpatrick & Bonnefoy, 1998: 26):

- Accident and injury prevention and control;
- Water quality;
- Air quality;
- Food quality and safety;
- Waste management and soil pollution;
- Human ecology and settlements;
- Health of people at work;
- Energy;
- Transport management;
- Land-use planning;
- Agriculture;
- Ionizing and non-ionizing radiation;
- Noise control;
- Tourism and recreational activities;
- Vector control.

According to Fitzpatrick and Bonnefoy (1998: 27), there is clearly a considerable degree of overlap between many of the core areas identified above, and they

should not be considered in isolation from each other. In particular, environmental health policy and management have an integrating role in all environmental health issues.

The organisational approach to environmental health service delivery differs widely throughout the world, despite the fact that the tasks to be performed have a large measure of uniformity (MacArthur, 1999: 18). The legal framework for the establishment of environmental health services in South Africa is rooted in the Constitution of the Republic of South Africa Act, 1996 (Act 108 of 1996), the Municipal Structures Act, 1998 (Act 117 of 1998) and the National Health Act, 2004 (Act 61 of 2003) (Agenbag & Balfour-Kaipa, 2008: 151).

The functional areas of the environmental health profession, as practised in South Africa, may be deduced from Section 1 of the National Health Act, 2004 (Act 61 of 2003). In terms of this section, “municipal health services” include the following:

- Water quality monitoring;
- Food control;
- Waste management;
- Health surveillance of premises;
- Surveillance and prevention of communicable diseases, excluding immunisation;
- Vector control;
- Environmental pollution control;
- Disposal of the dead; and
- Chemical safety.

However, it excludes port health, malaria control and the control of hazardous substances, which are provided for by the National and Provincial Health Departments. Cholera surveillance and control is an activity under the services: Surveillance and prevention of communicable diseases (see the fifth bullet above).

The scope of the environmental health profession, as practised in South Africa, was published under Government Notice R888 in Government Gazette 13184 of 26 April 1991; this was subsequently amended by Government Notice R698 in Government Gazette 32334 of 26 June 2009.

Eales et al. (2002:103), when describing the work of environmental health practitioners, maintain that the focus is on primary environmental health protection, through identifying, monitoring and evaluating the risks and planning interventions, which relate to a range of environmental hazards – microbiological, chemical or physical – whether in the home, at work, or in the street. According to Agenbag and Balfour-Kaipa (2008:151), environmental health practitioners have a key role to play in monitoring the quality of local service provision, minimising hazards, and in promoting the understanding of simple measures to improve the basic health and hygiene of vulnerable communities. They should advise municipalities on waste management and refuse removal, monitoring a range of potential environmental health risks – particularly those relating to water, air and food quality, identifying and addressing health threats, and liaising with nurses, laboratory staff and medical officers in investigating and addressing the outbreak of infectious diseases.

Environmental health services are at the core of Primary Health Care services and the prevention of disease (MacArthur, 1999:18). Environmental health practitioners thus have the potential to play an important role in supporting the integration of primary and preventive health care measures within municipal health services, promoting an understanding of good basic health and hygiene on the ground, and among decision-makers in all sectors, focusing attention on the health impacts of service provision, and promoting integrated development planning (Agenbag and Balfour-Kaipa, 2008: 151).

The professional regulatory framework of the environmental health profession will be discussed in the following section.

3.2.3 Professional regulatory framework.

In order to practise as an environmental health practitioner in the Republic of South Africa, a person needs to complete a three-year undergraduate qualification in environmental health, which is recognised by the Health Professions Council of South Africa. Currently, this three-year qualification is called the National Diploma: Environmental Health. The Baccalaureus Technologiae (B.Tech), Magister Technologiae (M.Tech), and Doctor Philosophiae (D.Tech) in Environmental Health are recognised by the Health Professions Council of South Africa as additional qualifications of environmental health practitioners (Health Professions Council of South Africa, 2009).

Furthermore, since April 2004, the Professional Board for Environmental Health Practitioners in the Republic of South Africa has introduced a compulsory system of Continued Professional Development, which could be defined as the systematic maintenance, improvement and broadening of knowledge and skills and the development of personal qualities necessary for the execution of professional and technical duties throughout a practitioner's working life (Health Professions Council of South Africa, 2009).

This programme is in line with the aims and objectives of the South African Institute of Environmental Health (South African Institute of Environmental Health, 2007). The aims and objectives of the South African Institute of Environmental Health are, according to Mudaly (personal communication September 15, 2009) to:

- Advance and promote the science and practice of Environmental Health;
- Affiliate and liaise with local, national and international bodies aimed at promoting the science and practice of environmental – as well as public/community health;
- Protect and promote the interests and status of all members registered with the Institute;
- Promote strong unity amongst members, irrespective of race, colour, sex, religion, creed, political aspiration and/or affiliation;
- Promote the professionalism of its members;

- Create structures that would promote and enable the involvement and participation in the affairs of the Institute by members at all levels; and
- Promote the basic training, as well as comprehensive specialized and advanced education of environmental health professionals, in addition to environmental health research.

A major part of the work of the environmental health practitioner in South Africa involves the enforcement of legislation (Agenbag & Balfour-Kaipa, 2008: 151 & the National Department of Health, 2009). According to the Health Professions Council of South Africa and the Professional Board for Environmental Health Practitioners (2009), the legislation with which the Environmental Health Practitioners are involved includes the:

- Atmospheric Pollution Prevention Act, 1965 (Act 45 of 1965);
- Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act 54 of 1972);
- Hazardous Substances Act, 1973 (Act 15 of 1973);
- International Health Regulations Act, 1974 (Act 28 of 1974);
- Health Act, 1977 (Act 63 of 1977);
- Animal Diseases Act, 1984 (Act 35 of 1984);
- Environment Conservation Act,1989 (Act 73 of 1989);
- Occupational Health and Safety Act, 1993 (Act 85 of 1993);
- Tobacco Products Control Act, 1993 (Act 83 of 1993);
- Constitution of the Republic of South Africa Act, 1996 (Act 108 of 1996);
- Genetically Modified Organisms Act, 1997 (Act 15 of 1997);
- Water Services Act, 1997 (Act 108 of 1997);
- National Environmental Management Act, 1998 (Act 107 of 1998);
- National Water Act, 1998 (Act 36 of 1998);
- The Municipal Structures Act, 1998 (Act 117 of 1998);
- The Municipal Systems Act, 2000 (Act 32 of 2000);
- Meat Safety Act, 2000 (Act 40 of 2000);
- Disaster Management Act, 2003 (Act 57 of 2002);
- National Health Act, 2004 (Act 61 of 2003);

- National Environmental: Air Quality Management Act, 2004 (Act 39 of 2004); and the
- National Environmental Waste Act, 2008 (Act 59 of 2008).

From the above, it may be deduced that the environmental health practitioner requires continuing development of expertise and an updating of knowledge, in order to maintain a leading role in dealing with environmentally related health problems. The environmental health practitioner must be in a position to exercise influence in promoting and regulating environmental health activities. In the following sections the place and role of environmental health within the organisational structure of the health care system in South Africa will be discussed.

3.3. The place and role of environmental health within the organisational structure of the health-care system in South Africa

In order to develop detailed environmental work methods and procedures for the surveillance and control of Cholera in KwaZulu-Natal, it firstly becomes necessary to identify the place and role of the environmental health decision-makers within the South African health-care system. Since there are a number of role-players whose decisions may influence the efficiency and/or effectiveness of Cholera surveillance and control within the said spheres, it is therefore important to achieve a comprehensive understanding of the function and relationship of the role-players within the national health-care system. The relevant decision-makers within the organisational structure of the National Department will be discussed first.

3.3.1. Environmental health decision-makers within the National Department of Health

Within the national sphere of government, a number of decision-makers can be identified, whose decisions may have either a direct or indirect influence on environmental health-service delivery throughout South Africa. The following section identifies and discusses these decision-makers. The Minister of Health is firstly introduced.

3.3.1.1. The Minister of Health

Section 3 of the National Health Act, 2004 (Act 61 of 2003) states that the Minister of Health is the Cabinet member responsible for health. The said Minister is responsible within the limits of available resources to:

- Endeavour to protect, promote, improve and maintain the health of the population;
- Promote the inclusion of health services in the socio-economic development plan of the Republic;
- Determine the policies and measures necessary to protect, promote, improve and maintain the health and wellbeing of the population;
- Ensure the provision of such essential health services, which must at least include primary health care services, to the population of the Republic, as may be prescribed after consultation with the National Health Council; and
- Equitably prioritise the health services that the State can provide.

The Minister of Health, in terms of Section 92(2) of the Constitution of the Republic of South Africa Act, 1996 (Act 108 of 1996), is accountable to Parliament for the exercise of powers and the performance of functions related to health. In terms of Section 90(1) of the National Health Act, 2004 (Act 61 of 2003), the Minister, after consultation with the National Health Council, may promulgate regulations regarding communicable diseases and notifiable medical conditions.

From the above, it may be deduced that the Minister of Health is responsible for the protection, promotion and maintenance of the health of the people of South Africa. It may also be deduced that the proposed regulations pertaining to Cholera surveillance and control must first be sanctioned by the Minister of Health before they can be promulgated as legislation.

The minister has more of an indirect influence on the quality of Environmental Health Services. He/she is more concerned with policy and policy-making than with the quality of service delivery. To assist the Minister in decision–making and

to enable the Minister to report to Parliament, a National Health Council has been established; this will be discussed below.

3.3.1.2. The National Health Council

The remit of the National Health Council is generally that of policy-making – it is to advise the Minister, who serves as chairperson of the said council, on policy concerning any matter that would protect, improve and maintain the health of the population (Gray et al., 2005:18). In terms of Section 22(2) of the National Health Act, 2004 (Act 61 0f 2003), the National Health Council consists of the following members:

- The Minister (or nominee), who acts as chairperson;
- The Deputy Minister of Health, if there is one;
- The relevant members of the Executive Councils of the nine provinces;
- One municipal councillor, representing organised local government and appointed by the national organisation contemplated in section 163(a) of the Constitution (i.e. it provides for the recognition of national and provincial organisations representing the municipalities);
- The Director-General and the Deputy Directors-General of the national department;
- The head of each provincial department;
- One person employed and appointed by the national organisation contemplated in section 163(a) of the Constitution; and
- The head of the South African Military Health Service.

The National Health Council must advise the relevant Minister on policy concerning any matter that will protect, promote, improve and maintain the health of the population. Some of the said matters include:

- Epidemiological surveillance and monitoring of national and provincial trends with regard to major diseases and risk factors for disease; and
- The obtaining, processing and use of statistical returns; (Section 23 of the National Health Act, 2004 (Act 61 of 2003)).

The National Health Council may consult with, or receive representations from any person, organisation, institution or authority. It may also create one or more committees to advise it on any matter (National Department of Health, 2004).

The National Health Council has more of an indirect influence on quality (effectiveness) of Environmental Health service delivery. In the next section the National Health Consultative Health Forum will be discussed.

3.3.1.3. The National Consultative Health Forum

In terms of Section 24(1) of the National Health Act, 2004 (Act 61 of 2003), the Minister must establish a body to be known as the National Consultative Forum, which must promote and facilitate interaction, communication and the sharing of information on national health issues between representatives of the national department, national organisations identified by the Minister and provincial consultative bodies in terms of Section 28 of the said Act. The forum must include all the relevant stakeholders, and it must meet at least once every twelve months. This forum plays a leading role in the sharing of health-related information with the stakeholders within and outside the health-care system (Gray et al., 2005: 18).

From the above, the deduction may be made that the National Health Council is responsible for the provision, development and co-ordination of all health care in South Africa, and that the National Consultative Health Forum promotes and facilitates interaction, communication and the sharing of information on national health issues between representatives of the national department, national organisations and provincial consultative bodies, and the relevant stakeholders.

The National Health Consultative Forum has more of an indirect influence on quality (effectiveness) of Environmental Health service delivery. It is therefore imperative that the National Health Council and the National Consultative Forum should have sufficient representation from the Environmental Health Profession, which in turn must advise the Minister of Health on information relating to the surveillance and control of cholera.

In the next section the functions of the National Department of Health led by the Director–General of Health will be discussed.

3.3.1.4. The Director-General of Health

The Director-General of the National Department of Health has the responsibility to communicate health-related information (including information related to Cholera) to the Minister of Health. This information can either be communicated directly to the Minister of Health, or through the National Health Council (Section 21 of the National Health Act, 2004 (Act 61 of 2003).

According to Section 21 of the National Health Act, 2004 (Act 61 0f 2003), the Director–General must ensure the implementation of national policy, and in accordance therewith, liaise with national health departments in other countries and with international agencies; and in addition, issue and promote adherence to the norms and standards on health matters, including amongst others:

- Environmental conditions that constitute a health hazard;
- The provision of health services;
- Any matter that affect the health status of people in more than one province;
- Identify national health goals and priorities and monitor the progress of their implementation;
- Co-ordinate health and medical services during national disasters;
- Facilitate the provision of indoor and outdoor environmental pollution control;
- Facilitate and promote the provision of health services for the management, prevention and control of communicable and non-communicable diseases; and
- Co-ordinate health services rendered by the national department with the health services rendered by provinces; and provide additional health services, as may be necessary to establish a comprehensive national health system.

The Director-General must prepare strategic, medium-term health and human resource plans annually, for the exercise of powers and the performance of duties of the national department responsible for finance and state expenditure and any other governmental planning exercise required by any other law. The Director-General must also integrate the health plans (which must comply with national health policy) of the national department and provincial departments once a year and submit the integrated health plans to the National Health Council. The said health plans, in terms of Section 215 of the Constitution of the Republic of South Africa, 1996 (Act 108 of 1996) relating to national, provincial and municipal budgets, form the basis of the department's budget.

From the information above, it can be surmised that the Director-General plays a key role in the promotion and implementation of policies regarding environmental health, including Cholera surveillance and control throughout South Africa.

The Director-General also has more of an indirect influence on quality (effectiveness) of Environmental Health service delivery. As the Director-General cannot perform the above-mentioned functions unilaterally, he or she relies on the Deputy Directors-General of the National Department of Health to supply him/her with sufficient feedback to make informed decisions.

In the next section the responsibilities of the Deputy Director-General of Health will be discussed.

3.3.1.5. The Deputy Director-General of Health

The Director-General of Health of the National Department of Health is assisted by six Deputy Directors General (Cele, personal communication September 25, 2009 & Van Rijswijk, National Department of Health personal communication October 14, 2009). The Deputy Directors-General are also members of the National Health Council, according to Section 22 of the National Health Act, 2004 (Act 61 of 2003).

The National Department of Health comprises Clusters and their Divisions (National Department of Health, 2009b). These are listed as follows:

- Branch 1: Chief Financial Officer and Corporate Services;
- Branch 2: Strategic Health Programmes;
- Branch 3: Health Planning and Monitoring;
- Branch 4: Human Resources Management and Development;
- Branch 5: Special Programmes and Health Entities' Management; and
- Branch 6: International Relations, Health Trade and Health Products.

Each branch is headed by the relevant Deputy Director-General (Van Rijswijk, personal communication, October 14, 2009).

The Deputy Director-General of Branch 5: Special Programmes and Health Entities' Management, has the responsibility to co-ordinate the activities of the sub-directorates within his/her portfolio, including the Chief Directorate: District Health Services and Environmental Health. The Deputy Director-General of Branch 2: Strategic Health Programmes has the responsibility to co-ordinate the activities of the sub-directorates within his/her portfolio, including the Chief Directorate: Communicable Diseases (Cele, personal communication September 25, 2009).

At the national sphere of government, the surveillance and control of Cholera fall within the scope of several chief directorates, as indicated above. The Deputy Directors-General have more of an indirect influence on the quality (effectiveness) of Environmental Health service delivery. The relevant Deputy Directors-General have the responsibility to ensure the effective service delivery of environmental health services through the Chief Directorate: District Health Services and Environmental Health. The next section will discuss the place and role of the National Directorate: Environmental Health within the National Department of Health.

3.3.1.6. National Directorate: Environmental Health

The Environmental Health Director reports to the Chief Directorate: District Health Services and Environmental Health, who in turn reports to the Deputy

Director-General of Branch 5: Special Programmes and Health Entities' Management (Cele, personal communication September 25, 2009). The Directorate: Environmental Health is responsible for (National Department of Health, 2009b):

- Developing norms and standards for environmental health;
- Ensuring that basic environmental needs are met and those environmental factors inimical to health are minimised; and
- Developing an environmental surveillance and evaluation system to monitor the effectiveness of environmental interventions.

The objectives of the Directorate: Environmental Health are to ensure a sustainable, safe and healthy environment, where South Africans can live, work and recreate through the protection of public health and the environment by providing adequate regulatory tools and comprehensive Environmental Health Services (National Department of Health, 2009b). The main functions of the Directorate: Environmental Health include, inter alia to (National Department of Health, 2009b):

- Provide support, training, monitoring and evaluation of Municipal Environmental Health Services;
- Administer the Hazardous Substances Act, 1973 (Act 15 of 1973) and relevant sections under the National Health Act, 2004 (Act 61 of 2003);
- Formulate a regulatory framework for improved social and living conditions in human settlements;
- Administer the relevant sections of the International Health Regulations Act, 1974 (Act 28 of 1974) through strengthened port health services;
- Co-operate with other government departments on air quality, water treatment, chemicals and health-care waste, water and sanitation;
- Initiate and co-ordinate chemical safety programmes; and to
- Work with the National Department of Environmental Affairs and Tourism on international environmental multilateral agreements.

From the above, it may be concluded that the Deputy Director-General of Branch 5: Special Programmes and Health Entities Management has to rely on the Director: Environmental Health to supply him/her with the necessary environmental health information, including information on the status of Cholera in South Africa. A deduction that can be made that the immediate source for environmental health information from a national perspective is the Director: Environmental Health.

A further deduction is that the Minister of Health must account to cabinet and parliament on the status of Cholera in South Africa. Such information would be provided by the Director: Environmental Health to the Director General via the Deputy Director-General of Branch 5: Special Programmes and Health Entities Management. The Director General can then present the information to the Minister of Health. As established earlier (see section 3.3.1.2), the National Health Council can also present the information to the Minister.

The Director: Environmental Health, consequently, plays a key role in the development of quality environmental health services at both provincial and municipal spheres. Various decisions have to be made, based on information related to environmental health service delivery at provincial and municipal spheres, decisions which may directly affect the quality of the services rendered.

According to Maniram (personal communication, October 13, 2009), the Director: Environmental Health of the National Department of Health has to rely on the provincial health departments (environmental health in the provincial sphere of government) to supply him/her with environmental health-related information (including information related to Cholera). He/she has a direct influence on the effectiveness of Environmental Health Service delivery in South Africa.

In the next section the organisational structure of the Provincial Health Departments will be discussed.

3.3.2. Environmental health decision-makers within the Provincial Health Departments

Within the provincial sphere of government a number of decision-makers can be identified, whose decisions could have either a direct or indirect influence on environmental health-service delivery within the provinces. The following section identifies and discusses these decision-makers. The Member of the provincial executive committee will first be introduced.

3.3.2.1. Member of the provincial executive committee responsible for health and the provincial legislature

The member of the Provincial Executive Council of Health (MEC) is the person who is accountable to the Provincial legislature and the public for the exercising of powers and the performance of functions within a Provincial Health Department (Maniram, personal communication, October 13, 2009). He/she is, therefore, responsible for the effective rendering of Environmental Health Services, including "Municipal Health Services", as defined by the National Health Act, 2004 (Act 61 of 2003).

The inference drawn from the above implies that the MEC is obliged to regularly provide the provincial legislature and the public with full and regular reports concerning matters under his/her control, including the monitoring and co-ordination of environmental health services within the province. The implication of the above is that the MEC for Health must at all times be aware of the status of the environmental health services that are being rendered within the province.

Although the MEC of Health has more of an indirect influence on quality (effectiveness) of environmental health service delivery, the provincial legislature relies on the MEC of Health for factual information on the surveillance and control of communicable diseases, including Cholera (Maniram, 2009). The next section will discuss the role of the Provincial Health Council.

3.3.2.2. Provincial Health Council

In terms of Section 26 of the National Health Act, 2004 (Act 61 of 2003), a Provincial Health Council must be established in each of the nine provinces of

South Africa. In terms of the KwaZulu-Natal Health Act, 2009 (Act 1 of 2009), this council shall be known as the KwaZulu-Natal Provincial Health Council. According to Section 16 of the said Act, the composition of the council is as stipulated in Section 26 of the National Health Act, 2004 (Act 61 of 2003), namely:

- The relevant member of the Executive Health Council, or his or her nominee, who acts as the chairperson;
- One Councillor from the metropolitan municipality in the province;
- One Councillor from each of the district municipalities in the province;
- The head of the provincial department. In the case of the KwaZulu-Natal province, this person is referred to as Head: Health (Schedule 2 of the Public Service Act, 1994 (Proclamation 103 of 1994));
- Not more than three representatives involved in the management of local government; these persons must be appointed by the national organisation (See section 163(a) of the Constitution) i.e. it provides for the recognition of national and provincial organisations representing the municipalities;
- One municipal councillor, representing organised local government and appointed by the national organisation, as discussed in section 163(a) of the Constitution (i.e. it provides for the recognition of national and provincial organisations representing the municipalities); and
- Such other persons as the MEC may consider appropriate.

The Provincial Council has more of an indirect influence on quality (effectiveness) of Environmental Health service delivery. The Provincial Council, must at the request of the MEC, or on its own accord, advise the relevant member of the executive council on policy concerning any matter that would protect, promote, improve and maintain the health of the population within the province, including proposed legislation relating to health matters, before it is introduced in the provincial legislature, and suggest practical guidelines for the management of health districts.

Section 17 (1) of the KwaZulu-Natal Health Act, 2009 (Act 1 of 2009) and Section 27 of the National Health Act, 2004 (Act 61 of 2003) apply, with regard to the functions of the KwaZulu-Natal Provincial Health Council; some of these matters include:

- Epidemiological surveillance and monitoring trends with regard to major diseases and risk factors for disease, i.e. Cholera;
- Targets, priorities, norms and standards relating to the equitable provision and financing of health services;
- Efficient co-ordination of health services within the province and between neighbouring provinces;
- Human resource planning, production, management and development;
- Equitable financial mechanisms for the funding of health services; and
- The obtaining, processing and use of statistical returns.

In terms of Section 27 of the National Health Act, 2004 (Act 61 of 2003), a Provincial Health Council may determine the timeframes, guidelines and the format for the preparation of district health plans within its jurisdiction; it may consult with or receive representations from any person, organisation, institution or authority; and it may create one or more committees to advise it on any matter.

In the next section the Provincial Consultative Health Forum will be introduced.

3.3.2.3. Provincial Consultative Health Forum

The KwaZulu-Natal Health Act, 2009 (Act 1 of 2009) gave effect to the National Health Act, 2004 (Act 61 of 2003) by establishing in terms of its section 19(1) a body to be known as the KwaZulu-Natal Provincial Consultative Health Forum. It is the responsibility of the KwaZulu-Natal Provincial Consultative Health Forum to promote and facilitate interaction, communication and the sharing of information on provincial health issues between representatives of the provincial department, and the provincial and municipal organisations identified by the MEC. The MEC must determine the composition and place, date and time of any

meeting (at least once every twelve months) of the provincial consultative forum; and it must include all the relevant stakeholders.

It is imperative that the Provincial Consultative Forum be provided with sufficient knowledge and representation on issues pertaining to environmental health and that they investigate such issues and report their findings to the Provincial Health Council. The relevant information concerning environmental health service in the province should be obtained from sources that will be discussed in the sections that follow. These sources reflect the situation within the KwaZulu-Natal province, and may differ from post structures and designations within other provinces. However, similar post structures/designations with similar functions may be identified within the other provinces.

The next section will discuss the Head of the Provincial Health Department in KwaZulu-Natal.

3.3.2.4. Head of the Provincial Health Department

In terms of Section 25 (1) of the National Health Act, 2004 (Act 61 of 2003), the Head of the Provincial Health Department must, in accordance with national health policy and the relevant provincial health policy in respect of, or within KwaZulu-Natal inter alia:

- Plan and manage the provincial health information system;
- Participate in interprovincial and intersectoral co-ordination and collaboration;
- Co-ordinate the funding and financial management of district health councils;
- Provide technical and logistical support to district health councils;
- Plan, co-ordinate and monitor health services, and must also evaluate the rendering of health services;
- Co-ordinate health and medical services during provincial disasters;
- Plan, manage and develop human resources for the rendering of health services;
- Facilitate and promote the provision of port health services;
- Control the quality of health services and facilities;

- Provide health services contemplated by specific provincial service programmes;
- Consult with communities regarding health matters;
- Promote health and healthy lifestyles;
- Promote community participation in the planning, provision and evaluation of health services;
- Provide environmental pollution control services; and
- Provide services for the management, prevention and control of communicable and non-communicable diseases.

The head of the provincial department has more of an indirect influence on the quality (effectiveness) of Environmental Health service delivery. Furthermore, the head of a provincial health department must prepare strategic, medium-term health and human resources plans annually for the exercise of the powers of, the performance of the duties of, and the provision of health services, in the province by the provincial department, and submit such plans to the Director-General within timeframes, and in accordance with the guidelines determined by the National Health Council. Provincial health plans must conform to national health policy (National Health Act, 2004 (Act 61 of 2003). In the next section the place and role of environmental health within the Provincial Health Department will be discussed.

3.3.2.5. Manager Environmental Health Services

Environmental Health is a division of the Non-personal Primary Health Care Services in the KwaZulu-Natal Provincial Health Department (KwaZulu-Natal, 2009). The structure responsible for Environmental Health in the KwaZulu-Natal province is the Component Head for Environmental Health, which is led by the Manager: Environmental Health Services (KwaZulu-Natal, 2009).

The role of the Manager: Environmental Health is to take full responsibility for the effective rendering of environmental health services throughout the province (Khanyile, personal communication, October 13, 2009). A further role of the said environmental health section is to monitor and co-ordinate environmental health-

related functions that have been delegated to the municipal sphere of government. These functions include the surveillance and control of Cholera, as may be deduced from Section 1 of the National Health Act, 2004 (Act 61 of 2003).

From an environmental health perspective, the Head of the Provincial Health Department has to rely on the Manager: Environmental Health to provide the necessary information that would enable him/her to inform the member of the Executive Council on the status of Environmental Health in the province. The Manager: Environmental Health is the key functionary that co-ordinates Environmental Health services in the KwaZulu-Natal Province (Khanyile, personal communication, October 13, 2009).

The Manager: Environmental Health works in close collaboration with other relevant health officers in different spheres of government, namely the Director: Environmental Health in the National Department of Health and the environmental health practitioners in the municipal spheres of government within t6he relevant province. The Manager Environmental Health has a direct influence on the effectiveness of Environmental Health Service delivery in the province. He/she is thus an important role-player, whose decisions may influence the efficiency of Cholera surveillance and control in KwaZulu-Natal.

In the following section, the Environmental health decision-makers within the municipal sphere of government will be discussed.

3.3.3. Environmental health decision-makers within the municipal sphere of government

South Africa has adopted the District Health System (DHS) model in its description of a single district health-management structure, to plan and implement a package of district health services within a demarcated health district (Hall et al., 2002: 3). A District Health System that is based on primary health care is a more or less self-contained segment of the national health system. It comprises, first and foremost, a well-defined population, living within a clearly delineated administrative and geographic area – whether urban or rural.

It includes all institutions and individuals providing health care in the district (Hall et al., 2005: 8).

The district health system is the vehicle for providing quality primary health care services to everyone in a defined geographical area. It is a system of health care in which individuals, communities and all health care providers of the area participate together in improving their own health in homes, work places and communities (Haynes, 2008:22). Its component elements need to be well-coordinated by an officer assigned to this function, in order to draw together all the elements and institutions into a fully comprehensive range of promotive, preventive (includes environmental health), curative and rehabilitative health activities (Hall et al., 2004:45).

The Health District, which is a new form of municipality, will be presented first in the next section.

3.3.3.1. Health District

The point of having health districts is to allow communities to interact with the people who manage health, and to allow health workers to interact with the people in other governmental sectors that affect health. Government health workers can also work together with non-government workers and private health workers (Nicholson, 2001: 29).

District health structures are meant to be at the centre of health-care service delivery. The boundary of each health district is the same as district and metropolitan municipal boundaries. However, to improve services in big municipalities, provincial government are allowed to set up health sub-districts. These districts (and sub-districts) are responsible for providing municipal health services (Health & Democracy, 2009).

The Constitution list three categories of municipalities, namely: metropolitan (Category A), local (Category B) and district (Category C) municipalities. It gave municipalities from categories A and C executive authority to deliver municipal health services, as defined by the Municipal Structures Act, 1998 (Act 117 of

1998) and the National Health Act, 2004 (Act 61 of 2003) (Agenbag & Balfour Kaipa, 2008:151).

In order to fulfil the above-mentioned strategy for a District Health System in South Africa, the provincial health departments, in terms of their own provincial health legislation, divided their provinces into a number of geographically coherent, functional health districts, whose boundaries are coherent with Category A (metropolitan) and Category C (district) municipalities (Constitution of the Republic of South Africa Act, 1996 (Act 108 of 1996)).

Legally, municipal health services are fully fledged line (core) functions of metropolitan and district municipalities. These municipalities must therefore accept full responsibility for providing the necessary resources for delivering environmental health services in terms of the Municipal Systems Act, 2000 (Act 32 of 2000); Nel & Agenbag, 2007:9).

The next section will describe the functions of a District Health Council.

3.3.3.2. District Health Council

In each province, the member of the Executive Council (MEC) responsible for health, together with the member of the Executive Council (MEC) responsible for local government, must establish a District Health Council for each health district within the relevant province. The district health council will be responsible for the development of district health plans in line with provincial health policies.

In terms of Section 31 (2) of the National Health Act, 2004 (Act 61 of 2003), a District Health Council consists of:

- A member of the metropolitan or district municipal council situated in the health district in question, nominated by the relevant council (is to be chairperson);
- A person appointed by the MEC to represent him or her;
- A member of the council of each local municipality within the health district, nominated by the members of the relevant council; and

- Not more than five other persons, appointed by the MEC after consultation with the municipal council of the metropolitan or district municipality.

The key functions of the District Health Council are (Gray et al., 2005:4):

- To promote the co-operative governance between spheres of governments;
- To ensure the co-ordination and integration of services within the health district; and
- To advise the MEC for Health, through the Provincial Health Council, on any health matters relating to the health district.

In terms of Section 32 of the National Health Act, 2004 (Act 61 of 2003), every metropolitan and district municipality must ensure that appropriate municipal health services are effectively and equitably provided in their respective areas. It is, therefore, envisaged that municipal health services would be delivered equitably throughout the district, and co-ordinated and funded by the metropolitan or district municipality (Gray et al., 2005:47). Each district and metropolitan health manager must, within the national budget, develop and present to the District Health Council and MEC, a district health plan. These plans will be included in the district health plan and implementation monitored by the District Health Council (Gray et al., 2005: 47).

In the next section the Health sub-district will be introduced.

3.3.3.3. A Health sub-district

Major differences between provinces are apparent in organisational structures relating to Health sub-districts; most provinces have sub-district management structures of varying capacities, although generally, with centralised control vested in the District (Haynes, 2008:26). The MEC for Health is ultimately responsible for ensuring the effective management of health districts and sub-districts in the province (Haynes & Hall, 2002:87).

A Health sub-district (metropolitan sub-council in the case of a metropolitan municipality) consists of political representatives, or councillors, representing the wards included in the sub-council area. The sub-council has such duties and powers as the metropolitan council may delegate to it; and it may make recommendations to the metropolitan council on any matter affecting environmental health within its wards (Wilson, 1994:5). An example of the division of a metropolitan (Category A municipality) into health sub-districts is the eThekwini Metropolitan Municipality in the KwaZulu-Natal province. This municipality is divided into three health sub-districts, namely:

- South Sub-district – Umkomaas, and the surrounding townships, and eThekwini and the surrounding townships:
- West Sub-district – Pinetown and surrounding townships; and
- North Sub-district – Durban, Umhlanga and the surrounding townships (eThekwini Metro Municipality, 2009).

A district municipality, in contrast to a metropolitan municipality, must establish within its area, internal municipal service districts to facilitate the provision of municipal services in the said parts of the municipality (Section 85 of the Local Government: Municipal Systems Act, 2000 (Act 32 of 2000). In terms of health care-service delivery, these municipal service districts are also referred to as Health sub-districts (Wilson, 1994:4).

The next section will discuss a local municipality.

3.3.3.4. A local municipality

A local municipality is defined, in terms of Section 1 of the Local Government: Municipal Structures Act, 1998 (Act 117 of 1998), as a municipality that shares municipal executive and legislative authority in its area with a district municipality (Category C municipality) within whose area it falls, and which is described in Section 155 (1) (b) of the Constitution of the Republic of South Africa Act, 1996 (Act 108 of 1996) as a Category B municipality. In terms of health-care service delivery, these municipalities are referred to as sub-units of a health sub-district of a Category C municipality.

An example of the division of a Category C municipality into health sub-districts, and the division of those health sub-districts into six local municipalities is Uthungulu District Municipality (also referred to as Uthungulu Health District – a Category C municipality) in KwaZulu-Natal province that has been divided into five sub-districts, namely: Empangeni, Uthungulu sub-district, Eshowe, Nkandla and Melmoth. Two of these health sub-districts, are further divided into local municipalities (Category B municipalities, namely:

- Empangeni Sub-district: - Lower Umfolozi, Eshowe, Nkandla and Melmoth; and
- Uthungulu Sub-District:- Ntambanana, KwaMbonambi (Provincial Department of Health KwaZulu-Natal, 2009).

In terms of Section 16 of the Local Government Municipal System Act, 2000 (Act 32 of 2000), local (Category B) municipalities must develop a culture of municipal governance that complements formal representative government with a system of participatory governance. For this purpose, local municipalities must encourage and create conditions that are favourable for the local community to participate in the affairs of the municipality, including strategic decisions relating to the provision of environmental health services by the relevant Category C municipality, with whom it shares its municipal executive and legislative authority (Maarschalk, 2003: 136).

The next section will discuss the place and role of environmental health within the district health system (municipal sphere of government).

3.3.4. The place and role of environmental health within the district health system

The national vision for health services is Primary Health Care (PHC) through a decentralised, municipal-based, District Health System (DHS) (Local Government Health Consortium, 2004: 8). The Minister of Provincial and Local Government, has specified Municipal Health Services (MHS) as a district and

metropolitan municipality's responsibility (Local Government Health Consortium, 2004: 8). In order to assist the members of a district health council to make informed decisions regarding environmental health services, they will require sufficient information. In the KwaZulu-Natal province, each District has a District Environmental Health Manager who is responsible for the co-ordination of environmental health service delivery within their respective health districts, as well as the provision of environmental health information to the relevant District Health Council.

To be able to effectively perform this function, the environmental health managers have to rely on the health sub-districts, which are situated within their health districts, to provide the relevant information (Maniram, personal communication, October 13, 2009).

The function of the district and metropolitan municipalities (health districts) is to coordinate and to support the health sub-districts within their areas of jurisdiction. Each health sub-district of a metropolitan and district municipality has at least one environmental health practitioner who is responsible for the co-ordination of environmental health service delivery within the area of the health sub-district. The said environmental health practitioner is also responsible for the provision of information to the decision-makers of the health sub-district and district or metropolitan municipality. From a health sub-district of a metropolitan (Category A) municipality's perspective, this official should be able to obtain the required information from the environment health practitioners who work within that health sub-district. From a municipal health sub-district perspective (Category C) the official would be able to obtain the required information from the environmental health practitioners who work at the local municipalities situated within the area of jurisdiction of the health sub-district (Maniram, personal communication, October 13, 2009 & KwaZulu-Natal Provincial Health Services Directory, 2008).

From a local municipality's perspective (Category B municipality), it may be concluded that the members of a local municipal council would require sufficient environmental health information to enable them to make informed decisions

from a local municipal council's perspective. Each local municipality is allocated an environmental health manager, who is employed by the relevant health district (Category C) municipality.

A function of this official is to provide the members of the relevant local municipal council, as well as the relevant health sub-district environmental health practitioners, with sufficient environmental health information to enable them to make informed decisions on issues pertaining to environmental health that could affect the local municipality. This official will also render, together with environmental health practitioners employed by the relevant district municipality, environmental health services within the area of jurisdiction of that local municipality (Maniram, personal communication, October 13, 2009 & KwaZulu-Natal Provincial Health Services Directory, 2008).

From the above, it may be deduced that environmental health services are vested in the municipal sphere of government as municipal health services. Cholera surveillance and control are activities under these services: surveillance and prevention of communicable diseases, as listed in KwaZulu-Natal Provincial Health Services Directory (2008).

3.4 Conclusion

The development of detailed environmental health-work methods and procedures for the surveillance and control of Cholera in the KwaZulu-Natal province requires a comprehensive understanding of the national health-care system within which environmental health practitioners operate. This chapter has attempted to describe the national health care system, and to identify the place and role of the environmental health practitioners within the national, provincial and municipal spheres of government.

The right to health care services is well established within the Constitution of the Republic of South Africa Act, 1996 (Act 108 of 1996). The South African government has adopted the primary health-care approach of health-care service delivery. This includes non-personal health-care services, namely: environmental health services.

The environmental health profession has a constitutional obligation to protect the people of South Africa against biological, chemical and physical dangers in the micro- and macro-environment that could have a negative influence on human health and wellbeing. The development of detailed environmental health work methods and procedures for the surveillance and control of Cholera could therefore be regarded as an attempt to fulfil this constitutional obligation.

The promulgation of the National Health Act, 2004 (Act 61 of 2003), provides the legislative framework for the State to unite the various elements of the national health system into one common goal, and to actively promote and improve the national health system in South Africa. The said Act delineates the organisational framework for health-care service delivery within each of the three spheres of government in South Africa.

In the analysis of the national health-care system, a number of decision-makers were identified within the three spheres of government. These decision-makers invariably have an influence on environmental health-service delivery; and they therefore play either a direct or an indirect role in the surveillance and control of Cholera by environmental health practitioners in the municipal sphere of government. The analysis of the organisational structure of the National Department of Health has enabled the identification of the following decision-makers:

- The Minister of Health and the Cabinet;
- Members of the National Health Council;
- The National Consultative Health Forum;
- The Director-General of Health;
- The Deputy Director-General of Branch 5: Special Programmes and Health Entities Management; and
- The Director: Environmental Health.

The environmental health decision–makers within the provincial sphere of government include:

- The member of the Provincial Executive Committee responsible for health and the Provincial legislature;
- The Provincial Health Council;
- The Provincial Consultative Health Forum;
- The Head of the Provincial Health Department; and
- The Manager: Environmental Health.

The municipal sphere of government is a part of the District Health System. The District Health System includes the following structures:

- Health District (Categories A and C municipalities);
- District Health Council (Management structure of a health district);
- A Health Sub-District (Sub-division of a health district); and
- A Local Municipality (Category B municipality).

In terms of the National Health Act, 2004 (Act 61 of 2003), a health district may be divided into health sub-districts, which should comprise one or more local municipalities in non-metropolitan areas. At the health sub-district level, variations may occur between provinces, and even within a province.

The environmental health decision–makers within the municipal sphere of government include:

- Municipal Council;
- District Health Council; and
- District Environmental Health Manager

The co-ordination of environmental health services within the municipal sphere of government depends to a large extent on the level of communication between the Environmental Health Managers in each district, on the metropolitan

municipality, and on the Manager: Environmental Health in the provincial health department.

Whilst environmental health services can be driven by legislation, they cannot be delivered by legislation alone. It is therefore important to provide details on functional/practical control strategies or activities to be performed once an outbreak of Cholera occurs. The implication of this is that each municipality within the KwaZulu-Natal province would need to follow a standardised set of work methods and procedures during surveillance and control activities. The work methods and procedures for the surveillance of Cholera will be presented in the next chapter.

CHAPTER FOUR

WORK METHODS AND PROCEDURES FOR THE SURVEILLANCE OF CHOLERA

4.1 Introduction

As described in Chapter Two, the epidemiology of Cholera has been dominated by its tendency to spread throughout the world in pandemics. The ability to control an infectious disease like cholera requires an effective and comprehensive public health-surveillance system.

Disease surveillance in public health includes the process of systematic collection, collation and the analysis of data – with prompt dissemination to those who need to know – for any relevant action to be taken. It includes the facilitation of the necessary response that would be able to effectively deal with the problem.

One of the most fundamental ways to approach problems – in an organised fashion – is the scientific method. This method is a structured procedure to solve problems. It consists of a number of steps which, if followed, should result in a better way of performing a task. The prescribed procedures would normally show how a policy must be carried out – and would supply a specific guideline for action.

In 2002, the National Department of Health updated the Guidelines for the control of Cholera; however, to date, none of the provinces and municipalities has developed the required detailed environmental health-working methods and procedures for the surveillance and control of Cholera within their areas of jurisdiction.

In this chapter, firstly, the concept of work methods and procedures will be described. Secondly, the basic principles of disease surveillance will be described. Thirdly, the current environmental health-working methods and procedures for the surveillance of Cholera in KwaZulu-Natal will be presented

and analysed. Fourthly, against the background of the findings, an attempt will be made to develop a formal set of work methods and procedures to be used by environmental health practitioners during the surveillance of Cholera in the KwaZulu-Natal Province, South Africa. The concept of work methods and procedures is discussed in the following section.

4.2 Work methods and procedures

The term “work procedure” is defined by Robbins (1982: 72) as “… a series of interrelated sequential steps established for accomplishing of a task”. Work procedures have been extensively used in organisations since time immemorial. According to Cheminais, Bayat, Van Der Waldt and Fox (1998: 49) work procedures obviate a trial-and-error system, by providing novices with tried and tested ways of executing their duties, and by promoting the concept of public accountability.

Generally, this would be done by providing norms for acceptable behaviour on the part of public officials. Well-conceived and proven work procedures are essential for the efficient functioning of any organisation. They offer the following advantages (Cheminais, Bayat, Van Der Waldt and Fox, 1998: 49):

- They serve as the basis for sound induction and training;
- They promote safety, effectiveness and efficiency;
- They prevent ambiguity and misunderstanding – by providing standardised, uniform norms for the behaviour of public sector personnel;
- They provide a basis for assessing the performance of individuals and sections; and
- They are useful in the investigation of any mishaps or wrongdoings.

Andrews (1988: 10) points out that due to the need to continually adjust procedures to cope with technological developments, legislation does not normally describe procedures in detail. They are set out in procedure manuals, which can be amended more easily and far faster than legislation.

One of the most fundamental ways to approach problems in an organised fashion is the scientific method. This method comprises a structured procedure to solve problems. It consists of a number of steps that, if followed, should result in a better way of performing a task (Aft, 200:24).

A task must be approached in an orderly manner if its objective is to be reached with a minimum of effort and expenditure (Cloete, 1993:77). Work methods in this study will be defined as the procedure comprising a sequence of actions by environmental health practitioners – used to accomplish the task of Cholera surveillance.

A procedure shows how a policy must be carried out; and it supplies a specific guideline for action; it is a series of interrelated sequential steps established for the accomplishment of a task (Kanawaty, 1995:154). Work procedures should also ensure that everyone co-operates in attaining the set objectives (Maarschalk, 2003:10).

In this study, work procedures will be defined as a series of scientifically formulated and interdependent consecutive steps, which must be taken in the achievement of Cholera surveillance.

Andrews (1988:10) points out that due to the need to continually adjust procedures to cope with technological developments, legislation does not normally describe procedures in detail. They are set out in procedure manuals, which can be amended more easily and faster than can any legislation.

From the above, it may be deduced that the particular work methods and procedures to be developed should compel environmental health practitioners to unite their efforts to work in an organised manner. In the next section the basic principles of disease surveillance will be explained.

4.3. The basic principles of disease surveillance

The World Health Organisation (2006: 1) defines surveillance as the ongoing systematic collection, analysis, and interpretation of outcome-specific data for

use in planning, implementing and evaluating public health policies and practices. Surveillance for communicable disease is a part of public health surveillance. This, in turn, is part of the wider health information system (World Health Organization, 2001: 1).

The key elements of disease surveillance are that: It is an ongoing activity, and is therefore routine; it is systematic, even legislated, i.e. it happens in a standardized and organized way; data are disseminated in a timely way, i.e. to those who need such data in time for action to be taken; and it should lead to the prevention and control action (World Health organization, 2001: 1).

Public health surveillance encompasses more than the collection and management of health-related data; however, it also requires analysis, interpretation and the use of that data (Teutsch & Churchill, 2000: 95). The objective of the surveillance system and the use of the information determines the data collected and the speed of information flow within the system (World Health Organisation, 2001: 1).

Surveillance is used to detect outbreaks of diseases; and over recent years, it has increasingly been recognised as a crucial component of national and global defences against catastrophic epidemics. Globally, regionally and locally, it also provides evidence and data for health planning and evaluation (Webb, 2005: 77). Early warning of epidemics is essential for effective and rapid control; while information on endemic communicable disease is essential for monitoring the disease (World Health Organisation, 2001: 1).

The core components during the surveillance of a health event are (The World Health Organisation, 2006: 18):

- Case detection;
- Case confirmation;
- Case registration;
- Reporting;

- Data analysis and interpretation;
- Epidemic preparedness;
- Response and control; and
- Feedback.

According to Thacker and Birkhead (in Gregg, 2002:26), the general elements to consider during the development of a surveillance system are:

- Mortality and morbidity data;
- Individual case reports;
- Epidemic reporting;
- Epidemic field investigation;
- Laboratory reporting;
- Hospital reporting;
- Survey of human cases; and
- Knowledge of the population and the environment.

Epidemic disease surveillance can be classified according to the method of routine reporting, special surveys and outbreak investigations (Katzenellenbogen et al., 1997: 142).

Methods of disease surveillance include routine reporting, sentinel reporting, special surveys and outbreak investigations. Generally, surveillance is classified as passive surveillance or active surveillance. These two approaches are described below.

- **Passive surveillance** is the most common method of surveillance. Generally, routine notifiable-disease surveillance relies on passive reporting. On the basis of a published list of conditions, health-care providers report notifiable diseases on a cases-by-case basis to the local health department (Thacker in Teutsch & Churchill, 2000: 22). In addition, laboratories notify the relevant health authority, whenever they come across an individual with one of the notifiable diseases (Webb, 2005: 82).

- **Active surveillance** is the specific collection of data from the health-care providers, both as the need arises and in the longer term (Webb, 2005: 80). It is used during outbreaks when health-care providers are contacted and asked to provide details of any cases they have seen. Laboratory data defining the strains of prevalent organisms are used for forward planning. Active surveillance may also include household surveys, in an attempt to detect the transmission of infections. Active surveillance systems can validate any passive reports, assure the complete reporting of conditions, or be used in conjunction with specific epidemiologic investigations (Thacker, in Teutsch & Churchill, 2000: 22).

Usually, both active and passive surveillance are combined within a Cholera-surveillance programme. The World Health Organisation Surveillance Standards (1999: 33) recommended type of surveillance for cholera is routine surveillance (this may be integrated with surveillance of diarrhoeal diseases); immediate case-based reporting of suspected cases from periphery to intermediate level, and outbreak investigation.

Surveillance detects and quantifies the occurrence of important and potentially important health risks or outcomes, revealing their distribution, incidence and prevalence (Webb, 2005: 77). A sensitive surveillance system is critical to enhance prediction and the early detection of outbreaks/epidemics, as well as the monitoring and evaluation of intervention programmes (National Department of Health, 2006: 12a).

Evidence from environmental investigations complements epidemiological findings, and may confirm the source of the infection (Joubert and Ehrlich, 2010: 235). Environmental investigation should use the descriptive information combined with knowledge of epidemiology and the clinical course of the disease, in order to formulate hypotheses as to the cause and most likely reservoir, or source of exposure, and mode of transmission (Joubert and Ehrlich, 2010: 236).

It may, therefore, be deduced that surveillance data are crucial, in order to develop an effective Cholera-surveillance system. Cholera data can be collected by means of the surveillance strategies that deal with any reported outbreaks or new cases (National Department of Health, 2002:9):

- Human case (bacterial) surveillance; and
- Environmental surveillance.

In the following sections, the above-mentioned strategies will be discussed. First to be discussed is human-case surveillance.

4.4. Human-case surveillance

For the purpose of this study, Cholera-case surveillance is divided into the following activities:

- Case detection;
- Reporting of a Cholera case;
- Outbreak investigation; and
- Confirmation.

The section below identifies and discusses the work methods and procedures for the detection of Cholera cases.

4.4.1. Case detection

Case detection is the process of identifying positive human cases of outbreaks (World Health organization, 2006: 18). A sensitive surveillance system is critical to facilitate the prediction and early detection of an outbreak/epidemic (National Department of Health, 2009: 9).

According to Merril and Timmrick (2006: 4), a standard set of criteria, or case definition, ensures that cases are consistently diagnosed – regardless of where or when they were identified, and who diagnosed the case. Furthermore, a

standard case definition should ensure uniformity in the early detection of an outbreak.

Teutsch and Churchill (2000: 20-21) recommend that case definitions should include the necessary criteria for person, place, time, clinical or laboratory diagnosis, and epidemiologic features. They are provisionally categorised by the degree of certainty, and regarded as “probable”, “suspected” or “confirmed” cases. The use of a standard case definition increases the specificity of reporting and improves the comparability of the health-related event from different sources of data, including geographic areas. The case definition of Cholera is discussed below.

The standard case definition for Cholera surveillance provided by the World Health Organisation (WHO, 1999:15; WHO, 2004, Cholera outbreak: 15) is illustrated in Table 3.

TABLE 3

WORLD HEALTH ORGANISATION’S CASE DEFINITIONS OF CHOLERA

Suspected case of cholera

- In an area where the disease is not known to be present, a patient aged five years or more develops severe dehydration or dies from acute watery diarrhoea with or without vomiting.
- In an area where there is a Cholera epidemic, a patient aged five years or more develops acute watery diarrhoea.

Clinical case definition

- In an area where the disease is not known to be present, severe dehydration or death in a patient aged five years or more, or;
- In an area where there is a Cholera epidemic, acute watery diarrhoea, with or without vomiting, in a patient aged five years or more.

Laboratory criteria for diagnosis

Isolation of *Vibrio cholerae* 01 or 0139 from stools in any patient with diarrhoea.

Case classification

Suspected: A case that meets the clinical case definition.

Probable: Not applicable.

Confirmed: A suspected case that is laboratory-confirmed. A case is "confirmed" when *Vibrio cholerae* 01 or 0139 is isolated from any patient with diarrhoea.

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

Classification

* Cholera does appear in children under five 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 such patients.

In children under five years of age, a number of pathogens can produce symptoms similar to those of Cholera, such as rice-water diarrhoea. To maintain specificity, therefore, children under five years of age are not included in this case definition of Cholera.

Source: Adapted from World Health Organization (1999: 15; 2004: 15)

The standard case definition for Cholera surveillance provided by the National Department of Health (2002:11) is illustrated in Table 4.

TABLE 4

NATIONAL DEPARTMENT OF HEALTH CASE DEFINITION OF CHOLERA

Recognition of Cholera cases with “rice-water stools” is very important; and health workers need to start treatment as early as possible to reduce potential contamination of the environment and death. Cholera should be suspected when:

- A patient older than five years develops severe dehydration from acute diarrhea (usually with vomiting); or
- Any patient above the age of two years has acute watery diarrhea in an area where there is an outbreak of cholera.

Source: Adapted from National Department of Health (2002: 11) and confirmed by the Research Focus Group (2010).

Health workers making a diagnosis must be familiar with the case definitions and with the clinical features of Cholera, as indicated in the case definitions. The World Health Organisation (2004: 15) recommends that in countries where Cholera outbreaks follow seasonal patterns, dissemination of the standard case definition to health-care workers before the expected “Cholera season” may help to increase awareness and ensure adequate diagnosis.

According to the National Department of Health (2009:9), community health workers, traditional healers, and community leaders should be informed about priority diseases, such as Cholera. The said guideline goes on to classify Cholera as an epidemic-prone disease.

For Cholera, a single suspected case is the trigger for action, reporting the case to a higher level, and conducting an investigation. This is confirmed by the World Health Organisation (2005: 8) and the National Department of Health (2009: 11)

who state that the alert threshold value for Cholera is one case. An alert threshold suggests to health staff that further investigation is needed. It therefore means that all cases that meet the criteria outlined in Tables 3 and 4 above, should immediately be reported to the local authority.

Community-health workers, traditional healers and community leaders should be informed about Cholera. This would help them in recognizing persons with these signs; and one should be encouraged to refer them to the nearest health facility (National Department of Health, 2009:9 and Research Focus Group, 2010). Work methods and procedures to be followed during the notifiable disease reporting processes are presented in the next section.

4.4.2. Reporting of a notifiable disease

Reporting of a notifiable disease refers to the process whereby surveillance data move through the surveillance system from the point of generation. It also refers to the process of reporting suspected and confirmed outbreaks. Different reporting systems may be in existence, depending on the type of data and the information being reported, the purpose and the urgency of relaying the information, and where the data/information is being reported (World Health Organisation, 2006: 18).

A notification can serve as the first step in a surveillance cycle, namely data capturing or data collection. The notification of a disease may be considered as a matter of assigning a level of public health importance to a disease (Webb et al., 2005: 80).

Notification of communicable diseases is governed both by country laws and international health regulations. According to the International Health Regulations, 2005, countries are obligated to report any occurrence of diseases of a sensitive nature to the World Health Organization (National Department of Health, 2006).

As in the majority of countries worldwide, South Africa has a national notification system for reporting notifiable medical conditions. The primary purposes of the

reporting system are disease control and the monitoring of disease trends in South Africa. The current disease notification system is based on the National Health Act, 2004 (Act 63 of 2003), coupled with regulations on the reporting of specific diseases to local, provincial and national health departments. The International Health Regulations, 2005, govern a broad range of public health emergencies of international concern.

In South Africa, notification can be done via electronic mail, fax or telephone to the local health authority concerned. Any person (not necessarily a health worker) can notify a medical condition (confirmed by the Research Focus Group, 2010). The formal work procedures for the notification of Cholera cases in KwaZulu-Natal can be found in Annexure 5 hereto attached.

Reports of Cholera should be standardized, so that, whenever possible, the same information is recorded for each case (World Health Organisation Regional Office for Africa, 2001: 56-57). A communicable disease reporting form should provide important information on the reporting process.

When a suspected case of Cholera is detected at a health facility, the nearest referral facility or designated local health officer should be notified immediately. The Provincial Department of Health should then be notified to investigate and confirm diagnosis. Upon confirmation, the National Department of Health should be notified, since Cholera is a notifiable disease (National Department of Health, 2002: 11). The currently used diagnosis form (Form GW 17/5) for notifiable disease reporting (confirmed by the Research Focus Group, 2010), is attached as Annexure 6. The following section discusses the investigation of a Cholera outbreak.

4.4.3. Investigation of a Cholera outbreak

The primary motivation of an outbreak investigation is to control the spread of the disease within the initial population at risk, and/or to prevent the spread to additional populations (Nelson & Williams, 2007: 154).

The objectives for the investigation of human cases of Cholera are, essentially, to first confirm the diagnosis of recent infection with *Vibrio cholerae* in an attempt to reduce morbidity and mortality through rapid identification, isolation, treatment and clinical management of cases and subsequent follow-up of contacts (Department of Health: Cholera Control Guidelines, 2000). Secondly, to ensure timely exchange of information among clinicians, investigators of public health, and government officials, in order to facilitate critical and informed decision-making at sub-district, district, provincial, national and international levels during investigation (Nelson & Williams, 2007: 155).

Investigations into disease outbreaks generally incorporate an epidemiological investigation, laboratory analysis, and an environmental investigation (Gelting, 2005). In case of a Cholera outbreak, it is necessary to follow up contacts of reported cases to ensure the identification of all cases and to limit the spread of the disease (Beaglehole et al., 2002: 103). The environmental health practitioner is often the initial contact with people in the community suffering from Cholera; therefore they have a critical role to play in identifying and reporting, and in the prevention and control of the disease (Research Focus Group, 2010).

A number of crucial activities must be undertaken as part of every Cholera outbreak investigation (World Health Organisation, 2005: 5). The detailed steps to be followed during an outbreak investigation are described by Nelson and Williams (2007: 155). The work procedures during the investigation of human cases of Cholera are indicated in Figure 2 below:

Figure: 2

Work procedures during a Cholera outbreak investigation

- Prepare for field work;
- Confirm the existence of an outbreak – verify the diagnosis;
- Identify and count cases and exposed persons;
- Define a case and actively search for cases and visit the patient's home;

- Collect risk information;
- Tabulate the data in terms of time, place, and person;
- Collect specimens for laboratory analysis;
- Conduct an environmental investigation;
- Analyse the data;
- Implement preventive and control measures; and
- Communicate the findings.

Source: Nelson and Williams, (2007: 155) and confirmed by the Research Focus Group, (2010).

Work methods and procedures for Cholera case investigation are presented in Annexure 7. Next presented are work methods and procedures for Cholera case confirmation.

4.4.4. Human-case confirmation

Case/outbreak confirmation refers to the epidemiological and laboratory capacity for confirmation. Capacity for case confirmation is enhanced through improved referral systems, networking and partnerships. This means having the capacity for appropriate specimen collection, packaging and transportation (World Health Organization, 2006a).

According to the National Department of Health (2002: 11), an attempt must be made to establish a bacterial diagnosis from rectal swabs or stool specimens; in cases of gastro-enteritis suspected of being due to, or possibly due to Cholera, suspected cases must be presented at hospitals/peripheral clinics or observed by mobile health teams and field workers in Cholera-designated areas. That is, when Cholera is suspected in an area, the diagnosis should be confirmed by laboratory investigations. Once the presence of Cholera has been confirmed in an area, it is not necessary to confirm all subsequent cases (National Department of Health, 2002: 11).

The appropriate collection of specimens is essential for the successful identification of *Vibrio cholerae* in clinical samples (World Health Organisation,

1999: 2). During an epidemic of cholera, the laboratory has four primary roles, namely:

- Initial identification of the organism causing the epidemic;
- Initial determination of the antimicrobial susceptibility pattern;
- Monitoring for changes in antimicrobial susceptibility patterns; and
- Defining the duration and geographical extent of the epidemic.

Work methods and procedures for the collection of stool specimens for Cholera investigations are presented in Annexure 8.

A Cholera outbreak should be concluded by an investigation report. The investigation report should explain why the outbreak occurred, and identify weaknesses in existing surveillance and control measures. This would enable recommendations to be made on specific prevention and control strategies (Katzenellenbogen, Joubert & Karim, 1997: 203).

According to (Gelting et al., 2005), an environmental investigation is designed to discover connections between factors in the environment and the outbreak. The environmental health practitioners focus their investigation on following up contacts and identifying the sources of contamination (Research Focus Group, 2010). In the following section environmental surveillance for Cholera is discussed.

4.5. Environmental-surveillance strategies for Cholera

Cholera is typically transmitted by the faecal-oral route, and the infection is predominantly contracted by the ingestion of water contaminated by faeces, and by similarly contaminated food. The high numbers required to cause infection make person-to-person contact an unlikely route of transmission (World Health Organisation, 2011a: 255).

Contamination of water due to poor sanitation is largely responsible for the transmission of Cholera. The presence of pathogenic *Vibrio cholerae* O1 and

O139 in drinking water supplies is of major public health importance and can have a serious health effect in affected communities (World Health Organisation, 2011a: 255).

It may be deduced that the people most at risk of contracting Cholera are those who do not have access to piped safe water and adequate and proper sanitation. The best control measures should focus on ensuring a safe water supply and sanitation in communities at risk of Cholera (National Department of Health, 2002: 9).

The basic requirements for Cholera preparedness include the establishment of a reliable surveillance and reporting system (National Department of Health, 2002: 10). According to the National Department of Health (2002: 13), environmental surveillance forms one of the most important parts in the control and preparedness of a Cholera epidemic.

Vibrio cholerae is highly sensitive to the disinfection process. Within a water safety plan, control measures that can be applied to manage the potential risk from toxigenic *Vibrio cholerae* include the protection of raw water supplies from human waste, as well as adequate treatment and protection of water during distribution (World Health Organisation, 2011a: 255).

In developing work methods and procedures for the environmental surveillance of Cholera, the surveillance plan should consider the following:

- Identifying communities, likely sources of infection and modes of transmission, in high-risk areas; and
- Identifying and assessing water supply and sanitation systems in these areas.

An environmental investigation should use the descriptive information combined with some knowledge of the epidemiology and the clinical course of the disease – in order to formulate hypotheses, as to the source of exposure and the mode

of transmission (Joubert and Ehrlich, 2010: 236). The environmental surveillance strategies for Cholera are presented under the following sections:

- Identifying communities in high-risk areas;
- Sanitary surveillance; and
- Surveillance of environmental surface water.

Identifying communities in high-risk areas is first discussed.

4.5.1. Identifying communities in high-risk areas

During the investigation of a Cholera outbreak, it is important to establish the magnitude of the outbreak and the mode of transmission, so that more effective and special control measures can be applied (National Department of Health, 2002: 12). Close communication should be established between the clinical staff and the environmental health practitioners. This allows suspected and confirmed cases to be identified and recorded in time and place, preferably on a spot map (National Department of Health, 2002: 12).

During an outbreak, it is useful to plot the spatial location of cases on a spot map. This may indicate that there is evidence of clustering of cases by place; and it may provide clues to the source of the exposure (Joubert and Ehrlich, 2010: 235). Cases confined to a geographical area, should be plotted on a large scale map showing features, such as roads, travel connections and the location of potential sources of exposure to infection, such as sources of drinking water and ablution facilities (Joubert and Ehrlich, 2010: 235 and confirmed by Research Focus Group, 2010).

Descriptive information should be entered onto a computer program, such as “Epi Info”, “Excell” or “Access”, as soon as possible, in order to create a basic list summarising the key attributes of all the cases (e.g. age, sex, date of onset, area of residence). A laptop computer is useful if available, especially if the investigation is being done in a rural area. This means that the information can be entered and analysed on the spot, while the investigation is in progress (Joubert and Ehrlich, 2010: 238).

The investigators should test all hypotheses and make a decision as to the most likely causative agent, sources and mode(s) of transmission. These would include exposure factors relating to environmental factors (for example, floods resulting from contaminated water), which may have been conducive to the outbreak of disease under investigation. Based on this information, recommendations can be made on specific measures that could be implemented (Joubert and Ehrlich, 2010: 238).

According to the Department of Water Affairs (2005: 16), hazard identification and risk assessment are the most effective means of consistently ensuring the safety of drinking water supplies, through the adoption of a comprehensive risk-based approach, enabling the identification of hazards and an assessment of their contribution to water quality risks. All hazards from catchment to consumer (and beyond the tap) need to be considered (Department of Water Affairs, 2005: 16). In the next section sanitary surveillance will be presented.

4.5.2. Sanitary surveillance

Sanitary surveys are a form of risk assessment; and they are designed to evaluate the water supply to see whether there is a likelihood of contamination occurring (World Health Organisation, Drinking Quality Water, 2008: 87). During the evaluation of water quality, environmental-health practitioners should assess drinking water quality, how the quality might have changed just prior to an outbreak and possible sources of faecal/pathogen contamination (Craun, 2001). During an outbreak, sanitary surveys should not be limited to the piped water supply, but extended to all water sources in the community (World Health Organisation, 1976: 37).

Currently, during a Cholera outbreak, the environmental-health practitioners conduct sanitary surveillance in accordance with the Guideline for Cholera Control, as follows (National Department of Health, 2002: 13; and confirmed by Research Focus Group, 2010):

- Monitor the spread of Cholera in risk areas by periodically sampling strategic sewage effluent (hospitals, prisons, hostels, sewage purification works) as an early-warning system. According to the National Department of Health, (2002: 13) work methods and procedures for the collection and sending of sewer pads for Cholera identification are presented in Annexure 9.

Sanitary surveys are fact-finding activities that should reveal system deficiencies that could result in failure to control contamination should it occur (World Health Organisation, 1976:137). In developing work methods and procedures for the sanitary surveillance of Cholera, it should be considered that there are three main types of risk factors that should be included in sanitary surveillance (World Health Organisation, 2008: 8d):

- **Hazard factors:** These are factors from which contamination may be derived; and they are a measure of sources of faeces in the environment. Examples would include pit latrines, sewers, solid waste dumps and animal husbandry.

- **Pathway factors:** These are factors that allow microbiological contamination to enter the water supply, but do not provide the faecal matter directly. Pathways are often critical to whether contamination occurs, as the presence of a hazard may not directly correlate with contamination if no pathway exists for the contamination to reach the water supply. Examples of pathway factors include leaking pipes, eroded catchment areas and damaged protection works.

- **Indirect factors:** These are factors that promote the development of pathway factors, but do not either directly allow water into the source, or are a source of faeces. Examples include lack of fencing or faulty surface water diversion drainage.

These factors can be incorporated into the sanitary inspection forms, which can be used by the environmental health practitioners. In a sanitary inspection, the major risks are identified that may lead to the contamination of a water supply.

This also provides a system that allows risks to be quantified (Howard, 2002: 11).

The sanitary inspection forms have a series of questions. These all have a YES/NO answer. For every question that has a “Yes” answer, one point is allocated; and for every “No” answer, zero points are allocated. By summing up all “Yes” scores, a final sanitary risk score can be obtained. This provides the overall assessment of the source. The work methods and procedures for conducting sanitary inspections are presented in Annexure 10.

Sanitary inspection data can act as a predictive tool. This means they allow for an assessment of whether contamination is likely to occur in the future, even when it is not found in the sample taken. This then allows preventive action to be taken (Howard, 2002: 19).

Every time a sample is taken for analysis of the water quality, it is essential that a sanitary inspection be carried out. By doing a sanitary inspection, this would be able to identify the immediate action required to stop contamination, and to implement the preventive measures to avoid any future problems (Howard, 2002: 19).

A good inventory of all water sources, obtained through sanitary surveys, is useful in identifying any potential risks of water contamination (World Health Organisation, 2004: 45). In the next section water supply surveillance will be discussed.

4.5.3. Surveillance of environmental surface water

Communities at greatest risk of contaminated water supply comprise householders who acquire water directly from water sources, such as rivers, boreholes, streams and collection, where water is stored prior to the point of use. These householders are also responsible for the quality of their drinking water, following collection and storage (Department of Water Affairs: Quality of domestic Water Supplies Management Guideline, 2002: 17). According to the

National Department of Health (2002: 7), these communities should be informed about sources of contamination and ways to avoid infection.

Howard (2002: 11) explains that contamination of point sources may occur because of poor sanitary protection measures – due to poor design, siting, construction or operation and maintenance. Water may also become contaminated, after people have collected it from a source and have taken it home. This may result from many factors, such as poor cleanliness of the container, poor personal hygiene and poor storage practices. Testing this water is important; and the data can be used to inform health education programmes (Howard, 2002: 125 and confirmed by Research Focus Group, 2010).

According to the Department of Water Affairs (2005: 21), the Department of Health has the overall responsibility of "protecting, respecting, promoting and fulfilling the rights of (the) people in South Africa to an environment that is not harmful to their health or wellbeing" (National Health Act, 2004 (Act 61 of 2003)). In this regard, the Department of Health is responsible for co-ordinating all health- related services in conjunction with the municipality, such as awareness of sources of infection and provision of disinfectants where needed (Department of Water Affairs, 2005: 21).

The Department of water Affairs points out that the tasks and duties of householders are *inter alia* to (Department of Water Affairs: Quality of Domestic Water Supplies, Volume 5: Management Guideline, 2002: 17):

- Ensure that water which comes directly from a source be at least treated with bleach, or boiled before it is used as drinking water; and
- Ensure that containers in which water is kept or transported are clean, and that open containers in which water is stored are kept covered.

The Department of Water Affairs (2005: 50) confirms that in communities not yet served with potable water, environmental health practitioners at District Municipality and Metropolitan level are required to monitor water quality at the

point- of-use, in order to monitor the success of the Water Service Authority's interventions in protecting public health.

Currently, the environmental practitioners sample surface waters for *Vibrio cholerae* O1 by placing Moore pads in rivers and streams in Cholera high-risk areas. The Moore pads are placed in flowing water in strategic areas, such as near hospitals and sewage treatment works (Research Focus Group, 2010). The samples are collected after five days, and sent for analysis to the National Health Laboratory Service (NHLS) in Ethekwini, KwaZulu-Natal. However, the Research Focus Group (2010), expressed concern that most of the Moore pad samples test negative for the presence of *Vibrio cholerae* O1, even during a Cholera outbreak.

The Research Focus Group (2010) confirmed that the environmental-health practitioners are reluctant to conduct surveillance to determine the presence of *Vibrio cholerae* O1, due to the high rate of negative results particularly, and in view of the high costs charged per sample for analysis. The Research Focus Group (2010) highlighted the need for the development of appropriate work methods and procedures for the sampling of environmental surface waters to determine the presence of pathogenic *Vibrio cholerae*.

In developing work methods and procedures for the surveillance of *Vibrio cholerae,* the researcher identified that the following important factors should be considered:

- **Environmental conditions**: Water sources often show seasonal variation in quality and quantity that is important for monitoring programmes (Howard, 2002: 10). It is likely that during cholera epidemics, bio-physico-chemical parameters of estuaries are ideal for the multiplication and transmission of *Vibrio cholerae*, and as a result, these water sources would be heavily contaminated with *Vibrio cholerae.*

- **The microbiological quality of water:** This may change rapidly over time and short distances; and water, therefore, requires frequent testing (Howard, 2002:

10). According to Emch (2008), during inter-epidemic periods, toxigenic *Vibrio cholerae* residing within aquatic plants do not lose their pathogenic properties. Environmental conditions may express the virulence genes in *Vibrio cholerae*. For example, sunlight can induce propagation of the toxigenic phase and the viability, i.e. the culturability, of *Vibrio cholerae* becomes stable in full sunlight compared with enteric bacteria, such as *E.coli,* which may impart selective advantage to *vibrios* at tropical latitudes (Sedas, 2007). Therefore, relying on *E.coli* or thermo-tolerant coliforms alone is not adequate for describing the microbiological quality of water; and other measures are needed (Howard, 2002: 11).

- **Water quality surveillance:** Water-quality monitoring and operational records should be regularly reviewed (Gelting et al., 2005). The Department of Water Affairs National Eutrophication Monitoring programme (2002: 106) recommends that when monitoring faecal pollution of surface waters, the following criteria should be taken into consideration: measure faecal coli forms, turbidity, pH, and temperature on a weekly basis. Furthermore, visual monitoring *in situ* is recommended for early detection of blooms and the spread of invasive macrophytes as a back-up, or to supplement sampling.

  If a bloom is suspected, then samples should be taken as soon as possible for phytoplankton count and identification of the nature of the bloom (algal, diatomic or cyanobacterial). The data obtained can be compared with the South African Water Quality Guidelines [DAWF 1996 a-g] (Department of Water affairs: National Eutrophication Monitoring programme, 2002:122).

- ***Vibrio cholerae* detection methods:** Traditional culture techniques for isolating *Vibrio cholerae* from water are frequently unsuccessful. More advanced techniques, using direct immunofluorescence microscopy, DNA hybridization, PCR, and improved culture methods, have frequently isolated both O1 and non-O1 strains, even in the absence of traditional faecal indicator bacteria, such as *Escherichia coli* and faecal streptococci (World Health Organisation Drinking Quality Water Guidelines, 2002: 128). *Vibrio cholerae*

> O1 and non-O1 have been detected in the absence of *E.coli*, and this organism (or alternatively, thermo-tolerant coliforms) is not a reliable indicator for *Vibrio cholerae* in water (World Health Organisation, 2011a: 256).

According to Joubert and Ehrlich (2010: 235), in South Africa the National Institute of Communicable Diseases (NICD) and a number of Health Science Faculties have specialized research laboratories where tests using molecular biology techniques can be done. For example, “DNA fingerprinting” may be requested, in order to characterize the organism in specimens from patients and environmental specimens. The use of this “molecular epidemiology” may be useful in confirming or refuting epidemiological links between cases, and in confirming environmental sources of the strain of the *Vibrio cholerae.*

With active environmental monitoring systems using epifluorescence microscopy and molecular methods for direct detection, the presence of *Vibrio cholerae*, cholera toxin carrying bacteria and vibriophages in sewage and surface waters have been shown to precede the onset of Cholera by 1 to 4 months (Sedas 2007).

During inter-epidemic periods *Vibrio cholerae* non-O1 is more readily detected than O1 (Wang et al., 2010). Other studies have shown that non-O1 *Vibrio cholera* survive better in the environment, and are more resistant than O1 strains to detergents and chelating agents, which may be discharged into the environment (Lipp et al., 2002).

According to Wang et al. (2010), in the interim periods between cholera outbreaks, *Vibrio cholerae* bacteria present mainly as non-toxigenic strains. However, if non-toxigenic strains abnormally increase during environmental monitoring, this would suggest that toxigenic strains may also be increasing under the same environmental conditions, as those that are suitable for the propagation of the pathogen. During the water sampling of environmental surface waters, the detection of Non-O1/non-O139 *Vibrio cholerae* strains can no longer be ignored (Wang et al., 2010).

Against the back-drop of what has been presented in this section, work methods and procedures for the surveillance of environmental surface water to identify the sources of contamination in environmental waters are developed and presented in Annexure 11. It may be concluded that an effective water-supply surveillance programme would need to monitor environmental waters' bio-physico-chemical parameters, and to adopt appropriate toxigenic *Vibrio cholerae* detection methods. This would help to efficiently accumulate water quality monitoring data, and to provide a basis for early warnings of Cholera outbreaks.

4.6. Conclusion

Cholera surveillance is the process whereby the systematic collection, collation and analysis of data with prompt dissemination to those who need to know, for relevant action to be taken. It includes the facilitation of the necessary response that would effectively deal with the problem.

One of the most fundamental ways to approach problems in an organised fashion is the scientific method. In this study, this method has been defined as follows:

- **Work methods**: As the procedure for a sequence of actions by environmental health practitioners to be used to accomplish the task of Cholera surveillance; and
- **Work procedures**: As a series of scientifically formulated and interdependent consecutive steps, this must be taken to achieve a Cholera surveillance programme.

The aim of work methods and procedures is to compel environmental-health practitioners to unite their efforts to work in an organised manner. For the purpose of this study, Cholera case surveillance has been discussed in terms of the following core-surveillance activities:

- Case detection;
- Reporting of notifiable disease;

- Investigation; and
- Confirmation.

Surveillance is classified into two types, namely: active surveillance and passive surveillance. Both are usually combined within a Cholera-surveillance programme.

In South Africa, the current notification system is based on the Health Act, 1977 (Act 63 of 1977). Each Cholera surveillance case must be reported to the local health department and the Provincial Department of Health, who then report the matter to the National Department of Health, and subsequently to the World Health Organisation.

A public health surveillance system is dependent on a clear case definition of the health-related event under surveillance. A Cholera case reporting form should be standardized, so that whenever possible, the same information is recorded for each case.

The early detection of a Cholera outbreak is dependent on an effective Cholera surveillance programme. Even a single confirmed case is the epidemic threshold for a Cholera outbreak investigation. When changes in the pattern of diarrhoeal illness occur, the notification process should be activated immediately. Gathering surveillance data for Cholera activities requires a combination of both active and passive surveillance. The activation of the notification process implies that the Cholera outbreak should be investigated immediately.

Environmental surveillance forms one of the most important elements in the control and preparedness for dealing with a Cholera epidemic. The surveillance plan for Cholera should consider the following:

- Identifying communities and likely sources of infection, and modes of transmission, in high-risk areas;
- Identifying and assessing water supply and sanitation systems in these areas.

Cholera is typically transmitted by the faecal-oral route, and the infection is predominantly contracted by the ingestion of faecally contaminated water and food. The high numbers required to cause infection make person-to-person contact an unlikely route of transmission.

An environmental investigation is designed to discover the connections between the relevant factors in the environment and the outbreak. Contamination of water due to poor sanitation is largely responsible for the transmission of Cholera. The presence of pathogenic *Vibrio cholera O1 and O139* in drinking water supplies is of major public health importance and can have serious health implications in affected communities. Communities at risk of Cholera are those that do not have access to safe drinking water.

In developing work methods and procedures for the environmental surveillance of Cholera the following issues were discussed:

- Identifying communities in high-risk areas;
- Sanitary surveillance; and
- Surveillance of environmental-surface water.

During a Cholera outbreak, it is useful to plot Cholera cases on a map; this may indicate evidence of clustering of cases by place, and may provide clues to the source of exposure, such as drinking water.

Hazard identification and risk assessment are the most effective means of consistently ensuring the safety of drinking water supplies. All hazards from catchment to consumer (and beyond the tap) need to be considered.

The householder is responsible for the quality of water following drawing at the point of collection and storage. The quality of this water may be unsatisfactory as regards quality, or it may become contaminated prior to its use. For the purpose

of this study, water quality, and the risk of contamination were described in terms of sanitary surveillance and water-supply surveillance.

The Department of Health is responsible for co-ordinating all health-related services in conjunction with the municipality, such as awareness of sources of infection and the provision of disinfectants, where and when needed. Environmental health practitioners at District Municipality and Metropolitan level are required to monitor water quality at the point-of-use, in order to assess the necessary interventions in protecting public health.

During the surveillance of water supplies, it should be considered that temperature, salinity and pH, all influence the survival and proliferation of *Vibrio cholerae* in the aquatic environment. The numbers of *Vibrio cholerae* suspended in water are generally low; however, the organism may be found in large numbers when associated with aquatic species, such as algae (blue-green algae, such as *Anabaena*), water hyacinth, duck weed, cyanobacteria, zooplankton (copepods) and crustaceans.

Stools of Cholera patients contain high concentrations of *Cholerae vibrios*, and they are highly infectious. When passed into the environment, they can contaminate water sources and food, and they may seed an environmental reservoir. During cholera epidemics, bio-physico-chemical parameters of estuaries are ideal for the multiplication and transmission of *Vibrio cholerae*; and as a result, these water sources would be heavily contaminated with *Vibrio cholerae.*

Traditional culture techniques for isolating *Vibrio cholerae* from water are frequently unsuccessful. However, active environmental-monitoring systems using epifluorescence microscopy and molecular methods for the direct detection of the presence of *Vibrio cholerae*, Cholera toxin-carrying bacteria and vibriophages in sewage and surface waters have been shown to precede the onset of Cholera by 1 to 4 months.

During inter-epidemic periods, *Vibrio cholerae* non-O1 is more readily detected than O1. If non-toxigenic strains abnormally increase during environmental monitoring, this would suggest that toxigenic strains may also be increasing under the same environmental conditions as are are suitable for the propagation of the pathogen. During the water sampling of environmental surface waters, the detection of Non-O1/non-O139 *Vibrio cholerae* strains can no longer be ignored.

A successful environmental surveillance programme for Cholera should include the ongoing monitoring of faecal pollution in environmental waters. In communities at greatest risk of Cholera, the following should be measured on a regular basis: faecal coli forms, *Vibrio cholerae* non-O1, turbidity, pH, and temperature. Furthermore, visual monitoring *in situ* is recommended for early detection of blooms and the spread of invasive macrophytes, as a back-up, or to supplement sampling.

Detailed environmental health-work methods and procedures during the surveillance of Cholera are attached as Annexures to this chapter; and they include the following:

- Work procedures for the notification of Cholera cases in KwaZulu-Natal – Annexure 5;
- Initial Diagnosis Form for notifiable diseases (GW 17/5) – Annexure 6;
- Cholera case-investigation questionnaire – Annexure 7;
- Work procedures for specimen collection from suspected Cholera- case outbreaks – Annexure 8;
- Work methods and procedures for the collection and sending of sewer pads for Cholera identification – Annexure 9;
- Work methods and procedures for conducting sanitary inspections – Annexure 10;
- Work methods and procedures for the surveillance of environmental-surface waters – Annexure 11.

Cholera surveillance is a basic requirement for preparedness in the event of a Cholera-control programme being needed. In the next chapter the control of Cholera will be presented.

CHAPTER FIVE

WORK METHODS AND PROCEDURES FOR THE CONTROL OF CHOLERA

5.1. Introduction

Safe water supplies, personal hygiene and adequate sanitation are the best means of preventing Cholera. These steps must be coupled with education, sound epidemiological and environmental health-risk assessment and accurate information. In this chapter, the environmental health work methods – and procedures for Cholera control will be developed from the following four perspectives:

- Basic strategies for Cholera control;
- Control strategies for Cholera-infected humans;
- Control strategies for the environmental transmission of Cholera; and
- The role of Cholera Outbreak-Response Teams.

Firstly, basic strategies for communicable disease control will be discussed. These control strategies describe strategies for eliminating or reducing the source of infection, interrupting the transmission of the disease, and protecting persons at risk.

Secondly, control strategies for the treatment of patients with Cholera, as well as the management of Cholera cases, are developed. These control strategies include prompt and effective treatment and the appropriate management of Cholera cases, as well as health education and legislative measures to control the disease.

Thirdly, control strategies for the environmental transmission of Cholera are developed. These control strategies include access to sufficient quantities of safe water, the treatment of water, environmental sanitation, food safety and health education.

Fourth to be discussed is the establishment of Communicable Disease-Outbreak-Response Teams. This section focuses on the place and role of

environmental practitioners in the National, Provincial, District and Sub-district Communicable Disease-Outbreak-Response Teams. Also discussed is the frequency of meetings for outbreak-response teams at the health district and sub-district levels. The basic strategies of Cholera control are introduced in the section that follows.

5.2. Basic strategies for Cholera control

The control of Cholera is a way of reducing the number and severity of cases (Walley and Wright, 2010:239). Connolly (2005: 127) states that a communicable disease, such as Cholera, can be controlled by eliminating or reducing the source of infection, interrupting the transmission of the disease, and protecting those persons at risk. Furthermore, control strategies can be divided into four categories, namely (Connolly, 2005:125):

- Prevention of exposure: The source of infection is reduced or removed, in order to prevent the disease spreading to other members of the community. This may involve identification of the source, prompt diagnosis and treatment using standard protocols, health education, improvements in environmental and personal hygiene, as well as the control of animal vectors or reservoirs;
- Prevention of infection: Susceptible groups are protected by the provision of safe water and good sanitation;
- Prevention of the disease: Rehydration treatment and high-risk groups must be provided with sufficient and safe water, improved sanitation and health education;
- Prevention of death: Prompt diagnoses and the speedy management of cases, together with the effective delivery of health-care services.

Webber (2005:29) states that communicable disease control can be directed at the chain of infection, namely the agent, the transmission route, the host and the environment. According to Connolly (2005:127), control measures of communicable diseases, such as Cholera, are prompt diagnoses and the treatment of cases, prevention of infection and/or environmental control measures. From the above it may be deduced that Cholera control can be achieved through the effective treatment of patients, appropriate case

management, as well as Cholera education and environmental-transmission (prevention and control) measures.

5.3. Control strategies for Cholera-infected humans

According to the World Health Organisation (2004: 7), Cholera case-control strategies should be aimed at the prevention and treatment of cases, in order to reduce excess morbidity and mortality, and to limit the spread of the disease. These measures should be put in place rapidly, and should not be delayed – while waiting for laboratory confirmation of Cholera.

The key to effective outbreak control is a rapid response, before the outbreak develops into an epidemic. One confirmed case of Cholera should prompt all diarrhoea cases to be treated as Cholera (World Health Organisation, 2002: 173).

Preventive and curative measures work together to reduce sources of infection by rapidly isolating and treating patients; and to reduce transmission through improvements in hygiene conditions and hygiene behaviour (World Health Organisation, 2002: 173).

The role of environmental-health practitioners in these activities is important. They can inform people about Cholera and encourage the early referral of patients to a treatment centre (World health Organisation, 2002: 173). Cholera case-control measures include the following:

- Cholera treatment;
- Case management;
- Cholera education; and
- Legislative measures.

In the following section the above-mentioned control measures will be discussed. Firstly, there is the setting up of Cholera treatment centres.

5.3.1. Treatment of Cholera patients

In a Cholera outbreak, the best control measures are early detection and the timeous treatment of patients (National Department of Health, 2002: 4). Cholera treatment is simply prompt administration of oral rehydration. This means that effective treatment can be within the immediate reach of most patients (World Health Organisation, 2004: 7).

Cholera treatment centres (CTCs) must be set up to provide rapid and efficient treatment for large numbers of patients in Cholera-affected areas (World Health Organisation, 2004: 37). Suspected cases of Cholera detected at community level should be referred to Cholera treatment centres (CTCs) for confirmation and appropriate treatment (National Department of Health, 2009a: 19).

Cholera treatment centres can be established in tents, schools (if closed) and other suitable buildings (World Health Organisation, 2009: 20). Where temporary Cholera treatment centres are required, environmental health considerations should influence their location and organisation (World Health Organisation, 2002: 50).

The organisation of the Cholera treatment centre is meant to offer the best care to patients, but also to protect other people from contamination. Fences around the CTCs are often necessary, in order to reduce the number of visitors (World Health Organisation, 2004: 38).

According to the Research Focus Group (2010), environmental-health practitioners would normally co-ordinate the environmental health-control measures in the establishment and operation of these treatment centres. The work methods and work-procedures for establishing and operating a Cholera treatment centre are presented in Annexure 12**.**

The management of a Cholera outbreak requires speed and good organisation (Webber, 2005: 96). According to the World Health Organisation (2004: 28), and the National Department of Health (2002:14), the best Cholera control measures

include the prompt and effective rehydration of Cholera cases. In the following section the management of Cholera cases will be presented.

5.3.2. Cholera case management

According to the National Department of Health (2002: 15), the recognition of Cholera cases (rice-water stools) is very important; and health workers need to start treatment as early as possible, in order to reduce the potential contamination of the environment and death as a result of dehydration.

Once a patient has been diagnosed, the treatment of all cases would be the same. In order to help treat cases effectively, a standard treatment schedule should be devised and made available to all staff (Webber 2005: 64). The necessary drugs and treatment supplies should be available at each treatment facility (National Department of Health, 2009a: 19). In the next section the supply of emergency stocks of essential supplies is presented.

5.3.2.1. Emergency stocks of essential supplies

Health facilities must have access to adequate quantities of essential supplies, particularly oral rehydration salts, intravenous fluids, and appropriate antibiotics, chloride of lime, hypochlorite, water dispensers and water-treatment tablets (World Health Organisation, 2009: 17).

Health districts at risk of Cholera outbreaks should set up a contingency stock of drugs and supplies, allowing them thereby to manage the first cases without delay – before receiving the necessary support from higher levels (National Department of Health, 2009a: 19). The contingency stock should be carefully monitored, in order to avoid shortages and the expiry of drugs and supplies (National Department of Health, 2009a: 19). The requirements for supplies and equipment for the first week of a Cholera epidemic are as follows (National Department of Health, 2002: 26):

- Rehydration supplies:
  - 650 packets oral rehydration salt;
  - 120 bags Ringers Lactate solution;

  - 10 scalp vein sets;
  - 3 x 2 nasogastric tubes [paediatric and adults].
- Other treatment supplies:
  - 2 large water containers each with a tap [marked at 5-10 litre levels for making] Oral Rehydration Solution (ORS);
  - 20 bottles [1 litre] of Oral Rehydration Solution;
  - 20 teaspoons;
  - 5 kg cotton wool; and
  - 3 reels of adhesive tape.

The above is an estimate for 100 patients (based on the current population in an area with an attack rate of 0.2). Reassessment on a weekly basis for the actual attack rate must be done (National Department of Health, 2002: 26).

In order to provide appropriate treatment, health professionals need specific training. Regular refresher courses are consequently also recommended.

Effective rehydration is the cornerstone of diarrhoeal disease control (National Department of Health, 2002: 22). In applying effective Cholera treatment cognisance must be taken of the following measures:

- Rehydration therapy;
- Antibiotics and prophylaxis; and
- Vaccines.

The following describes a typical rehydration therapy for Cholera cases.

5.3.2.2. Rehydration therapy

According to the National Department of Health (2002: 15), patients should be encouraged to seek medical attention from trained health workers as rapidly as possible. While preparing to go to a health facility for treatment, patients should immediately start increasing the amount of fluids they drink (World Health Organisation, 1993: 20 and 2004: 28).

Sugar-salt solution, oral rehydration solution (ORS) sachets, and other fluids available in the home can be used to prevent or delay the onset of dehydration while on the way to the health facility (World Health Organisation 2004: 28).

The KwaZulu- Natal Cholera Control Guideline (2000) recommends the following glucose-electrolyte solution for cases with diarrhoea, including patients with Cholera:

- 8 teaspoons sugar;
- ½ teaspoon salt; mixed with
- 1 litre water.

Once the patient has arrived at the emergency treatment facility, the severity of dehydration is assessed by the designated health-care worker, according to the diarrhoea treatment chart (World Health Organisation, 2009a: 36). The steps in the procedure for the management of Cholera patients are as follows (National Department of Health, 2002: 15):

Step 1: Assess dehydration;
Step 2: Rehydrate the patient, and monitor frequently, and assess hydration status; and
Step 3: Maintain hydration: replace continuing fluid losses until the diarrhoea stops.

In order to reduce the duration and severity of diarrhoea in children under the age of five (5) years, Zinc supplementation (Zinc sulphate) in combination with oral rehydration solution is administered (National Department of Health, 2010b: 84).

Additional procedures regarding the management of suspected Cholera cases can be found in the Guidelines for Cholera Control (National Department of Health, 2002: 15). In the next section the use of antibiotics, vaccines and prophylaxis will be briefly discussed.

5.3.2.3. Antibiotics and prophylaxis

The World Health Organisation (1993: 22; 2004: 29 and 2011c) recommends that appropriate antibiotics can be given to severe cases of Cholera, in order to diminish the duration of the diarrhoea, to reduce the volume of rehydration fluids and shorten the duration of *Vibrio cholerae* excretion. However, the National Department of Health (2002: 20) and the KwaZulu-Natal Health Department (2000) emphasise that antibiotic management is not recommended for Cholera patients, including severe cases.

The use of antibiotics in mild cases can quickly use up supplies and hasten the development of antibiotic resistance among *Vibrio cholerae*. Prophylaxis with antibiotics, such as tetracycline, is not recommended because of the high incidence of resistance (National Department of Health, 2002: 20).

During very severe dehydration, under the supervision of a medical doctor and in the absence of resistance, antibiotics may be given in a hospital setting (National Department of Health, 2002: 20 and 2010b: 85; KwaZulu-Natal, 2000). Administration of a single dose of doxycycline should not provoke any adverse effects (National Department of Health, 2010b: 85).

Knowledge of antibiotic sensitivity patterns of recent isolates in the immediate area or adjacent areas is very important. Antibiotic-resistant *Vibrio cholerae* O1 should be suspected if diarrhoea continues after 48 hours of antibiotic treatment (National Department of Health, 2000). National recommendations should be checked (National Department of Health, 2010b: 85). In the following section the use of vaccines is discussed.

5.3.2.4. Vaccines

The National Department of Health (2002: 20) and the KwaZulu-Natal Cholera Control Guidelines (2000) both state that Cholera vaccination is NOT recommended, and the vaccines currently available do not help in controlling Cholera – for the following reasons (National Department of Health, 2000):

- Vaccines lack the required potency and have a low rate of protective efficacy;
- Vaccines provide immunity of limited duration only; and
- They do not reduce the rate of asymptomatic infections.

The Clinical Guidelines of the National Department of Health (2010b) make no reference to the use of vaccines in the management of Cholera cases.

Using vaccines can prompt a false sense of security. According to the World Health Organisation (2011c), the current policy is that an internationally licensed oral cholera vaccine (OCV) is available on the market in limited stocks, and is suitable for travellers. This vaccine has been proven safe and effective, and is available for individuals aged two years and above. The vaccine is administered in two doses 10-15 days apart, and given in 150 ml of safe water.

According to the World Health Organisation (2011c), the above-mentioned oral Cholera vaccine has been used recently for mass vaccination campaigns. The World Health Organisation's official recommendations for its use during emergencies are that:

- OCV should always be used as an additional public health tool, and should not replace the usually recommended control measures, such as improved water supplies, adequate sanitation and health education. It needs also to be linked to strengthened surveillance and early warning; and
- The current internationally available prequalified vaccine is not recommended once a cholera outbreak has started, due to its 2-dose regimen and the time required in reaching protective efficacy, the high cost and the heavy logistics associated with its use.

According to the Cholera Control Guidelines of the National Department of Health (2000), prompt fluid therapy with volumes of electrolyte solution, enough to correct dehydration, acidosis and hypokalemia remain the prescribed steps to Cholera therapy. Up to 80% of patients can be treated adequately through the administration of ORS (World Health Organisation, 2011c). It may be concluded that the effective treatment of Cholera resides in prompt rehydration, through the

administration of oral rehydration salts (ORS) or intravenous fluids, depending on the severity of the treated cases.

Communities benefit from the education on Cholera issues, and the importance of early diagnosis and prompt treatment – and to have knowledge on the transmission of the disease. It is imperative that advice be given to family members and the community about protecting themselves from contamination. Cholera education will accordingly be discussed next.

5.3.3. Cholera hygiene / health education

According to Connolly (2005: 88), health education and community participation during intervention strategies, play a key role in Cholera prevention and control. Cholera education strategies should focus on specific human behaviour that can contribute to reducing the risk of Cholera infection and transmission.

Cholera outbreaks can be more quickly controlled when people understand how to help limit the spread of the disease (World Health Organisation, 1993: 24). The human interventions for people with diarrhoea include (World Health Organisation, 2004: 77 and Research Focus Group, 2010):

- The prevention of dehydration (the loss of water from the body);
- The drinking of a solution of oral rehydration salts made with safe (treated) water;
- Immediate health care with continuous rehydration.

The human actions required during patient care include (World Health Organisation, 2004: 77):

- Washing of hands after taking care of patients, touching them, their stools, vomit, or clothes;
- Avoiding contaminating a water source by washing a patient's clothes in it;
- Stools and vomit from a Cholera patient can be mixed with disinfectant (e.g. cresol); and

- Disinfecting the patient's clothing and bedding with a solution of Chlorine (0.05%) or by stirring them in boiling water or by drying them thoroughly in the sun before and after normal washing.

The key to human Cholera intervention is personal hygiene, namely (World Health Organisation, 2004: 79):

- Washing of hands with soap, ashes or lime:
  - Before cooking;
  - Before eating and before feeding anyone;
  - After using the latrine or changing nappies and cleaning children after they have used the latrine;
  - Using the latrine to defaecate; and
  - Keeping the latrine clean.

According to the Research Focus Group (2010), environmental-health practitioners are involved in organising and presenting Cholera education talks where people are usually waiting at government venues, including clinics.

From the above it may be deduced that Cholera education and community participation together comprise a strategy to change human behaviour to align with the principles of Cholera control. However, an adequate and safe supply of water, and satisfactory sanitation, are imperative in the prevention and control of Cholera transmission.

Cholera control measures may need to be addressed in the context of governmental sector frameworks outside the health sector, such as local government, environmental and water affairs. In the next section the legislative measures for Cholera control are discussed.

5.3.4. Legislative measures for the control of Cholera

Cholera control can be carried out and maintained effectively by legislative measures (National Department of Health, 2009a: 5). In this context legislative measures comprise the regulations and laws that relate to Cholera control.

In South Africa, a number of legislative measures for the control of Cholera exist. These include the:

- International Health Regulations, 2005;
- National Health Act, 2004 (Act 61 of 2003);
- Water Services Act, 1997 (Act 108 of 1997);
- Disaster Management Act, 2002 (Act 57 of 2002);
- Intergovernmental Relations Framework Act, 2005, (Act 13 of 2005); and the
- Health Professions Act, 1974 (Act of 1974).

The abovementioned legislated Acts were discussed in Chapter Three (see section 3.2.3). Any Cholera control strategy must comply with the said legislation.

In analysing the abovementioned legislations, it becomes noticeable that no provision is made for work methods and work-procedures on how to execute the legal requirements. This situation contributed to the need for this study and is supported by the Research Focus Group (2010). The control strategies for environmental Cholera control are discussed in the next section.

5.4. Environmental control strategies for Cholera

Cholera prevention and control can be achieved through various strategies comprising those interventions that target the risk factors contributing to the spread of the disease in the environment (Gospodinov & Burnham, 2008: 389). The spread of Cholera in the environment is primarily linked to contaminated water and food, unsatisfactory human waste disposal and poor hygiene practices.

Measures for the control of the spread of Cholera in the environment should be aimed at improved access to water, proper human waste management, enhanced food safety and hygiene practices (World Health Organisation, 2008c). These measures will be discussed under the following headings:

- Human waste disposal;
- Water quantity and quality;
- Food safety; and
- Hygiene practices.

Firstly to be discussed is human waste disposal.

5.4.1. Human waste disposal

Contamination of water with pathogenic *Vibrio cholerae*, due to poor sanitation, is largely responsible for the transmission of Cholera (World Health Organisation, 2008). The community should be informed about sources of contamination and ways to avoid infection (Department of Health 2002: 7).

During a Cholera outbreak, one of the first priorities in controlling the spread of Cholera should be the containing and disposal of human waste (Gospodinov & Burnham, 2008: 7). Attention to sanitation should markedly reduce the risk of transmission of Cholera (Department of Health, 2002: 7). This is especially true where lack of good sanitation may lead to contamination of water sources. High priority should be given to observing the basic principles of sanitary waste disposal, and particularly to the protection of water sources from faecal contamination (Department of Health, 2002: 7).

According to Section 3 (1) of the Water Services Act, 1997 (Act 108 of 1997), everyone has a right of access to basic sanitation. The minimum standard for basic sanitation services is, according to Section 2 of *Government Gazette No. 7079* (Vol. 432, No. 22355) of the Department of Water Affairs (2001):

a) The provision of appropriate health and hygiene education; and
b) A toilet which is safe, reliable, environmentally sound, easy to keep clean and prevents the entry of disease-carrying pests.

The development of sanitary systems appropriate to local conditions should be facilitated (Department of Health, 2002: 7). High priority should be given to observing the principles of sanitary human waste disposal, and particularly to the protection of water sources from faecal contamination (National Department of Health, 2009a: 20).

To make sure that human faeces are disposed of safely, teams should be assigned to inspect local areas for human waste disposal. Latrines appropriate

to local conditions should be constructed with the co-operation of the Community (National Department of Health, 2009a: 20).

In an emergency, while more permanent latrines are being built, a simple pit can be dug as a temporary solution for the disposal of human excreta, as follows (National Department of Health, 2002: 7):

- It should measure 0.3 x 0.3 metres, have a depth of 0.5 metres, and be at least 30 metres from a well or other source of drinking water;
- Where possible, the pit should be at least 6 metres from the nearest house;
- It should be located uphill from the water source or dug in marshy soil;
- The bottom of the pit should never penetrate the ground water table;
- After each use, a layer of soil should be laid down in the pit;
- In an area affected by Cholera, the pit should also be coated each day with a layer of unslaked lime.

These latrines should be regularly inspected and vector control measures applied against flies, cockroaches and rodents. Community education on sanitation practices should be regularly re-enforced (National Department of Health, 2009 a: 20).

Social habits concerned with the disposal of excreta are often strongly held and unless these are approached in a sensible manner, any system will fail (Webber, 2005: 50). Particular emphasis must be given to the need to involve the community at all stages from planning to evaluation, to adapt projects and programmes to the local situation, and to provide continuing support to the community after the system has been installed (Webber, 2005: 50; National Department of Health, 2002: 7; Kwa Zulu-Natal, 2000).

The following factors should be considered when selecting sanitation systems (Gospodinov & Burnham, 2008: 394):

- Acceptance – cultural factors are considered in the design;
- Access – the population has access to latrines;

- Use – the population is educated on proper latrine use;
- Maintenance – proper maintenance of latrines is organised;
- Drainage – the latrines are protected from surface water drainage.

During a Cholera outbreak, sanitation measures should be re-inforced. It is imperative to conduct community education and sanitary practices (National Department of Health 2009a: 20). In the following section health and hygiene education is discussed.

5.4.1.1. Health and hygiene education

According to the Department of Health (2002: 7), basic hygiene involving thorough hand-washing following contact with excreta, should be encouraged for adults, infants and children. There is a need to provide education and to disseminate information on the following (Agenda 21 www.unep.org):

- Identifying the risks of Cholera;
- Building awareness of the environmental control methods; and
- Enabling communities to play a role in the control of Cholera.

The Department of Water Affairs recommends that health and hygiene education should include the following (Department of Water Affairs, 2002: 2):

- **Personal hygiene**: including the importance of washing hands after going to the toilet, or changing the nappies of babies, before the preparation of food, or the handling of drinking water;
- **Household hygiene**: including the importance of keeping the home and toilet clean, safe disposal of refuse and solid waste, cleanliness in areas where food is stored and prepared, and ensuring that food and drinking water are kept covered and uncontaminated;
- **Community hygiene**: including the importance of the whole community working together for better health, a cleaner environment, issues relating to the disposal of excreta, and waste management, as well as the issues of vending food, keeping of animals and storm-water drainage; and

- **User education**: including the proper operation and maintenance of toilet facilities.

In South Africa currently the PHAST initiative (Participatory Hygiene and Sanitation Transformation) is a programme which has helped communities to own, run, manage and maintain their own sanitation systems. Through the PHAST initiative, local communities have developed expertise in a range of areas, including the construction of the infrastructure itself, as well as the accompanying health education, management of the project, financial management and advocacy (Department of Water Affairs, 2004: 25 and confirmed by the Research Focus Group, 2010).

Safe sanitary practices include ensuring that water sources do not become faecally contaminated. In the following section water supply will be discussed.

5.4.2. Water supply

Cholera control strategies are required to prevent and control the likelihood of the water supply becoming contaminated with pathogenic *Vibrio cholerae* (Department of Water Affairs, 2005: 17). The best means of controlling Cholera is improved access to a safe water supply (World Health Organisation, 2011a:150).

During a Cholera outbreak, adequate quantities of water are needed to maintain good hygienic practices, and thus lower the risk of Cholera transmission (Gospodinov & Burnham, 2008: 395).

The first objective is to provide water in sufficient quantities. This is followed by improving its quality, and in the long term, a piped system should be constructed where possible. The water supplies need to be maintained, otherwise when they break down, the disease should be expected to return (Webber, 2005: 44).

According to Section 3 (1) of the Water Services Act, 1997 (Act 108 of 1997), everyone has a right of access to a clean basic water supply. The minimum standard for basic water supply services is, according to Section 3 of

Government Gazette No. 7079 (Vol. 432, No. 22355) (Department of Water Affairs, 2001):

a) The provision of appropriate education in respect of effective water use; and
b) A minimum quantity of potable water of 25 litres per person per day, or 6 kilolitres per household per month.

Monitoring the availability of water during Cholera outbreaks is an essential component of a Cholera control programme (Gospodinov & Burnham, 2008:395).

Section 5(4) of the Water Services Act, 1997 (Act 108 of 1997) states that in emergency situations a Water Service Authority must take reasonable steps to provide water to any person within its area of jurisdiction – at the cost of the authority (Department of Water Affairs, 2005: 22). If no local water sources are available, during an emergency, a water supply may need to be brought in by trucks (National Department of Health, 2009a: 20).

According to the World Health Organisation (2011a:253), once a minimum quantity of water is available, its health-related quality is important for adequate health. Within a water safety plan, control measures that can be applied to manage the potential risk from toxigenic *Vibrio cholerae* include the protection of raw water supplies from human waste, adequate treatment and the protection of water during distribution (World Health Organisation, 2011a: 253).

In order to ensure the microbiological safety of the water supply from water resources to distribution, the Water Services Authority regularly checks the disinfection efficacy of drinking water, as follows (Department of Water Affairs: Disinfection as a water-treatment process (2005:6 and South African National Standards, SANS 241: 2005 Drinking Water Specification) requires that:

- Sampling and analysis of the drinking water for microbiological indicators of water quality and contamination (for example, total coliforms, faecal coliforms, and *E.coli*) to confirm effective disinfection;

- Sampling and analysis for free chlorine residual and turbidity, in order to optimise disinfection efficiency. Note that, in the absence of a microbiological test, a free chlorine residual (target range of 0.2 mg/L to 0.5 mg/L) in a water with low turbidity (< 1 NTU) indicates that the water is safe to drink.

Vibrio cholerae is highly sensitive to disinfection (World Health Organisation 2011a: 253). During a Cholera outbreak, or when faecal contamination is detected, the concentration of free chlorine should be increased to greater than 0.5 mg/l (WHO, 2011a: 150).

Chlorinated water is to be tested for the chlorine residual (World health Organisation Technical Notes, 2011b). The method recommended for the determination of chlorine residual in drinking water is the dpd (diethyl paraphenylene diamine) indicator test using a compactor. The test is the quickest and simplest method for testing chlorine. With this test, a tablet reagent is added to a sample of water, colouring it red. The strength of the colour is measured against the standard colours on a chart to determine the chlorine concentration. The stronger the colour indicated, the higher the concentration of chlorine in the water (World health Organisation Technical Notes, 2011b).

The Department of health is responsible for co-ordinating all health-related services, in conjunction with the municipality; these include water analysis, health and hygiene education, as well as the awareness and provision of disinfectants, where needed (Department of Water Affairs, 2005: 28 and confirmed by the Research Focus Group, 2010).

Where water supplies are at risk of contamination, households should be taught about the necessity and techniques for sanitising water in the home (National Department of Health, 2002: 7). Work methods and procedures for the treatment of water supplies at point of use are presented in Annexure 13.

Against the background of what has already been discussed in this section, the best means for controlling Cholera is an improved access to safe water supplies (World Health Organisation, 2011a:152), together with the provision of health

and hygiene education, to ensure a safe water supply at household level (Department of Water Affairs, 2005: 4).

In the following section, health and hygiene training and awareness will be discussed.

5.4.2.1. Health, hygiene training and awareness

According to the Department of Water Affairs (2005: 29), health and hygiene education has been singled out as the most effective mechanism for preventing water-related illness. Health and hygiene awareness aims at changing/improving health and hygiene habits, thus serving as a barrier to Cholera. It addresses several issues, such as:

- Safe collection, transportation and storage of water;
- Eliminating bacteriological contaminants, by training in the treatment methods, including boiling, use of household bleach or chlorine granules; and
- Safe disposal of waste and faecal matter to prevent contamination of the water source (Department of Water Affairs, 2005: 29).

Several methods have been introduced to ensure the effectiveness of health, hygiene awareness and education, such as Participatory Hygiene and Sanitation Transformation (PHAST) tools (Department of Water Affairs, 2005: 29).

Since food is an important vehicle for the transmission of Cholera, food safety will be discussed in the following section.

5.4.3. Food safety

Attention to food safety is an essential preventive measure, which should be intensified when there is a threat of Cholera. Enhanced food hygiene and safety practices are important in the prevention of Cholera transmission (World Health Organisation, 2004: 49).

Environmental health practitioners must be vigilant in inspecting food handling practices (World health Organisation, 2004: 49 and Department of Health, 2002:

9). Food businesses should be monitored, to ensure that they comply with food-safety standards (World Health Organisation, 2002: 149).

Safe and hygienic handling, preparation, storage and the serving of food is important. Health education should to be intensified where there is a threat of Cholera (World Health Organisation, 2004: 49 and Department of Health, 2002: 9). Street food vendors and communal food sources, such as social gatherings, special events and funerals require particular attention, since they pose a special Cholera health risk (World Health Organisation, 2004: 50).

If water bodies are used for fishing or for harvesting vegetables, and where crops are watered with possibly contaminated water, assessment and analysis of the risks should be undertaken, in order to decide what special measures may be needed to prevent the further spread of Cholera (World Health Organisation, 2002: 149). The testing of food is to be done in accordance with the South African National Standard (SANS) 6196: 2006: Examination for the presence of viable pathogenic *Vibrio* organisms in foods (Department of Health, 2009a: 21).

5.4.3.1. Health education

According to the Department of Health (2002: 9), health education activities for food handlers in areas under threat of Cholera should stress the following:

- Exclude infected persons from handling food;
- Wash vegetables and fruit with treated water before use;
- Prepare and store food under hygienic conditions;
- Cook food thoroughly in treated water, and eat while still hot, or reheat it thoroughly, before eating;
- Prevent contamination of food by contact with other contaminated raw food, contaminated surface or flies;
- Wash hands thoroughly after using the toilet, and before preparing or eating foods;
- Discourage people from eating together from a communal food container;

- Leftover food should be reheated before eating; and encourage the breast-feeding of infants.

It is important to liaise with local media, such as the press, and with radio and television, to ensure correct health education messages are passed on to the general public. The following sections will discuss the place and role of Cholera Outbreak Response Committees.

5.5. The place and role of environmental health in the National Communicable Disease Outbreak Response Committee

According to the National Department of Health (2009a: 6), a Cholera outbreak response needs a well-organised system with clear roles and responsibilities at all levels. The national, provincial and municipal (Metro and District) Health Departments should establish and sustain well-constituted and well-functioning outbreak-response teams.

The overall aim of the outbreak response teams is to (National Department of Health, 2009a: 6):

- Identify Cholera outbreaks by ensuring the existence of a functional surveillance system;
- Prepare for and investigate Cholera outbreaks wherever they occur; and
- Prepare adequately and timeously for emergencies; and
- Ensure rapid response and the systematic management of Cholera outbreaks, in order to reduce morbidity and mortality.

The Outbreak Response Committee should be at the National and Provincial levels, and be multi-sectoral and multidisciplinary, as well as being responsible for co-ordinating outbreak responses. Within the National Department of Health, representatives should come from the following units (National Department of Health, 2009a: 6):

- Communicable disease control;
- Surveillance (including the programme specific surveillance);

- Epidemiology and Information Systems;
- Laboratory Services;
- Environmental Health, including Port Health;
- Health Promotion;
- Clinical care; and
- Infection Control.

Additional members who are critical, and should be part of the overall outbreak response committee, are representatives from (National Department of Health, 2009a: 6):

- Finance;
- Pharmacy;
- Communications;
- Hospital Management;
- Emergency Medical Services;
- Disaster Management; and
- Primary Health Care (PHC), etc.

The National Department of Health (2009a: 6) goes on to say that the constituents of the committee would also depend on the personnel available within the health system, and also on the priority conditions or outbreaks experienced by the country, province or district.

The functions of the Outbreak Response Committee are to (National Department of Health, 2009a: 7):

- Contribute to the preparation of the plans of action for epidemic preparedness and response that have been created, to allow for appropriate resource allocations;
- Mobilise human, material and financial resources for epidemic prevention and control;
- Provide information and education to the general public before, during and after outbreaks/epidemics;

- Monitor the implementation of outbreak/epidemic control actions;
- Co-ordinate assistance for epidemic prevention and control from various partners;
- Monitor resource utilisation (drugs, vaccines, supplies, disinfectants, logistics, human and financial resources);
- Recommend appropriate strategies and measures for the rapid containment of epidemics;
- Monitor and evaluate overall preparedness, investigation and response to ensure documentation of all outbreaks and provide feedback at all levels.

According to Cele (personal communication, September 25, 2009), the National Directorate: Environmental Health must provide leadership to environmental health practitioners in the provincial and municipal spheres regarding their role in Cholera-Outbreak-Response Teams. This includes the following (National Department of Health, 2009a: 26):

- Conduct environmental assessments and management of risk factors predisposing individuals to Cholera;
- Distribute and share the environmental health-assessment information with other outbreak response team members, such as Communicable Disease Control Co-ordinator, Health Promotion Manager and Surveillance Officer;
- Collect environmental samples for laboratory testing, in order to confirm sources of outbreaks; and
- Facilitate Port Health activities.

The detailed roles and responsibilities of the different sectors within the National Outbreak Response Committee can be found in the Cholera preparedness plans of the National Department of Health (2009a: 26-27). In the following section the place and role of environmental health in Provincial Outbreak Response Teams will be discussed.

5.5.1. The place and role of environmental health in Provincial Outbreak Response Committees

At the provincial sphere, a Provincial Outbreak Control Co-ordinator has been appointed (B. Margot, Acting Manager Provincial Communicable Disease Control: KwaZulu-Natal, personal communication, November 11, 2009). These co-ordinators have the responsibility of establishing multidisciplinary Provincial-Outbreak-Control Teams and of preventing and controlling Cholera outbreaks in their provinces (National Department of Health, 2009a: 27).

The multidisciplinary Provincial Outbreak Response Committee is made up of the following sectors, and was confirmed by Margot (personal communication, November 11, 2009):

- Communicable Disease Control;
- Clinical Care;
- Surveillance/Epidemiology;
- Environmental Health; and
- Health Promotion.

According to Margot (personal communication, November 22, 2010 and confirmed by Research Focus Group, 2010), a Provincial Outbreak-Response Committee is chaired by the Provincial Outbreak Coordinator who reports to the Chief Director: Communicable Diseases at the National Department of Health and the Head of the Health Department in the provincial sphere.

The Provincial Outbreak-Response Committee can co-opt any member of the private sector with specialised expertise to advise on certain matters. It is the role of the Provincial Outbreak-Response Team to ensure that an integrated and uniform approach is followed in dealing with Cholera outbreaks.

The activities of the outbreak-response team include the common understanding of reducing morbidity and mortality from Cholera infections. The objective can be

realised through the following general responsibilities of the team, which are, according to the National Department of Health (2009a: 7) to:

- Verify and confirm any rumour of disease outbreak at all levels;
- Carry out outbreak investigation;
- Co-ordinate the implementation of the plan of action, and participate actively in the implementation of Cholera prevention and control strategies;
- Provide technical support to health facilities during Cholera outbreaks/epidemics; and
- Monitor and evaluate overall preparedness, investigation, response and documentation.

During outbreaks, the decision-makers within the Department of Health should chair the outbreak-response committee/team at national, provincial and district levels. During outbreaks, teams should meet daily – with the frequency being reduced depending on the extent of the Cholera outbreak. During non-outbreak/epidemic periods, the core team should meet monthly, and the extended team, including members from other departments, should meet at least quarterly.

Districts at risk of Cholera outbreaks should systematically convene meetings of the team at the beginning of each Cholera season, in order to assess the trends of the Cholera disease, and to review the implementation of epidemic preparedness plans. The proceedings of all meetings must be documented.

The National Department of Health (2009a: 8) goes on to explain that it is critical for the participating units, organisations and individuals to clearly understand their roles and responsibilities. As a result, terms and references should be agreed upon, and every member should honour them.

The terms of reference are expected to be dynamic in nature, and should be continuously reviewed. The involvement of various stakeholders would be determined by the nature of the Cholera outbreaks and the district's capabilities to handle these outbreaks/epidemics.

A further function of the Provincial Outbreak-Response Committee (National Department of Health, 2009a: 7) is to assist in planning, formulating policy guidelines, providing information, providing physical and financial support, providing training, research and capacity building on Cholera surveillance and control, which would continually be executed at provincial sphere (Margot, personal communication, November 22, 2010).

A key function of the Director: Environmental Health in KwaZulu-Natal, who should form part of the Provincial Outbreak Response Committee, is to monitor and ensure the proper implementation of preparedness plans in the provincial and local spheres (Margot, personal communication, November 22, 2010 and Research Focus Group, 2010). The said Director is also responsible for the training of environmental health practitioners at district and sub-district levels within the KwaZulu-Natal province on epidemiological Cholera investigations.

The next section discusses the place and role of environmental health within a Health-District Outbreak-Response Team.

5.5.2. The place and role of environmental health in the Health District Outbreak Response Team

The Outbreak Response Teams (ORTs) are at health district and sub-district levels, with membership that is multidisciplinary and multi-sectoral with responsibilities from the following units/departments (National Department of Health, 2009a: 7):

- Department of Health;
- Health facilities (clinical managers, Chief Executive Officer's, Infection Control nurses, etc);
- Communicable-Disease Coordinators (CDC);
- Surveillance officers and/or Health Information Officers;
- Environmental Health;
- Laboratory services;

- Public Health Specialists; and
- Other relevant government departments.

The District Outbreak-Response Teams of the health districts have similar compositions (confirmed by the Research Focus Group, 2010).

In the case of a Cholera outbreak, the Outbreak-Response Team should assist the community in the implementation of measures aimed at containing the outbreak. The response activities include the following: Strengthening Cholera case management, updating health staff skills on Cholera management, Cholera surveillance, health education and communication, access to clean water, safe disposal of human waste, food handling practices and the dissemination of technical recommendations appropriate to the Cholera outbreak (National Department of Health, 2009a: 18).

The District Outbreak-Response Team is responsible for collecting and providing information and reports to the Provincial Outbreak-Response Committee (confirmed by the Research Focus Group, 2010). From Section 1 of the National Health Act, 2004 (Act 61 of 2003), it was deduced that the surveillance and prevention of communicable diseases is a function of environmental practitioners in the municipal sphere of government. In terms of the regulations defining the scope of the profession of Environmental Health (Regulation 698 of 26 June 2009), environmental health practitioners are responsible for the following:

- Promoting health and hygiene, aiming at preventing environmentally induced diseases, such as Cholera;
- Collecting, analysing and disseminating epidemiological data and information;
- Using the Participatory Hygiene and Sanitation Transformation (PHAST) training approaches for effectual control measures at community level;
- Conducting epidemiological surveillance of diseases;
- Establishing an effective health surveillance and information system; and developing environmental health measures, including protocols, with reference to epidemics, emergencies and Cholera mitigation of populations.

According to the Research Focus Group (2010), environmental-health practitioners should play a leading role in co-ordinating and facilitating surveillance and control of Cholera in a District Outbreak-Response Team.

In order to respond effectively in an event, such as a Cholera outbreak, environmental health-response teams must have experienced leaders, trained personnel, adequate transport and logistical support, appropriate communication, and rules and guidelines for working in emergencies (World Health Organisation, 2002: 51 and confirmed by Research Focus Group, 2010).

There can frequently be a lack of communication between stakeholders when there is no outbreak of Cholera. This leads to gaps in preventive activities (Research Focus Group, 2010).

The next section discusses the place and role of environmental health in a Health Sub-District Outbreak-Response Team.

5.5.3. The place and role of environmental health in a Health Sub-District Outbreak-Response Team

Each municipal sub-district within the district municipalities, including the Metropolitan District Municipality of KwaZulu-Natal, should have Sub-District/Metropolitan Sub-Council Outbreak-Response Teams in consultation with the relevant role players. These teams generally consist of nurses from clinics, local doctors and an environmental-health practitioner. They are less structured than the District Outbreak-Response Teams, and they meet on an ad-hoc basis (Research Focus Group, 2010).

According to the Research Focus Group (2010), and Margot (personal communication, November 22, 2010), the Sub-District Outbreak Teams should meet on a weekly basis, and an environmental-health practitioner should be part of the said team. A representative of the Sub-district Outbreak-Response Team should attend monthly meetings of the District Outbreak-Response Team. According to Margot (personal communication, November 22, 2010), environmental-health practitioners should not always wait for information on

Cholera from nurses, clinics and hospitals, but should play a more proactive role and conduct surveillance strategies to identify individuals and places at risk within their respective areas of jurisdiction.

According to the World Health Organisation (2002: 51), environmental-health planning for emergencies, such as Cholera outbreaks, takes place in the context of an interlinked set of co-ordinated planning processes and organisational structure. According to Margot (personal communication, November 22, 2010 and confirmed by the Research Focus Group, 2010), the Sub-District Outbreak-Response Teams should promote an integrated and co-ordinated approach to Cholera surveillance and control in their areas of jurisdiction.

All government organs and role-players within a health sub-district should put special emphasis on the prevention and mitigation of a Cholera outbreak. Sub-district Outbreak-Response Teams should act as repositories and as conduits for information concerning Cholera outbreaks within their areas of jurisdiction. Sub-district Outbreak-Response Teams should also promote Cholera surveillance and control by capacity building, training and education in the communities that are vulnerable to an outbreak. Sub-district Outbreak-Response Teams should promote the recruitment, training and participation of volunteers – in the event of a Cholera outbreak (World Health Organisation, 2002: 51).

According to the Research Focus Group (2010), Cholera training needs should be included in the integrated development plans of municipalities, and should be part of the annual municipal budget. This would ensure that Cholera preparedness strategies become a priority within the municipal sphere.

The next section discusses the frequency of meetings for outbreak-response teams at the municipal sphere of government.

5.5.4. Frequency of meetings of outbreak-response teams at the municipal sphere of government

According Mugero and Hoque (2001), the frequency of meetings at the municipal sphere of government would depend on the development of the epidemiological

situation. During outbreaks, it is recommended that the team meet on a daily basis. This frequency may be reduced, depending on the extent and duration of the outbreak.

Once the control measures have been launched, and when epidemiological surveillance data show no more extension of the epidemic, a weekly meeting may suffice. During every team meeting, the responsibilities of members should be reviewed, in order to ensure the success of the control actions.

Outbreak co-ordinators should ensure proper secretarial support; and proper minutes must be kept of each meeting. The minutes of the monthly District Outbreak-Response Team meetings must be captured electronically on the District Health Information System (DHIS) that is linked with the Provincial and National Health Departments (Mugero & Hoque, 2001).

According to Margot (personal communication November 11, 2010), outbreak-response teams often meet on an irregular basis. According to Mugero and Hoque (2001), during non-outbreak periods, outbreak-response teams should meet monthly. Outbreak-response teams should systematically assess the trends of Cholera outbreaks, and continuously review the implementation of existing preparedness plans.

5.6. Conclusion

Cholera control includes all the actions and programmes directed towards prompt diagnosis and treatment of Cholera cases, in order to reduce case morbidity and mortality, and the prevention and control of Cholera transmission in the environment. In this chapter, strategies for Cholera control were developed from four perspectives, namely: basic strategies for Cholera control, control strategies for Cholera in humans, environmental transmission, and the role of Cholera outbreak-response teams.

Most documentary sources discuss Cholera control under two main categories, namely: control strategies for treatment, and the case management of Cholera in humans, as well as the prevention and control of Cholera transmission in the

environment. Control strategies for Cholera in humans were identified and developed, in terms of the following: prompt and effective treatment within immediate reach of the affected community; appropriate case management in terms of a standard treatment schedule for prompt rehydration therapy, and the availability of treatment supplies to be administered by trained staff at all health facilities.

Rehydration, as the most effective treatment strategy for Cholera patients, was presented. Effective Cholera treatment within the immediate vicinity (reach of patients) is crucial. Work methods and work-procedures for the establishment of temporary Cholera-treatment centres were presented and discussed. Furthermore, the stance of both the World Health Organisation and the National Department of Health on Cholera-case management through the use of antibiotics, prophylaxis and vaccines, was also discussed.

It was concluded that prompt diagnosis and treatment, together with the appropriate case management of Cholera cases, coupled with health education, comprise a valuable strategy to change human behaviour to confirm the principles of human Cholera-case control. Prevention and control guidance for people living in Cholera high-risk areas were also presented.

These guidelines provide specific work procedures to be followed in an attempt to reduce Cholera mortality and the risk of Cholera transmission and infection. Cholera control can only be carried out and maintained effectively by legislative measures. Hence, Cholera control legislative measures were identified and discussed.

Control strategies for Cholera control in the environment were also identified and discussed. These control strategies include work methods and work-procedures for sanitary measures of human waste disposal, adequate and safe water supply, enhanced food safety measures, and health and hygiene education for Cholera control in the environment. Control strategies aimed at environmental sanitation, adequate and treated water supply, enhanced food-safety practices, together with health education, should significantly reduce the opportunities for

human exposure to possible sources of Cholera in the environment, and the subsequent transmission and further spread of Cholera infection.

Lastly, the establishment of Communicable Disease Outbreak-Response Teams was discussed. A Cholera outbreak investigation and its control is a multidisciplinary endeavour that needs close collaboration within the different spheres of government. When a Cholera outbreak occurs, a Cholera Outbreak team should be set up immediately by the Outbreak-Control Co-ordinator of the affected Health District. The said team should implement outbreak investigations and control measures in co-operation with the relevant staff from the provincial and national health departments.

The place and role of environmental health in the national, provincial, district and sub-district communicable disease outbreak-response teams were identified and discussed. The successes of Cholera control strategies would depend on the co-operation of all the relevant role-players within these spheres of government.

In the next chapter, a conclusion with the emphasis on the findings of the study will be presented. Limitations will be discussed and applicable recommendations will be made.

CHAPTER SIX

CONCLUSION, LIMITATIONS AND RECOMMENDATIONS

The aim and objectives of this study were presented in **Chapter One**. The general aim of this study was to develop a standardised set of Environmental Health work methods and procedures, which would contribute to the effective surveillance and control of Cholera in the KwaZulu-Natal Province of South Africa. In order to reach this aim, the objectives of the study were to:

Firstly, analyse and describe the epidemiology of Cholera, with the focus on the history of Cholera epidemics, the distribution and characteristics of the disease in South Africa, as a prerequisite for the development of work methods and procedures for the surveillance and control of the disease;

Secondly, to analyse the national health-care system, with specific reference to the place and role of environmental-health practitioners at national, provincial and municipal spheres – in relation to Cholera surveillance and control – with the purpose of identifying any inadequacies, and making of appropriate recommendations.

Thirdly, to analyse relevant research that has been done globally – and to use it, against the background of the above – to scientifically develop working methods and procedures to be used by environmental-health practitioners during the surveillance and control of Cholera in the KwaZulu-Natal Province, South Africa.

The researcher followed a qualitative research design that was explorative, descriptive, inductive, and deductive in nature. The methods of data collection were documentary research and focus-group

interviews. The research population used during the study comprised two focus groups (also referred to as the sample groups) listed below.

- Group1: Focus-Group Interview – Pietermartzburg, November 24, 2010; and
- Group 2: Focus-Group Interview – Empangeni, December 14, 2010.

A documentary research approach was employed as the primary method of data collection for the study. The relevant research data were collected from government legislation and publications, official national and international statistics, as well as other national and international publications.

The researcher has used semi-structured questions to obtain the relevant information from the participants in the focus groups. The purpose of using semi-structured questions in the focus groups was to draw on the knowledge and experience of communicable disease surveillance and control in relation to Cholera, as well as the respondents' views on the role of the Environmental-Health Practitioners in the Communicable Disease Outbreak-Response Teams at the three different spheres of government.

The process of qualitative data analysis was followed, based on data reduction and interpretation; and was conducted as an activity simultaneously with data collection, data interpretation (coding) and narrative writing. The information from the data assisted with the development of the environmental-health work methods and procedures for the surveillance and control of Cholera in the KwaZulu-Natal province, South Africa.

In **Chapter Two,** the epidemiology of cholera was presented and discussed. It was found that Cholera is a clinical disease caused by *Vibrio cholerae*, usually of the serogroup O1. In its severe form Cholera

is characterized by the passage of “rice-water stools” that rapidly lead to dehydration, which can lead to death, if prompt and appropriate treatment is not administered. Two distinctive epidemiological features of Cholera are its tendency to appear in explosive outbreaks, often starting in several distinct foci simultaneously, and its propensity to cause true pandemics that progressively affect many countries in a number of continents over the course of many years.

It was established that *Vibrio cholerae* is a well-defined species on the basis of biochemical tests. The important distinctions within the species are made on the basis of the production of Cholera enterotoxin (Cholera toxin [CT]), serogroup and its potential for epidemic spread. Two serogroups, O1 and O139 have been associated with the epidemic disease, but there are also strains of these serogroups which are not pathogenic; and these are known as non-O1/O139 serogroups.

The *Vibrio cholerae* O1 serogroup consists of two biotypes, classical and El Tor, which can be divided into two serotypes, namely: Ogawa and Inaba. In 1992, an outbreak in India was caused by a new strain that did not agglutinate with any of the existing antisera to 138 sero groups of *Vibrio cholerae*. The strain was designated as a new serogroup, O139.

It is believed that the seventh pandemic El Tor strain could have given rise to the O139 strain by genetic shuffling. Furthermore, the non-O1, non-O139 *Vibrio cholerae* strains with pathogenic potential could have emerged by the exchange of O-antigen biosynthesis genes.

Recent studies have established that *Vibrio cholerae* is naturally occurring in both marine and fresh-water environments; and that it exists in association with plankton. Various biological and physicochemical factors influence the growth, survival and distribution of *Vibrio cholerae* in aquatic environments.

Vibrio cholerae O1 becomes coccoid and enters into a non-culturable state in the environment when conditions are not conducive for active growth. Biofilms formed in situ in the aquatic environment, for most of the year, would contain Cholera bacteria in the non-culturable state of ‘‘conditionally viable environmental cells’’ (CVEC). These CVEC cells are well-adapted to the aquatic ecosystem. These viable non-culturable state (VNC) bacteria do not grow on conventional culture media, but remain intact and retain their metabolic activity and respiration.

In general, *Vibrio cholerae* can be isolated from only 1% of water samples collected during epidemic periods, and rarely if ever, between epidemics. However, the use of direct immunofluorescence of *Vibrio cholerae* O1 (DFA-DVC) technique, polymerase-chain reaction (PCR) and improved culture methods have isolated both O1 and non-O1 strains, even in the absence of traditional indicator bacteria, such as *Eschericia coli* and faecal streptococci.

Several studies have confirmed that in environmental waters, *Vibrio cholerae* attaches to surfaces provided by plants, filamentous green algae, copepods (zooplankton), crustaceans and insects. Furthermore, algal and zooplankton blooms can also promote the proliferation of *Vibrio cholerae.*

In a country where Cholera is endemic, the ingestion of water from ponds and rivers during plankton blooms provides the requisite infectious dose for clinical Cholera. Cholera is contracted upon ingestion of an infective dose of *Vibrio cholerae* from contaminated water or food.

People develop Cholera when they ingest an infective dose of *Vibrio cholerae* O1 or O139. The disease is characterised by a short incubation period (8 to 72 hours). Approximately 75% or more of initial infections with *Vibrio cholerae* O1 or O139 may be asymptomatic, depending on the infecting dose.

It has been determined that rehydration is the mainstay of Cholera treatment. The successful treatment of patients with symptoms depends on rapid replacement of fluid and electrolyte losses. With proper treatment, mortality amounts to less than 1% of the reported cases.

The management of Cholera patients should focus on the recognition of Cholera cases; and health workers should start rehydration as soon as possible, to reduce any potential contamination of the environment and death. Given the spread of the disease, a well-coordinated strategy for preparedness is required at provincial and health-district level for robust response, and to mitigate an epidemic impact.

In **Chapter Three,** the definition of Environmental Health was presented and discussed from an international and South African context. It was deduced that Environmental Health is a science that not only studies how the environment influences human health, but also how the environment influences disease. The deduction was made that the environment (i.e., air, water and soil) has physical, chemical, biological and social features, and that it is the influence that these features have on human health that the “science” of environmental health is studying.

Furthermore, environmental health can be regarded as a facet of public health that involves the analysis (assessing, identification) of the said factors in the environment, and the introduction of strategies (correcting, controlling and preventing) to rectify or prevent the occurrence of those factors that could potentially adversely affect the state of human health.

The functional areas of the environmental-health profession, as practised in South Africa can be deduced from Section 1 of the National Health Act, 2004 (Act 61 of 2003). It was concluded that all the functional areas of the environmental health practitioner, including the scope of the profession, as practised in South Africa, correlate with those of the international perspective.

A number of legislative documents relevant to Cholera surveillance and control were also presented. These include the:

- Atmospheric Pollution Prevention Act, 1965 (Act 45 of 1965);
- Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act 54 of 1972);
- Hazardous Substances Act, 1973 (Act 15 of 1973);
- International Health Regulations Act, 1974 (Act 28 of 1974);
- Health Act, 1977 (Act 63 of 1977);
- Animal Diseases Act, 1984 (Act 35 of 1984);
- Environment Conservation Act,1989 (Act 73 of 1989);
- Occupational Health and Safety Act, 1993 (Act 85 of 1993);
- Tobacco Products Control Act, 1993 (Act 83 of 1993);
- Constitution of the Republic of South Africa Act, 1996 (Act 108 of 1996);
- Genetically Modified Organisms Act, 1997 (Act 15 of 1997);
- Water Services Act, 1997 (Act 108 of 1997);
- National Environmental Management Act, 1998 (Act 107 of 1998);
- National Water Act, 1998 (Act 36 of 1998);
- The Municipal Structures Act, 1998 (Act 117 of 1998);
- The Municipal Systems Act, 2000 (Act 32 of 2000);
- Meat Safety Act, 2000 (Act 40 of 2000);
- Disaster-Management Act, 2003 (Act 57 of 2002);
- National Health Act, 2004 (Act 61 of 2003);
- National Environmental: Air Quality Management Act, 2004 (Act 39 of 2004); and the
- National Environmental Waste Act, 2008 (Act 59 of 2008).

It was found that the right to health care services is well established within the Constitution of the Republic of South Africa Act, 1996 (Act 108 of 1996). The South African government follows the primary health care philosophy of health-care service delivery, which includes personal and non-personal health-care services (environmental health services). The Constitution of the Republic of South Africa Act, 1996 (Act 108 of 1996) is the supreme law and the foundation of the health-care system in South Africa. It gives conspicuous expression to the fundamental right to health care for all; and it also rules that the delivery of health care for all;

and the delivery of health-care services comprise a concurrent function in all three spheres of government within the framework of co-operative governance.

The development of environmental-health work methods and procedures for the surveillance and control of Cholera can, therefore, be regarded as an attempt to fulfill a constitutional imperative.

It was found that the promulgation of the National Health Act, 2004 (Act 61 of 2003), provides the legislative basis for the State to unite the various elements of the national health system under a common umbrella, and to actively promote and improve the national health system in South Africa. Furthermore, the said Act defines the organisational framework for health-care service delivery within each of the three spheres of government. The National Health Act, 2004 (Act 61 of 2003) is important legislation for the implementation of the constitutional rights on health. The Act was promulgated to provide a framework for a structured and uniform national health system. It delineates the health services in three spheres of government, namely: national, provincial and municipal.

From the said Act, it may be deduced that Cholera surveillance and control are functions of environmental health practitioners in the municipal sphere of government (‘surveillance and prevention of communicable diseases’).

The organisational structure of the national health system in South Africa was explained and discussed from the national, provincial and municipal perspectives. **Chapter Three,** therefore, attempted to describe the national health-care system, and to identify the place and role of environmental-health practitioners within the national, provincial and municipal spheres of government.

An analysis of the national health-care system enabled the identification of a number of decision-makers in all three spheres of government that could have an influence on environmental health service delivery. The said decision-makers can play either a direct or an indirect role in the surveillance and control of Cholera. The organisational analysis of the national sphere (National Department of Health) enabled the identification of the following decision-makers:

- The Minister of Health and the Cabinet;
- Members of the National Health Council;
- The National Health Advisory Committee;
- The National Consultative Health Forum.
- The Director-General of Health;
- The Deputy Director-General: Health-Service Delivery; and
- The Director: Environmental Health.

It was pointed out that the environmental health decision-makers within the provincial sphere of government (Provincial Department of Health in the KwaZulu-Natal province) include the:

- Member of the Provincial Executive Committee responsible for Health in the Provincial Legislature;
- The Provincial-Health Council;
- The Chief Director: District-Health Services;
- The Director: Primary-Health Care; and
- The Deputy Director: Environmental Health.

To be able to identify the environmental-health decision-makers within the municipal sphere of government, it was essential to carry out an analysis of the organisational structure of the District-Health System, as it applies to local government in South Africa. It was therefore necessary to explain what is meant by Health District, District Health Authority, District Health Council, Health Sub-district and a Local Municipality.

It was stated that the district-health system is a fundamental organisational framework of the health-care system in South Africa. The Constitution of the Republic of South Africa Act, 1996 (Act 108 of 1996), prescribes three categories of municipalities, namely: Category A (metropolitan municipalities), Category B (local municipalities) and Category C (district municipalities). The six metropolitan municipalities (Category A), together with 46 district (Category C) municipalities together constitute the health districts (a total of 52) in South Africa.

In the municipal sphere of government, health-care service-delivery can be divided into three tiers, namely: health districts, health sub-districts and local municipalities. The responsibility for environmental health services is transferred from provinces to the Category A and C municipalities. Environmental health practitioners play an important role in Cholera surveillance and control within the municipal health services.

What became evident from the Research-Focus Group, (2010), is that there is a need to advance the devolution of environmental-health practitioners from provincial level to municipalities. Furthermore, municipalities must be encouraged to budget appropriately for the strategies of Cholera surveillance and control. The said municipalities must address Cholera-preparedness plans as an integral part of their annual integrated-development plans. It was also found that all too often the value of an environmental health practitioner's role is acknowledged only when disaster or disease strike, yet health budgets at all spheres of government can be reduced through preventive environmental health measures and timeous monitoring.

From the focus group interviews conducted during the study, it was found that a need exists for the education of all role players and the training of environmental health practitioners on detailed work methods and procedures for the surveillance and control of Cholera. Liaison and communication networks need to be strengthened between local

municipalities, in an attempt to identify and monitor Cholera outbreaks at an early stage.

Work methods and procedures for Cholera surveillance were developed in **Chapter Four**. The basic principles of Cholera surveillance were discussed. It was concluded in this chapter that Cholera surveillance is a continuous and systematic process of standardised information collection, the analysis, the interpretation and the dissemination of descriptive information on Cholera-monitoring activities. Surveillance was classified as active surveillance and passive surveillance; both of these can be combined within a Cholera-surveillance programme. Four core strategies of Cholera case surveillance were developed in **Chapter Four,** under the following headings:

- Human-case detection;
- Notifiable-disease reporting;
- Investigation of Cholera outbreaks; and
- Human-case confirmation.

In South Africa, the current notification system is based on the National Health Act, 2004 (Act 63 of 2003). Each Cholera surveillance case must be reported to the local Health Department and the Provincial Department of Health, who then report this to the National Department of Health, and subsequently to the World Health Organisation. A public health-surveillance system is dependent on a clear case definition of the health-related event under surveillance. Consequently, a case definition for Cholera, provided by the World health Organisation and the National Department of Health was presented in **Chapter Four.**

The early detection of a Cholera outbreak is dependent on an effective Cholera surveillance programme. Even a single confirmed case is the epidemic threshold for a Cholera-outbreak investigation. Once a Cholera outbreak has been identified, routine passive surveillance should be

replaced by active surveillance. This implies that the outbreak must be investigated immediately.

Work methods and procedures developed for the surveillance of Cholera cases in **Chapter Four** include:

- Work procedures to report Cholera cases;
- Initial diagnosis form for notifiable diseases: Form (GW17/5);
- Cholera-case investigation form; and
- Work methods and procedures for the collection of stool specimens during Cholera-case investigations.

It may be said that the management of Cholera patients should focus on the recognition of Cholera cases, and health workers should start rehydration as soon as possible, to reduce potential contamination of the environment and the possibility of death.

Environmental surveillance is important in the control and preparedness of a Cholera epidemic. The environmental-surveillance strategies for Cholera include:

- Identifying communities in high-risk areas;
- Sanitary surveillance; and
- Surveillance of environmental-surface water.

An environmental investigation is designed to discover connections between the environment and the outbreak, in order to identify the source of exposure and the mode of transmission.

Work methods and procedures developed for the environmental surveillance of Cholera in **Chapter Four** include:

- Work methods and procedures for sampling strategic sewage effluent;

- Work methods and procedures for sanitary investigations; and
- Work methods and procedures for the surveillance of environmental-surface water.

Work methods and procedures for the different control strategies of Cholera were developed in **Chapter Five.** These control strategies include:

- Basic strategies for Cholera control;
- Control strategies for Cholera –infected humans;
- Environmental control strategies for Cholera; and
- The role of Cholera-Outbreak Response Teams.

Basic strategies for Cholera control are aimed at developing measures to protect people at risk, measures to interrupt the transmission of Cholera, and strategies to eliminate or reduce the source of infection.

Work methods and procedures for the control of Cholera in humans were developed from the following perspectives:

- Cholera treatment;
- Case management;
- Cholera education; and
- Legislative measures.

It was determined that Cholera treatment is simply prompt administration of oral rehydration. This means that effective treatment can be within immediate reach of most patients. Therefore, Cholera Treatment Centres (CTCs) must be set up to provide rapid and efficient treatment for large numbers of patients in Cholera-affected areas. Suspected cases of Cholera detected at community level should be referred to Cholera Treatment Centres (CTCs) for confirmation and appropriate treatment.

Work methods and procedures for the establishment of Cholera Treatment Centres were developed under the following headings:

- Location;
- Planning;
- Organisation; and
- Infection control.

It was established that effective rehydration (i.e. prompt fluid therapy with volumes of electrolyte solution, enough to correct dehydration, acidosis and hypokalemia) remains the cornerstone to Cholera therapy. Up to 80% of patients can be treated adequately through the administration of oral rehydration salts (ORS) or intravenous fluids, depending on the severity of the cases. The currently recommended glucose-electrolyte solution for the treatment of patients with diarrhoea, including Cholera, was presented, as well as the steps in the procedure for the management of Cholera patients.

Chapter Five also addresses health education, which is a strategy to assist communities to learn about the disease and the importance of early diagnosis, prompt treatment and knowledge on the transmission of the disease. Prevention and control advice for people living in areas affected by Cholera were developed under the following headings:

- The prevention of dehydration (the loss of water from the body);
- Immediate health care with continuous rehydration;
- The human actions required during patient care; and
- The key to human Cholera intervention is personal hygiene.

Control strategies comprise those interventions that target the risk factors contributing to the spread of the disease in the environment. Measures for the control of the spread of Cholera in the environment should be aimed at improved access to water, proper human-waste

management, enhanced food safety and hygiene practices. Work methods and procedures for the control of Cholera in the environment were developed from the following perspectives:

- Human-waste disposal;
- Water quantity and quality;
- Food safety; and
- Hygiene practices.

It was established that during a Cholera outbreak, one of the first priorities in controlling the spread of Cholera should be proper disposal of human waste, and the reinforcement of appropriate sanitation measures. It was determined that the PHAST initiative (Participatory Hygiene and Sanitation Transformation) is a programme, which has helped communities to own, run, manage and maintain their own sanitation systems.

The best means of controlling Cholera is improved access to a safe water supply. The first objective is to provide water in sufficient quantity. This is followed by improving its quality. It has been established that during a Cholera outbreak, or when faecal contamination is detected, *Vibrio cholerae* is highly sensitive to disinfection. The method recommended for the determination of chlorine residual in drinking water is the dpd (diethyl paraphenylene diamine) indicator test using a compactor.

Where water supplies are at risk of contamination, households should be taught about the necessity and techniques of sanitising water in the home. Work methods and procedures for the treatment and storage of water in the home were also presented.

Attention to food safety is an essential preventive measure in the spread of Cholera. Health education is to be intensified where there is any threat of Cholera. Street food vendors and communal food sources, such as

social gatherings, special events and funerals, require particular attention, since they pose a special Cholera-health risk.

Also presented in **Chapter Five** was the role of the Cholera-Outbreak Response Teams. When a Cholera outbreak occurs, a Cholera-Outbreak-Response Team should be set up immediately by the Outbreak Coordinator of the affected Health District. In practice, a Cholera-Outbreak-Response Team should be established before an outbreak occurs. Members of the said team are normally performing their usual duties, but in the event of an outbreak of Cholera, they come together to undertake special functions.

The said team must implement epidemiological investigations and control strategies with the necessary coordination by all the relevant staff from the Provincial and National Departments of Health. Lastly, discussed in **Chapter Five** was the place and role of environmental health in Cholera-Outbreak Response Teams from national, provincial, health district and health sub-district perspectives. It was found that the environmental-health practitioners form part of the Cholera-Outbreak-Response Teams at all spheres of government, and that they play a key role in epidemiological and environmental investigations and Cholera prevention and control.

Limitations

The researcher recognized, as with all qualitative studies, that the sample size and specific nature of the sample and research context prohibit generalization. However the richness of the data collected provided much insight into the role (functional activities) of the environmental health practitioner in Cholera surveillance and control, and the envisaged benefits of utilising focus group interviews as a method of data collection were therefore realized.

The specific limitations of the study were identified as follows:

- There was a limited amount of literature available on this research topic; and
- The existing national Cholera-control guidelines have not been updated since 2002.

In the light of the research findings, and indicated limitations the recommendations are presented in the following section.

Recommendations

The work methods and procedures for Cholera surveillance and control, as developed in this study, provide numerous opportunities for further exploration. Recommendations include:

1. The education of all role-players on the disease and the training of environmental health practitioners on detailed work methods and procedures for the surveillance and control of Cholera. The said education and training should be co-ordinated by the National Department of Health.

2. The establishment of an effective Cholera surveillance and control strategy within the KwaZulu-Natal province. Effective surveillance can facilitate timely action for the control of a Cholera outbreak. Without adequate surveillance, local health officials would not be able to understand the true scope of a Cholera outbreak, and might not recognise a new pandemic until many people had been affected.

3. Provincial Health Departments should encourage their respective municipalities to budget appropriately for strategies of Cholera surveillance and control. Municipalities should address Cholera preparedness plans, as an integral part of their annual integrated-development plans.

4. From the analysis of the organisational structure of the national sphere of government, it was found that the time it takes for information to reach the Minister of Health is problematic. The formal lines of communication are time consuming. Communication systems should be developed that allow the Director: Environmental Health to communicate urgent environmental health information directly to the said Minister.

5. The existing national Cholera-control guidelines should be updated to accommodate relevant information generated from this study.

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INTERVIEWS:

Mrs A.P.R. Cele: Environmental Health Director, National Department of Health, South Africa. Personal Interview: Pretoria, September 25, 2009;

Mr W.D. Khanyile: Manager: Provincial Environmental Health Services, KwaZulu Natal. Personal Interview: Pietermaritzburg, November 22, 2010;

Mr B. Margot: Acting Manager: Provincial Communicable Disease Control, KwaZulu-Natal; Personal Interview: Pietermaritzburg, November 22, 2010;

Mr J. Maniram: Manager: Municipal Health Services, Informatics & Legislation – Provincial Environmental Health Services, KwaZulu Natal. Personal Interview: Pietermaritzburg, November 22, 2010;

Mr S. Mudaly: Chairman South African Institute of Environmental Health, South Africa. Personal Interview: Durban, September 15, 2009.

Focus Group Interview Group 1: Pietermartzburg, November 24, 2010

Mr A. Lindy, Environmental Health Practitioner: Msunduzi Municipality, KwaZulu-Natal. Focus Group Interview: Pietermartzburg, November 24, 2010;

Mr Z.F. Ndlovu, Manager: Water, Sanitation, Health & Hygiene-Provincial Environmental Health Services, KwaZulu-Natal Province. Focus Group Interview: Pietermartzburg, November 24, 2010;

Mr D. Nzimande, Manager: Environmental Health Services, Umgungundlovu District Municipality, KwaZulu-Natal. Focus Group Interview: Pietermartzburg, November 24, 2010;

Mr J. Pather, Manager: Environmental Health Services, Msunduzi Municipality, KwaZulu-Natal. Focus Group Interview: Pietermartzburg, November 24, 2010.

Focus Group Interview Group 2: Empangeni, December 14, 2010

Mr. B. Dlamini, Manager: Environmental Health Services, Uthungulu District Municipality, KwaZulu-Natal. Focus Group Interview: Empangeni, December 14, 2010;

Mr P.M. Makhanye, Environmental Health Practitioner: Umkhanyakude District Municipality, KwaZulu-Natal. Focus Group Interview: Empangeni, December 14, 2010;

Mr W.B. Ndlovu, Environmental Health Practitioner: Uthungulu District Municipality, KwaZulu-Natal. Focus Group Interview: Empangeni, December 14, 2010;

Mr J.N. Nkwanyana, Environmental Health Practitioner: Uthungulu District Municipality, KwaZulu-Natal. Focus Group Interview: Empangeni, December 14, 2010.

ANNEXURE 1

REQUEST TO PARTICIPATE IN THE RESEARCH STUDY

Faculty of Health Sciences

NMMU

Tel: +27 (0)41 504-xxxx Fax: +27 (0)41-504-xxxx

E-mail Faculty Chairperson: xxxx@nmmu.ac.za

Date

Ref: xxxx

Contact person: xxxx

Dear

ENVIRONMENTAL HEALTH WORK METHODS AND PROCEDURES FOR THE SURVEILLANCE AND CONTROL OF CHOLERA IN THE KWAZULU-NATAL PROVINCE, SOUTH AFRICA

You are being asked to participate in a research study. We will provide you with the necessary information to assist you to understand the study and explain what would be expected of you (the participant). These guidelines would include the risks, benefits, and your rights as a study subject. Please feel free to ask the researcher to clarify anything that is not clear to you.

To participate, it will be required of you to provide a written consent that will include your signature, date and initials to verify that you understand and agree to the conditions.

You have the right to query concerns regarding the study at any time, and to immediately report any new problems during the study, to the researcher.

Telephone numbers of the researcher are provided. Please feel free to call these numbers.

Furthermore, it is important that you are aware of the fact that the study has to be approved by the Research Ethics Committee (Human) of the university. The RECH consists of a group of independent experts that has the responsibility to ensure that the rights and welfare of participants in research are protected and that studies are conducted in an ethical manner. Studies cannot be conducted without the RECH's approval. Queries with regard to your rights as a research subject can be directed to the Research Ethics Committee (Human). You can call the Director: Research Management at (041) 504-4536.

If no one can assist you, you may write to: The Chairperson of the Research, Technology and Innovation Committee, PO Box 77000, Nelson Mandela Metropolitan University, Port Elizabeth, 6031.

Participation in research is completely voluntary. You are not obliged to take part in any research. If you choose not to participate in medically related research, your present and/or future medical care will not be affected in any way and you will incur no penalty and/or loss of benefits to which you may otherwise be entitled.

If you do participate, you have the right to withdraw at any given time, during the study without penalty or loss of benefits. However, if you do withdraw from the study, you should return for a final discussion or examination in order to terminate the research in an orderly manner.

If you fail to follow instructions, or if your medical condition changes in such a way that the researcher believes that it is not in your best interest to continue with this study, or for administrative reasons, your participation may be discontinued. The study may be terminated at any time by the researcher, the sponsor or the Research Ethics Committee (Human) that initially approved the study.

Although your identity will, at all times remain confidential, the results of the research study may be presented at scientific conferences or in specialist publications.

This informed consent statement has been prepared in compliance with current statutory guidelines.

Yours sincerely

Ana Bigara

RESEARCHER

ANNEXURE 2

INFORMATION AND INFORMED CONSENT FORM

Nelson Mandela Metropolitan University
for tomorrow

INFORMATION AND INFORMED CONSENT FORM

(Please delete any information not applicable to your project and complete/expand as deemed appropriate)

Title of the research project	Environmental health work methods and procedures for the surveillance and control of Cholera in the KwaZulu-Natal Province, South Africa.
Reference number	
Principal investigator	Dr H.J. Maarschalk
Address **Postal Code**	Department of Environmental Health NMMU (North) 6031
Contact telephone number **(private numbers not advisable)**	041 5043273
A. DECLARATION BY OR ON BEHALF OF PARTICIPANT **(Person legally competent to give consent on behalf of the participant)**	*Initial*

I, the participant and the undersigned	
I.D. number	
OR	
I, in my capacity as	
of the participant	
Address (of participant)	
A.1 I HEREBY CONFIRM AS FOLLOWS:	
1. I, the participant, was invited to participate in the abovementioned research project that is being undertaken by	
	Ana Doherty Bigara
	Environmental Health
of the Department of	
	Health Sciences
in the Faculty of	
of the Nelson Mandela Metropolitan University.	
2. The following aspects have been explained to me, the participant:	

2.1 Aim: The investigators are studying environmental health work methods and procedures for the surveillance and control of Cholera in the KwaZulu-Natal Province, South Africa. The information will be used for the surveillance and control of Cholera by environmental health practitioners in the Kwa-Zulu Natal province.	
2.2 Procedures: I understand that participation is voluntary and that confidentiality will be maintained.	
2.3 Risks: No risks are envisaged.	
2.4 Possible benefits: As a result of my participation in this study I may make a contribution to the development of environmental health work methods and procedures for the surveillance and control of Cholera in South Africa.	
2.5 Confidentiality: My identity will not be revealed in any discussion, description or scientific publications by the investigators.	
2.6 Access to findings: Any new information/or benefit that develops during the course of the study will be shared as follows: The study will be made available to all participants. Results will be submitted to the South African Institute for Environmental Health (SAIEH), published in an accredited journal and presented by the supervisor at a relevant conference.	
2.7 Voluntary participation/refusal/discontinuation: My participation is voluntary ☐ YES ☐ NO My decision whether or not to participate will in no way affect my present or future medical care/employment/lifestyle ☐ TRUE ☐ FALSE	
3. The information above was explained to me the participant by:	

	Ana Doherty Bigara in Afrikaans ☐ English X Xhosa ☐ Other ☐ and I am in command of this language/it was satisfactorily translated for me by (name of translator) N/A I was given the opportunity to ask questions and all these questions were answered satisfactorily.	
4.	No pressure was exerted on me to consent to participation and I understand that I may withdraw at any stage without penalisation.	
5.	Participation in this study will not result in any additional cost to me.	

A.2 I HEREBY VOLUNTARILY CONSENT TO PARTICIPATE IN THE ABOVEMENTIONED PROJECT

Signed/confirmed at

	on		

Signature or right thumb print of participant	Signature of witness
	Full name of witness

STATEMENT BY OR ON BEHALF OF INVESTIGATOR(S)

I, **Ana Doherty Bigara** declare that I have explained the information given in this Document to

and/or his/her representative

- he/she was encouraged and given ample time to ask me any questions;
- this conversation was conducted in

Afrikaans		English	X	Xhosa		Other	

and no translator was used / this conversation was translated into

N/A

I have detached Section D and handed it to the participant

	YES		NO

Signed/confirmed at

	on		

	Signature of witness
Signature of interviewer	Full name of witness

D. IMPORTANT MESSAGE TO PATIENT/REPRESENTATIVE OF PARTICIPANT

Dear participant/representative of the participant

Thank you for your/the participant's participation in this study. Should, at any time during the study:

- an emergency arise as a result of the research, or
- you require any further information with regard to the study, or
- the following occur

• **Changes that may influence the outcome of the results.**

(indicate any circumstances which should be reported to the investigator)

Kindly contact

Ana Bigara

at telephone number

0834602710

(it must be a number where help will be available on a 24-hour basis, if the research project warrants it)

ANNEXURE 3

PERMISSION TO CONDUCT RESEARCH

HEALTH
KwaZulu-Natal

Health Research & Knowledge Management sub-component
10 – 103 Natalia Building, 330 Langalibalele Street
Private Bag x9051
Pietermaritzburg
3200
Tel.: 033 – 3953189
Fax.: 033 – 394 3782
Email.: hrkm@kznhealth.gov.za
www.kznhealth.gov.za

Reference : HRKM09/09
Enquiries : Mrs G Khumalo
Telephone : 033 – 3953189

02 March 2009

Dear Ms A Bigara

Subject: Approval of a Research Proposal

1. The research proposal titled **'Environmental Health work methods and procedures for the surveillance and control of cholera in the KwaZulu-Natal Province, South Africa'** was reviewed by the KwaZulu-Natal Department of Health. The proposal is hereby **approved** for research to be undertaken at the relevant DoH Units **provided that**:

   Letters of support for your study are obtained from the Communicable Disease Manager and the District Managers **before** commencing with the study.

2. You are requested to undertake the following:
   a. Make the necessary arrangement with identified facility before commencing with your research project.
   b. Provide an interim progress report and final report (electronic and hard copies) when your research is complete.

3. Your final report must be posted to **HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200** and e-mail an electronic copy to hrkm@kznhealth.gov.za

For any additional information please contact Mrs G Khumalo on 033-3953189.

Yours Sincerely

Dr. S.S.S. Buthelezi
Chairperson: Provincial Health Research Committee
KwaZulu-Natal Department of Health

HEALTH
KwaZulu-Natal

DEPARTMENT OF HEALTH
Environmental Health
121 Capital Towers Building
Pietermaritzburg, 3200
Private Bag X9051, PMB, 3200
Tel.: 033 846 7503, Fax.: 033 846 7272
Email.:avril.stieger@kznhealth.gov.za
www.kznhealth.gov.za

29th January 2009

Ana Bigara
104 Bowen Avenue
Glenwood
DURBAN
4001

Dear Ana

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH: M.TECH: ENVIRONMENTAL HEALTH

1. Your letter dated 20th January 2009 has reference.

2. It is appreciated that such research initiative is taken and it is being supported.

3. However, it is important to note the following:-
   3.1 The department is experiencing severe financial limitations which have necessitated that steps are taken to institute stringent cost containment measures.

   3.2 Environmental Health Services (MHS) are completely decentralised and the health districts have line authority over Environmental Health Service delivery in their respective areas of jurisdiction.

   3.3 It is therefore recommended that the request for permission for the required participation of the District EHPs be forwarded direct to the District Managers.

4. For the participation of the Provincial Environmental Health component, Mr ZF Ndlovu is available if prior arrangements are made with him for the interview to be conducted only in Pietermaritzburg.

Mr. WD Khanyile

Manager: Environmental Health

CC : Ms AP Hargreaves

Mr ZF Ndlovu

HEALTH
KwaZulu-Natal

COMMINCABLE DISEASE PROGRAMME (CDC)

Private Bag X 9051, Pietermaritzburg, 3200
330 Langalibalele Street, Pietermaritzburg, 3201
Tel.: (033)395 2586/2918 Fax.: (033) 3425830
Cellphone number: 083 457 1185
Email.:bruce.margot@kznhealth.gov.za
www.kznhealth.gov.za

Enquiries : Mr B Margot
Date : 10 February 2009

Ana Bigara
104 Bowen Avenue
Glenmore
Durban
4001

Dear Ana

REQUEST FOR PERMISSION TO CONDUCT RESEARCH: M.TECH: ENVIRONMENTAL HEALTH

Your letter dated 20th January 2009 is acknowledged and has reference.

It is appreciated that such research initiative is taken and it is being supported.

For the participation of the Communicable Diseases Control component, I will be available provided that prior arrangements are made for the focus group interview to be conducted in Pietermaritzburg.

Thank you,

Mr Bruce Margot
Acting Chief Technical Advisor-CDC

Source: Provincial Department of Health, KwaZulu-Natal, 2009

Letter: Request for permission to conduct research: KwaZulu-Natal Provincial Health Department – Directorate: Environmental Health and Communicable Disease Control

Ana Bigara
104 Bowen Avenue
Glenmore
Durban
4001
10 March 2009

The District Manager
Ms CD Maoela
Umkhanyakude Health District
P/bag X026
Jozini
3969
Tel: + 27 (0) 35 572 1327
Fax: + 27 (0) 35 572 1251

Dear Ms CD Maoela

RESEARCH – M.TECH: ENVIRONMENTAL HEALTH – REQUEST TO INTERVIEW PERSONNEL RESPONSIBLE FOR COMMUNICABLE DISEASE CONTROL

I am currently registered at the Nelson Mandela Metropolitan University (NMMU) in Port Elizabeth for a Master's Degree in Environmental Health. My dissertation is entitled "Environmental Health work methods and -procedures for the surveillance and control of Cholera in the KwaZulu-Natal Province - South Africa".

Permission to conduct the research has been granted by Dr. S.S.S Buthelezi, Chairperson: Provincial Health Research Committee, KwaZulu-Natal Department of Health (please refer to letter attached, dated 02 March 2009).

To enable me to effectively execute this study I will need to conduct a minimum of two focus group interview's with environmental health practitioners in KwaZulu-Natal. Sample criteria for inclusion in the focus group will be as follows:

- Subjects must be registered as environmental health practitioners with the Health Professionals Council of South Africa;
- Subjects must have at least 1 year of experience in communicable disease surveillance and control; and
- Subjects must be willing to participate in the study.

For the purpose of this study at least one subject from each of the following authorities should be part of one of the focus groups:

- Ugu District Municipality;
- uMgungundlovu District Municipality;
- uThukela District Municipality;
- uMzinyathi District Municipality;
- Amajuba District Municipality;
- Zululand District Municipality;
- uMkhanyakude District Municipality;
- uThungulu District Municipality;
- Ilembe District Municipality;
- Sisonke District Municipality;
- eThekwini Municipality (Metro);
- Environmental Health Division - Provincial Department of Health – KwaZulu-Natal; and the
- Communicable Disease Coordinator - Provincial Department of Health – KwaZulu-Natal.

To enable me to effectively execute this study I will need at least one member of your staff to participate in one of the focus groups. I will co-ordinate the logistics in such a way as to ensure minimal inconvenience in terms of travel arrangements.

I would like to do the focus group interviews during May 2009. The focus group interviews should not be more than one and a half hours per session at two *(still to be determined)* convenient venues in KwaZulu-Natal. Dr H.J. Maarschalk, Principal Lecturer in the Department of Environmental Health at the NMMU will be supervising the study and may be contacted at telephone number 041 – 504 3273 should you have any questions.

Your favourable consideration of this request would be appreciated.

Yours sincerely,

Ana Bigara
M.Tech Environmental Health student

Mangosuthu University of Technology:
Tel: 031 2613644 (H) 031 9077649 (W)
Fax: 0866729006
Cell phone: 0834602710
E-mail: Ana@mut.ac.za

DEPARTMENT OF HEALTH

PROVINCE OF KWAZULU-NATAL

UMKHANYAKUDE HEALTH DISTRICT OFFICE

Main Road Jozini
Private Bag X026, Jozini, 3969
Tel.: 035-5721327, Fax.: 035-5721251
Email.: dudu.maoela@kznhealth.gov.za
www.kznhealth.gov.za

Date: 19 March 2009
Enquiries: C.D. Maoela

Anna Bigara
104 Bowen Avenue
Glenmore
Durban
4001

Dear Madam

RE: REQUEST TO CONDUCT INTERVIEWS RESEARCH WITH ENVIRONMENTAL HEALTH PRACTITIONER

The above communication dated 19 March 2009 has reference.

Our office is willing to participate in the proposed research.

For future all communication to be forwarded to Mr B. Makhoba (Chief Environmental Health Practitioner) who is heading this component.

Yours Sincerely

Miss C.D. Maoela
THE DISTRICT MANAGER
HEALTH SERVICE CLUSTER
UMKHANYAKUDE HEALTH DISTRICT

Source: Provincial Department of Health, KwaZulu-Natal, 2009

ANNEXURE 4

DATA ANALYSIS: RESEARCH FOCUS GROUP INTERVIEWS

BY INDEPENDENT CODER

MAIN THEMES	SUB THEMES AND CATEGORIES
THEME 1: Participants had both challenging and positive experiences in the management of surveillance and control of cholera prevention and outbreaks	**Sub-theme 1.1:** Participants had challenging experiences when managing surveillance and control of cholera prevention and outbreaks. Participants experienced: ♦ Difficulties due to delay in implementation of the devolution process leading to gaps in the prevention of cholera outbreaks ♦ Lack of adequate funding leads to limited research regarding safe water supplies ♦ Shortage of trained staff, particularly related to community education ♦ Inadequate or absent routine surveillance of water supplies ♦ Lack of communication between all stakeholders involved in cholera prevention leading to gaps in cholera management ♦ Need to ensure that prevention work done by EHPs is recognised and valued
	Sub-theme 1.2 Participants had various positive experiences when managing surveillance and control of cholera prevention and outbreaks. • Districts work well together from a specified control centre during active cholera outbreaks and utilize standardized forms • EHPs expressed the need to be actively involved in all communities • Multidisciplinary teamwork and interaction is integral in the prevention of cholera and the treatment thereof • Good planning and teamwork within the EHP network assists in the prevention of outbreaks of cholera • Community health workers who are trained and able to assist are

	essential in the prevention of cholera in all areas • Communication between all stakeholders is essential in the prevention, treatment and support for communities required when dealing with cholera
Theme 2: Participants experienced a need for improving the management of surveillance and control of cholera prevention and outbreaks.	**Sub-theme 2.1** Participants experienced a need for a holistic approach to the management of surveillance and control of cholera prevention and outbreaks
	Sub-theme 2.2 Participants experienced a need for comprehensive training for all categories of staff involved in the management of surveillance and control of cholera prevention and outbreaks
	Sub-theme 2.3 Participants experienced a need for improved funding, interventions and increased public awareness regarding the management of surveillance and control of cholera prevention and outbreaks

ANNEXURE 5

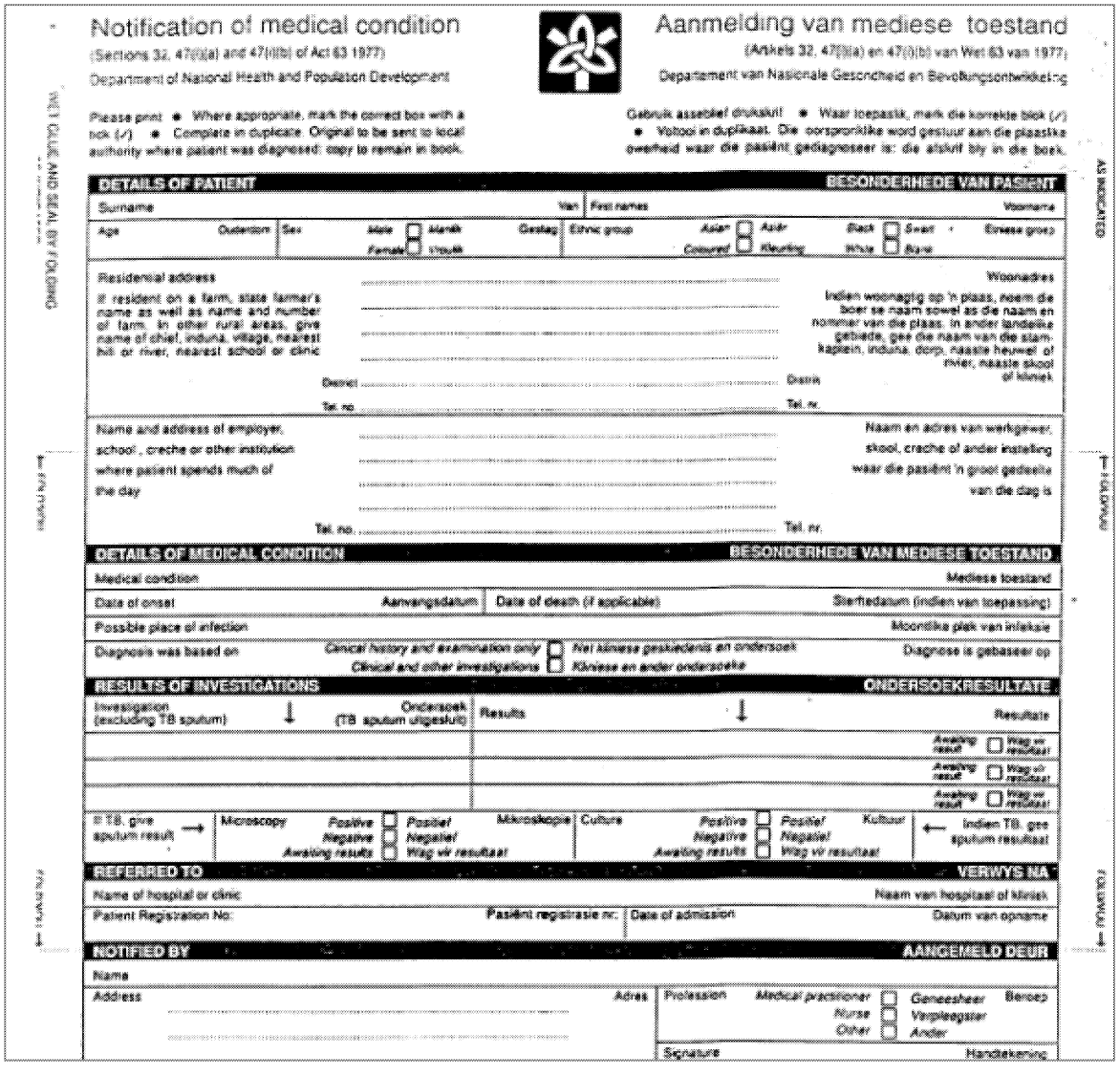
WORK PROCEDURES FOR THE NOTIFICATION OF CHOLERA CASES IN KWAZULU-NATAL

Disease-Notification System (National Department of Health, 2012; Research Focus Group, 2010):

1. The initial notification is normally made by health personnel (e.g., clinical personnel, infection-control nurses, other hospital staff, public or private medical practitioners.
2. The initial notification of a case of Cholera is done on a case-based form (*GW 17/5*) with the relevant details, to make tracing as easy as possible. This form makes provision for the notification of cases, as well as deaths.
3. Any person contracting Cholera, and who then dies from the disease should be reported twice: first as a "Case" and then later as a "Death" This will ensure that when estimating the "Case Fatality Rate" (CFR %), all deaths in the numerator are also included in the denominator.
4. The completed GW 17/5 forms are to be sent to the Local Authority (Local Municipality) for action. The municipality then reports to the KwaZulu-Natal Provincial Department of Health, and then to the National Department of Health.
5. Cholera is a Category A: medical condition; and it therefore requires immediate notification to the Provincial Department of Health by telephone or fax upon initial diagnosis (presumptive or confirmed), with written notification form (GW 17/5) to follow within five days.
6. Any Health-Care professional identifying a single case of Cholera (presumptive or laboratory confirmed) should make an immediate notification directly to the designated local health officer through fax or telephonically, as rapidly as possible (within 24 hours).
7. The local health officer must report to the Provincial health officer and/or to the National Department of Health.
8. Where it is applicable, laboratory confirmation should be obtained at the earliest opportunity, and also reported to the designated health office.

ANNEXURE 6

INITIAL DIAGNOSIS FORM FOR NOTIFIABLE DISEASES: FORM (GW 17/5)



Notification of medical condition

(Sections 32, 47(i)(a) and 47(i)(b) of Act 63 1977)

Department of National Health and Population Development

Please print ● Where appropriate, mark the correct box with a tick (✓) ● Complete in duplicate. Original to be sent to local authority where patient was diagnosed; copy to remain in book.

Aanmelding van mediese toestand

(Artikels 32, 47(i)(a) en 47(i)(b) van Wet 63 van 1977)

Departement van Nasionale Gesondheid en Bevolkingsontwikkeling

Gebruik asseblief drukskrif! ● Waar toepaslik, merk die korrekte blok (✓) ● Voltooi in duplikaat. Die oorspronklike word gestuur aan die plaaslike owerheid waar die pasiënt gediagnoseer is; die afskrif bly in die boek.

DETAILS OF PATIENT / BESONDERHEDE VAN PASIENT

Surname / Van | First names / Voorname

Age / Ouderdom | Sex / Geslag: Male / Mannlik, Female / Vroulik | Ethnic group / Etniese groep: Asian / Asiër, Coloured / Kleurling, Black / Swart, White / Blank

Residential address / Woonadres

If resident on a farm, state farmer's name as well as name and number of farm. In other rural areas, give name of chief, induna, village, nearest hill or river, nearest school or clinic

Indien woonagtig op 'n plaas, noem die boer se naam sowel as die naam en nommer van die plaas. In ander landelike gebiede, gee die naam van die stamkaptein, induna, dorp, naaste heuwel of rivier, naaste skool of kliniek

District / Distrik

Tel. no. / Tel. nr.

Name and address of employer, school, creche or other institution where patient spends much of the day / Naam en adres van werkgewer, skool, creche of ander instelling waar die pasiënt 'n groot gedeelte van die dag is

Tel. no. / Tel. nr.

DETAILS OF MEDICAL CONDITION / BESONDERHEDE VAN MEDIESE TOESTAND

Medical condition / Mediese toestand

Date of onset / Aanvangsdatum | Date of death (if applicable) / Sterfdatum (indien van toepassing)

Possible place of infection / Moontlike plek van infeksie

Diagnosis was based on / Diagnose is gebaseer op: Clinical history and examination only / Net kliniese geskiedenis en ondersoek; Clinical and other investigations / Kliniese en ander ondersoeke

RESULTS OF INVESTIGATIONS / ONDERSOEKRESULTATE

Investigation (excluding TB sputum) / Ondersoek (TB sputum uitgesluit)	Results / Resultate
	Awaiting result / Wag vir resultaat
	Awaiting result / Wag vir resultaat
	Awaiting result / Wag vir resultaat

If TB, give sputum result / Indien TB, gee sputum resultaat

Microscopy / Mikroskopie: Positive / Positief; Negative / Negatief; Awaiting results / Wag vir resultaat

Culture / Kultuur: Positive / Positief; Negative / Negatief; Awaiting results / Wag vir resultaat

REFERRED TO / VERWYS NA

Name of hospital or clinic / Naam van hospitaal of kliniek

Patient Registration No. / Pasiënt registrasie nr. | Date of admission / Datum van opname

NOTIFIED BY / AANGEMELD DEUR

Name

Address / Adres

Profession / Beroep: Medical practitioner / Geneesheer; Nurse / Verpleegster; Other / Ander

Signature / Handtekening

Source: National Department of Health, (2009)

ANNEXURE 7

CHOLERA CASE-INVESTIGATION QUESTIONNAIRE

Interview Details			
Interviewer name		Date of interview	/ /20_ _
District			
Telephonic reporting by			
Presenting Health Care Facility			

Demographic Data						
Patient name		Date of birth	/ /			
Gender	M ☐ F ☐					
Age (in years)		Home telephone number				
Home address: Street		Do you reside at the address given?	1	Yes	2	No
Suburb		If no, where do you normally live?				
Town						
Province						
Postal code						
If an adult - do you work/study	☐Yes	What is your occupation?				

Details of workplace / place of study	Name	
	Physical address	
If a child, does the child attend day care /crèche/school? ☐ Y ☐ N	If yes, give day care /crèche/school name: Telephone number:	
Who was interviewed? ☐ The Case ☐ Other		

If "other", specify	Name	
	Relation to case	
	Contact Tel. No.	

Details about Illness	
13 When did you start to feel unwell?	...../...../..... dd/mm/yy Time (approx)_____ Are you still ill? Yes ☐ No ☐ If NO – How many days were you ill for? _____
Which of the following symptoms were present during the illness?	☐Watery diarrhoea ☐Vomiting ☐Abdominal cramps ☐Other – *specify other* _____

Were stool specimens collected? ☐ Yes: ☐ No ☐ Unknown If yes: Laboratory name: _____ Specimen reference no. _____		
Were you admitted to hospital? ☐Yes ☐No		
If yes: Date admitted:		Name of Hospital:
Number of days in hospital?		
Nature of diagnosis	☐ Clinical only ☐ Laboratory confirmed (*V.cholerae* isolated from stool/rectal swab)	
Has the case been notified?	☐Yes ☐No	If yes, case notification number: _____

Exposure history

Did you travel anywhere in the last 10 days?

☐ Y ☐N ☐ Don't know

	If Yes : Travel Destination	Departure date	Return date
		/ /	/ /
		/ /	/ /

Did you have contact with anyone who had travelled outside of Gauteng in the 10 days before your diarrhoea started?

If Yes: Who? Where did they travel to? (*Destination)*	Departure date	Return date	Date of contact
	/ /	/ /	/ /

Did you have any visitors from outside of Gauteng in the 10 days before your diarrhoea started?

☐ Y ☐N ☐ Don't know

If Yes: Who? Where did they come from?	Departure date	Return date	Date of contact
	/ /	/ /	/ /

Were you in contact with anyone who had diarrhoea in the 10 days before your diarrhoea started?

☐ Y ☐N ☐Don't know

If yes, specify	Name	Relation	Date(s) of contact

Did you attend any gatherings or events (wedding receptions, festivals, funerals, church gatherings, choir gathers, baptisms, etc.) in the 10 days before your diarrhoea started?

☐ Y ☐N ☐Don't know

If yes, specify	Event	Location/venue	Date

AT HOME, indicate which water is used for which use (tick all applicable)

Type of water	Drinking	Preparing food	Bathing	Brushing teeth
Municipal tap water indoors	☐	☐	☐	☐
Municipal tap water outdoors but on your property	☐	☐	☐	☐
Municipal common source water	☐	☐	☐	☐
Private well/borehole water	☐	☐	☐	☐
Untreated surface water (river, pond, dam)	☐	☐	☐	☐

AT WORK / SCHOOL / DAY-CARE, indicate which water is used for which use (tick all applicable)

Type of water	Drinking	Preparing food	Bathing	Brushing teeth
Municipal tap water indoors	☐	☐	☐	☐
Municipal tap water outdoors but on your property	☐	☐	☐	☐
Municipal common source water	☐	☐	☐	☐
Private well/borehole water	☐	☐	☐	☐
Untreated surface water (river, pond, dam)	☐	☐	☐	☐

In what type of containers do you store your water (not refrigerated water)?	☐Plastic containers without lids ☐Plastic containers with lids ☐Metal containers without lids ☐Metal containers with lids
What do you use to scoop water from the container?	

Where did you shop for fresh fruit or vegetables in the last 10 days?

Store name / Vendor	Location

Where did you buy your milk in the last 10 days?

Store name / Vendor	Location

Did you eat or drink any unpasteurised dairy/milk products in the 10 days prior to your illness onset?	1	Yes		2	No

If yes, then where?	

In the 10 days before your illness onset, did you eat food/beverages at or from any of the following types of places outside of your home? Tick which of them apply and provide details

Type of establishment	Name and location	Date	Foods/beverages consumed
☐ Restaurant			
☐ Fast-food establishments			
☐ Work canteen			
☐ Delicatessen			
☐ Supermarket ready-to-eat food			
☐ Street vendor foods			
☐ Snack-bar or tuck shop			
☐ Petrol station			
☐ Another household			

Who prepares food in your household?

What water do you use to wash fruit and vegetables?

AT HOME,

a) Which forms of toilet do you make use of?

☐Indoor flushing toilet

☐Flushing toilet on stand but outside house

☐Pit Latrine

☐Other

_____

b) Which of the following are available at the toilet?

☐Tap with running water

☐Soap

AT WORK,

a) Which forms of toilet do you make use of?

☐Indoor flushing toilet

☐Flushing toilet on stand but outside house

☐Pit Latrine

☐Other _____

b) Which of the following are available at the toilet?

☐Tap with running water

☐Soap

Have you or any member of your household used the stream for any activities in the 10 days prior to your diarrhoea started?

☐Yes ☐No ☐Don't know

If yes, what activities?

Remarks:

General Environmental Health Practitioner Assessment:

General hygiene conditions in the home? (Remember to check where and how food and water is stored and for how long?)

Food and water storage assessment? (Collect food and water samples; test for chlorine residual in water storage facilities).

Overcrowded conditions?

Refuse removal?

Pest problems at home?

Any other comments:

Thank you for taking the time to complete this questionnaire

Source: Adapted from National Institute of Communicable Diseases (personal correspondence Archer, 2010; Research Focus Group, 2010).

ANNEXURE 8

WORK PROCEDURES FOR SPECIMEN COLLECTION FROM SUSPECT CHOLERA CASE/OUTBREAK

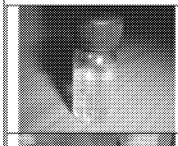
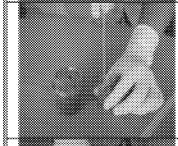
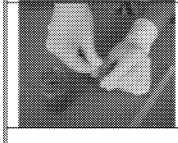
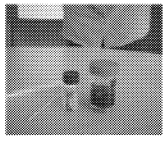
NATIONAL HEALTH LABORATORY SERVICE

Cholera: Guidelines for specimen collection from a suspect case/outbreak

Updated: 17 January 2010

IMPORTANT NOTES:

1. The typical "rice water" stool is not present in most cases of cholera.
2. The Department of Health must be immediately notified telephonically of all suspect cases of cholera. Do not wait for a laboratory result before.

	If > 2 hour delay before processing, place the stool specimen Cary-Blair transport medium as described in the steps below. If possible, the transport medium should have been chilled for 1 to 2 hours.
	1. Collect a small amount of stool by inserting a sterile cotton tipped swab into the stool, in the green topped container, and rotating it 2. If mucous and shreds of intestinal epithelium are present, these should be sampled with the swab.
	3. Immediately insert the swab into the transport medium. 4. The swab should be pushed completely to the bottom of the tube of transport medium.
	5. Break off and discard the top portion of the swab-stick that is protruding above the edge of the container, leaving the cotton tip in the transport medium.
	6. Replace the screw cap on both containers and tighten firmly. 7. Place labels on both the bottles (i.e. the transport medium AND the green top container with stool). Include all the required patient detail, clinical presentation and history, and the name of the attending healthcare practitioner. State the nature of the specimen (i.e. stool or rectal swab). 8. If there is a delay in transport (or processing in the laboratory) immediately place both containers in a refrigerator (at 4°C) or cold box until collected by the courior. DO NOT FREEZE. 9. Send both containers to the laboratory for testing, and specifically request testing for cholera in additional to standard tests (i.e. **MC&S and cholera**). Cholera is not routinely tested for.

Collection of RECTAL SWABS:

1. Moisten the swab in sterile transport medium (Cary-Blair).
2. Insert swab gently into the rectal sphincter (2 to 3cm) and rotate to sample anal crypts. Remove swab and check for visible faeces.
3. Immediately insert the swab into the transport medium (see steps above), label the specimen, and deliver to laboratory promptly.
4. If delays are anticipated, the swab in transport medium should be refrigerated. DO NOT FREEZE.

Source: National Health Laboratory Service, National Institute of Communicable Diseases (2010).

ANNEXURE 9

WORK METHODS AND PROCEDURES FOR COLLECTION AND SENDING OF SEWER PADS FOR CHOLERA IDENTIFICATION.

Waste water sampling and sample preparation – for the investigation of sewage effluents (National Department of Health, 2002:25; Centres for Disease Control and Prevention and World Health Organisation: Laboratory Methods for the Diagnosis of *Vibrio cholerae*, 1999:27-31):

- Samples should be collected in special wide-necked bottles (obtained from National Health Laboratory Service: NHLS), containing (double strength) alkaline peptone water;
- Commercially available plain sterile surgical gauze swabs (Moore swab) measuring approximately 10cm square should be used,
  - Place Moore swabs in all main intake lines at the sewage plant or other central locations in the sewage system;
  - The site for swab placement must be carefully evaluated for conditions that could inhibit the recovery of *Vibrio cholerae* organisms;
  - Placement must be upstream of any septic waste dump sites or partially treated recycled sewage, in order to avoid possible contamination with toxic waste;
- Tie one corner with a length of wire (or string, if no rats are present) and immerse the pad to hang below the surface of the effluent. The swab should remain in place for 24 to 72 hours, after which it should be pulled out;
- Hold a 2-3 cm. long piece of the swab with sterile forceps; cut it off with sterile scissors, and place the piece in the peptone water bottle. Close the lid tightly;
- Place the used instruments in a jar or flat container with methylated spirits. The instruments must be completely immersed. On arrival at the next sewer pad site remove the instruments from the jar and then hold a lighted match to the instruments to remove all traces of alcohol.
- Complete the attached label and send the specimen to the laboratory serving the local hospital or clinic.

Source: Own research findings.

ANNEXURE 10

WORK METHODS AND PROCEDURES FOR CONDUCTING SANITARY INSPECTIONS

I. Type of Facility PIPED WATER

1. General Information : Zone:

: Area

2. Code Number

3. Date of Visit

4. Water samples taken? ..... Sample Nos. .....

II Specific Diagnostic Information for Assessment

(please indicate at which sample sites the risk was identified)	Risk	Sample No
1. Do any tapstands leak	Y/N	.....
2. Does surface water collect around any tapstand?	Y/N	.....
3. Is the area uphill of any tapstand eroded?	Y/N	.....
4. Are pipes exposed close to any tapstand?	Y/N	.....
5. Is human excreta on the ground within 10m of any tapstand?	Y/N	.....
6. Is there a sewer within 30m of any tapstand?	Y/N	.....
7. Has there been discontinuity in the last 10 days at any tapstand?	Y/N	.....
8. Are there signs of leaks in the mains pipes in the Parish?	Y/N	.....
9. Do the community report any pipe breaks in the last week?	Y/N	.....
10. Is the main pipe exposed anywhere in the Parish?	Y/N	.....

Total Score of Risks ..../10

Risk score: 9-10 = Very high; 6-8 = High; 3-5 = Medium; 0-3 = Low

III Results and Recommendations:

The following important points of risk were noted: (list nos. 1-10)

Signature of Health Inspector/Assistant:

Comments:

Source: Howard, (2002: 190)

I. Type of Facility: PIPED WATER WITH SERVICE RESERVOIR

1. General Information : Zone
: Area

2. Code Number

3. Date of Visit

4. Water samples taken? …… Sample Nos. ……

II Specific Diagnostic Information for Assessment

	Risk	Sample No
(please indicate at which sample sites the risk was identified)		
1. Do any standpipes leak at sample sites?	Y/N	……
2. Does water collect around any sample site?	Y/N	……
3. Is area uphill eroded at any sample site?	Y/N	……
4.Are pipes exposed close to any sample site?	Y/N	……
5. Is human excreta on ground within 10m of standpipe?	Y/N	……
6. Sewer or latrine within 30m of sample site?	Y/N	……
7. Has there been discontinuity within last 10 days at sample site?	Y/N	……
8. Are there signs of leaks in sampling area?	Y/N	……
9. Do users report pipe breaks in last week?	Y/N	……
10. Is the supply main exposed in sampling area?	Y/N	……
11. Is the service reservoir cracked or leaking?	Y/N	……
12. Are the air vents or inspection cover insanitary?	Y/N	……
Total Score of Risks	…/12	

Risk score: 10-12 = Very high; 8-10 = High; 5-7 = Medium; 2-4 = Low; 0-1 = Very Low

III Results and Recommendations:
The following important points of risk were noted: (list nos. 1-12)

Signature of Health Inspector/Assistant:

Comments:

Source: Howard, (2002:191)

I	**Type of Facility**	**HYDRANTS AND TANKER TRUCKS**	
1.	General information	: Sub-Metro	
		: Community	
2.	Code Number:		
3.	Date of visit:		
4.	Is water sample taken?.....Sample No.....Thermotolerant Coliform Grade.....		
II	**Specific Diagnostic Information for Assessment**		**Risk**
1.	Is the discharge pipe dirty?		Y/N
2.	Can the discharge pipe touch the ground?		Y/N
3.	Is the delivery nozzle dirty or in poor condition?		Y/N
4.	Are there any leaks close to the riser pipe of the hydrant?		Y/N
5.	Is the base of the riser piped for the hydrant sealed with a concrete apron?		Y/N
3.	Is the tanker ever used for transporting other liquids?		Y/N
7.	Is the inside of the tanker dirty?		Y/N
8.	Does the tanker fill through an inspection cover on the tanker?		Y/N
9.	Is the discharge nozzle dirty or in poor condition?		Y/N
10.	Does the tanker leak?		Y/N
		Total Score of Risks	…./10

Contamination risk score: >8/10 = very high; 6-8/10 = high; 4-7/10 = intermediate; 0-3/10 = low

III **Results and Recommendations**

The following important points of risk were noted: (list nos.1-10)
And the authority advised on remedial action

Signature of inspector:

Comments:

Source: Howard, (2002:192)

I. Type of Facility **BOREHOLE WITH HANDPUMP**

1. General Information : Zone
: Location

2. Code Number

3. Date of Visit

4. Water sample taken? …… Sample No. …… FC/100ml ……

II **Specific Diagnostic Information for Assessment**

	Risk
1. Is there a latrine within 10m of the borehole?	Y/N
2. Is there a latrine uphill of the borehole?	Y/N
3. Are there any other sources of pollution within 10m of borehole? (e.g. animal breeding, cultivation, roads, industry etc)	Y/N
4. Is the drainage faulty allowing ponding within 2m of the borehole?	Y/N
5. Is the drainage channel cracked, broken or need cleaning?	Y/N
6. Is the fence missing or faulty?	Y/N
7. Is the apron less than 1m in radius?	Y/N
8. Does spilt water collect in the apron area?	Y/N
9. Is the apron cracked or damaged?	Y/N
10. Is the handpump loose at the point of attachment to apron?	Y/N
Total Score of Risks	…./10

Risk score: 9-10 = Very high; 6-8 = High; 3-5 = Medium; 0-3 = Low

III **Results and Recommendations**

The following important points of risk were noted: (list nos. 1-10)

Signature of Health Inspector/Assistant:

Comments:

Source: Howard, (2002:195)

I. Type of Facility PROTECTED SPRING

1. General Information : Zone:
: Location

2. Code Number:

3. Date of Visit:

4. Water sample taken? …… Sample No. …… FC/100ml ……..

II Specific Diagnostic Information for Assessment

	Risk
1. Is the spring unprotected?	Y/N
2. Is the masonary protecting the spring faulty?	Y/N
3. Is the backfill area behind the retaining wall eroded?	Y/N
4. Does spilt water flood the collection area?	Y/N
5. Is the fence absent or faulty?	Y/N
6. Can animals have access within 10m of the spring?	Y/N
7. Is there a latrine uphill and/or within 30m of the spring?	Y/N
8. Does surface water collect uphill of the spring?	Y/N
9. Is the diversion ditch above the spring absent or non-functional?	Y/N
10. Are there any other sources of pollution uphill of the spring? (e.g. solid waste)	Y/N
Total Score of Risks	…./10

Risk score: 9-10 = Very high; 6-8 = High; 3-5 = Medium; 0-3 = Low

III Results and Recommendations:

The following important points of risk were noted: (list nos. 1-10)

Signature of Health Inspector/Assistant:

Comments:

Source: Howard, (2002:196)

I. Type of Facility RAINWATER COLLECTION AND STORAGE

1. General Information : Zone
: Location

2. Code Number

3. Date of Visit

4. Water sample taken? …… Sample No. …… FC/100ml ……

II Specific Diagnostic Information for Assessment

	Risk
1. Is rainwater collected in an open container?	Y/N
2. Are there visible signs of contamination on the roof catchment? (e.g. plants, excreta, dust)	Y/N
3. Is guttering that collects water dirty or blocked?	Y/N
4. Are the top or walls of the tank cracked or damaged?	Y/N
5. Is water collected directly from the tank (no tap on the tank)?	Y/N
6. Is there a bucket in use and is this left where it can become contaminated?	Y/N
7. Is the tap leaking or damaged?	Y/N
8. Is the concrete floor under the tap defective or dirty?	Y/N
9. Is there any source of pollution around the tank or water collection area?	Y/N
10. Is the tank clean inside?	Y/N
Total Score of Risks	…./10

Risk score: 9-10 = Very high; 6-8 = High; 3-5 = Medium; 0-3 = Low

III Results and Recommendations:
The following important points of risk were noted: (list nos. 1-10)

Signature of Health Inspector/Assistant:

Comments:

Source: Howard, (2002:198)

I. Type of Facility WATER TREATMENT PLANT

Date of survey: _____

Survey carried out on: Source Intake Plant
(circle all those inspected)

Inspector: _____

Name of plant: _____

Name of Principal Operator: _____

Name of Responsible Engineer/Manager: _____

Years in operation: _____ Area served (Km2): _____

Population served: _____

Design capacity (m3): _____ Current production (m3/day): _____

Fence around plant? Y/N Fencing in good condition? Y/N Security guard? Y/N

II. Source (circle one): Reservoir Stream River Well Other

III Intake:
1. Condition of intake works: Good Average Poor

2. Problems with aquatic vegetation?: Y/N

3. Spontaneous settlement close to intake: None Small-scale Significant Serious

4. Industrial pollution close to source

5. Agricultural pollution close to source:

6. Sewage discharge/urban run-off close to intake?

IV Treatment processes (circle all those used):

Fine screen Grit chamber Oil/grease trap Pre-sedimentation Pre-disinfection

Activated carbon Aeration Coagulation/flocculation – Lime Alum Polyelectrolyte

Sedimentation: Rectangular Circular Other

Filtration: Rapid Slow Granular carbon

Disinfection: Chlorine Ozone Other
Other processes: _____

Source: Howard, (2002:199-2003)

V. Sedimentation:

1. No. of sedimentation tanks: _____
2. Frequency of desludging: _____
3. Type of desludging facility: _____
4. Method of sludge disposal: _____
5. General appearance of final water: _____
6. Turbidity at inlet: _____ Turbidity at outlet: _____
7. Retention time: _____

VI Filtration

1. No. of filters: _____
2. Filtration rate: _____
3. Filter run (time): _____
4. Depth of gravel: _____
5. Depth of sand: _____
6. Turbidity at inlet: _____ Turbidity at outlet: _____
7. Criteria for backwashing:

Air scour: Rate_____ Duration: _____

Water scour: Rate_____ Duration: _____

8. Is air and water supply distribution in sand bed even? Y/N
9. Capacity of clean water for backwash: _____
10. Any mud balls or cracks in filter: Before backwash - Y/N After backwash – Y/N
11. How is wash-water disposed of? _____

VIII: Disinfection

1. Any failures/interruption in disinfection: Y/N
2. Frequency of interruption: _____
3. Cause of interruption: _____

Source: Howard, (2002:199-2003)

4. Disinfectant used: _____

5. Dosage of disinfectant: _____

6. Dosing method: _____

7. Safety equipment and measures adequate: Y/N

8. Reserves of disinfectant available? Y/N Quantity: _____

9. Storage conditions: Good Average Poor

IX Clear water tanks

1. No. of tanks: _____

2. Capacity of each tank: _____

3. Concentration of free residual at outlet: _____

4. pH: _____

5. Chemical used for pH adjustment and dosage: _____

6. Are any tanks leaking? Y/N

7. Are tanks properly covered and locked? Y/N

8. Is the inside of the tank clean? Y/N

9. Are air vents and overflow pipes protected by screens? Y/N

X Process control

1. Jar test	Yes	No	Frequency: _____
2. pH	Yes	No	Frequency: _____
3. Free chlorine:	Yes	No	Frequency: _____
4. Colour:	Yes	No	Frequency: _____
5.Turbidity:	Yes	No	Frequency: _____
6. Faecal coliforms:	Yes	No	Frequency: _____

XI Record keeping

1. Chemical consumption	Good	Poor	Updated: _____
2. Process control tests	Good	Poor	Updated: _____
3. Bacteriological quality:	Good	Poor	Updated: _____
4. Residual chlorine:	Good	Poor	Updated: _____

XII Maintenance:

1. Screen:	Good	Poor
2. Pumps:	Good	Poor

Source: Howard, (2002:199-2003)

3. Chlorine dosing: Good Poor
4. Instrumentation: Good Poor
5. Cleanliness: Good Poor
6. Chemical storage: Good Poor

XIII Personnel
1. No. of present staff: Permanent_____ Casual_____

2. Educational level of plant superintendent or principal operator: _____

3. Years at this plant: _____

4. Total experience in water treatment: _____

XIV Problems recorded with:
1. Treatment processes: _____
(please list processes and describe problems)

2. Customer complaints: _____
(please indicate how many complaints, nature of complaints and frequnecy)

XV Flow diagram of treatment works: *(insert diagram)*

XVI Actions
1. Suggested remedial actions:
(please indicate priorities)

3. Have previously identified problems been rectified? Y/N

Signature:

Source: Howard, (2002:199-2003)

Household water quality inspection

Source of water .....

1. Is drinking water kept in a separate container (ask to be shown this)?

❑ Yes ❑ No

2. Is drinking water container kept above floor level and away from contamination?

❑ Yes ❑ No

3. Do water containers have a narrow mouth/opening?

❑ Yes ❑ No

4. Do containers have a lid/cover?

❑ Yes ❑ No

5. Is this is in place at time of visit

❑ Yes ❑ No

6. How is water taken from the container?

❑ Poured ❑ Cup ❑ Other utensil

7. Is the utensil used to draw water from the container clean?

❑ Yes ❑ No

8. Is the utensil used to draw water the container kept away from surfaces and stored in a hygienic manner?

❑ Yes ❑ No

9. How often is the container cleaned?

❑ Every day ❑ Every month ❑ Never

❑ Every week ❑ Rarely

10. How is the container cleaned?

.....

11. Is the inside of the drinking water container clean?

❑ Yes ❑ No

12. Is the outside of the drinking container clean?

❑ Yes ❑ No

Source: Howard, (2002:203).

ANNEXURE 11

WORK METHODS AND PROCEDURES FOR THE SURVEILLANCE OF ENVIRONMENTAL SURFACE WATERS

A. Visual assessment:

In identifying sites for visual inspection, consider the following (National Eutrophication Monitoring Programme, 2002:106):

- The location of algal scums floating on the surface of water bodies would tend to move according to wind direction, and to accumulate near the banks of the water body in the downwind direction;
- Excessive phytoplankton growth is often associated with slow moving water, as typically occurs in impoundments;
- In an impoundment, spatial variability occurs vertically, laterally and longitudinally:
  - Vertical variability is invariably caused by seasonal stratification (and destratification) of the water body, and
  - South African impoundments are mostly monomictic (i.e. overturn of the water occurs once a year in the autumn). Thereafter, the water is well mixed throughout the winter until late spring (late September or early October);
- The highest concentrations of nutrients may therefore be expected in the surface layers sometime after turnover and before stratification occurs. (High concentrations can also be caused at other times by high rainfall events and flooding);
- Bear in mind that some phytoplankton can occur in layers;
- Sites should be chosen, so that they take account of seasonal variations and other variations over time,
  - The flow of water in a watercourse is less in dry seasons; so, for a constant pollution source, pollutant concentrations would be higher; and
  - Wet seasons result in greater surface runoff. Therefore, pollution arising from runoff would be greater. High rainfall events also cause sudden increases in pollution levels.

- Local knowledge of phytoplankton bloom history and a good understanding of local growth conditions would greatly enhance the capacity to anticipate bloom formation. Such knowledge should be used whenever possible. As knowledge and understanding of any given water body accumulates, regular patterns of algal or cyanobacterial growth may be noticed. In the long term. Monitoring may then be focused on the critical periods and locations.

B. Water and waste water sampling methods:

1. Sampling equipment (National Department of Health, 2012 Draft norms and standards on Water Quality Monitoring):
   - Sterile sample bottles;
   - Sealed container or cooler box and ice to keep the samples cooled;
   - A map showing sampling locations must be included when gathering sampling equipment;
   - A gas burner;
   - Filed notebook/data sheet(s);
   - Latex gloves to prevent further contamination of samples by hands;
   - pH field instrument;
   - Nephelometric turbidity meter or Secchi disk;
   - Thermometer;
   - Distilled water for cleaning probes; and
   - Instrument for free available chlorine measurements.

2. **Water sampling and sample preparation – for the investigation of surface waters:**

   - Water samples should be collected in sterilized bottled following standard procedures (South African National Standard: SANS 6315, 2003: 9):

     - Water sample membrane filtration technique: the sample volume may vary according to the source and the level of sensitivity desired, however.
       - 1 000 ml sample is recommended for most investigations;

- Moore swab concentration technique: this is the classical method of concentrating pathogens and tracing their origin in water.
  - Commercially available plain sterile surgical gauze swabs (Moore swab-approximately 10cm square, made with absorbent cotton) should be used. Tie one corner with a length of wire or string and suitably anchor the swab below the surface of the water;
  - Suitably anchor sterile gauze swabs in the water to be tested;
  - Collect the swabs with entrapped water in sterile jars, after being in the water for 5 days;

- Plants should be collected in sterile polyethylene bags, and phytoplankton and zooplankton should be collected using plankton nets, and kept in sterile glass bottles;

- Sediment should be collected by a core sampler and kept in polyethylene bags.

3. **All field samples should be transported to the laboratory inside a cooled container (at about 4-10^{o}C) and processed within 6 hours.**

4. **The analytical method is outlined:**

a. Water and wastewater/sewage effluent: in the South African National Standard: SANS 6315, (2003: 9); and

b. Plants and sediment: World health Organisation: Drinking Water Quality Guidelines, (2002:126-14).

Strains of *Vibrio cholerae* that do not agglutinate in either O1 or 0139 antisera should be labelled non-O1 or non-O139; if further serogrouping is deemed necessary, it should be done at an International Reference Centre for serogrouping of *Vibrio cholera* (World health Organisation: Drinking Water Quality Guidelines, (2002:126-141).

5. **Laboratory test information (National Health Laboratory Service (NHLS) – National Institute of Communicable Diseases (NICD), 2012):**

- Primary identification, serotyping and antimicrobial susceptibility
  - Contact NICD Hotline to facilitate laboratory testing;
  - Liaise with local NHLS (including for turn-around time);
  - Specimens should be referred to local regional NHLS laboratory for primary identification; and
  - Isolates to be referred to Enteric Diseases reference Unit (EDRU), NICD-NHLS (contact telephone number: 011 555 0333/0334).

- Further identification, serotyping and antimicrobial susceptibility (Enteric Diseases reference Unit (EDRU), NICD-NHLS) :
  - Extended serotyping;
  - Antimicrobial susceptibility testing;
  - Screening for extended spectrum beta-lactamase (ESBL);
  - Cholera enterotoxin detection via PCR;
  - Biotyping via PCR;
  - DNA fingerprinting of strains via PFGE analyses.

Culture isolates sent from other laboratories: isolate the subcultures onto Dorset transport medium, incubated at 37 degrees overnight at laboratory of origin, prior to submission to EDRU. Dorset slope to be kept at room temperature upon receipt at NICD. Results provided in 1-4 days.

Source: Own research findings.

ANNEXURE 12

CHOLERA CONTROL TREATMENT CENTRES (CTCs)

1. **Location:**
   - Identification of suitable sites: A place where patients can be properly treated, and patients can be reached easily, in order to reduce the risk of case fatalities (CFR) during epidemics;
   - Organisation of patient flow: Selection and observation, hospitalisation, convalescent room for Oral Rehydration Salts (ORS) treatment, neutral area (for kitchen, stocks and material, etc.);
   - CTC maybe in an existing health facility referred to as a Cholera Treatment Unit (CTU) by the World Health Organisation, (2004:36), or other existing building, such as a school or community hall. If there is no suitable building, the CTC could be set up in a tent in the field;
   - Health authorities and communities should be involved in the selection of sites and their preparation. The CTC should not be close to a water source or any other functioning public structure (e.g. schools, dispensaries, markets.

2. **Planning:** The following should be considered (Haiti Cholera Manual, 2011:26 and World Health Organisation, 2004:36):

   - Good drainage away from the site (Do not select low ground or depressions);
   - Good access for patients and supplies (consider the distance and availability of transport): To market = 100m; water source = 40m on sandy soil, 15 m, if clay and other buildings and dwellings = 100m;
   - Adequate safe water supply;
   - Appropriate waste management facilities and practices;
   - Appropriate cleaning practices;
   - Adequate ventilation;
   - Sufficient light (ideally electricity), especially in hospital wards;
   - Precautions to control rodents, pests and other vectors;

- Provisions for disposal of excreta, vomit, or medical and other waste;
- Convenient hand-washing and toilet facilities;
- Concrete floor – or if temporary, a plastic sheet cover;
- Adequate space: Ward capacity approximately 2.5m^2 per patient plus 1 attendant. A 29m^2 tent can accommodate 10 patients + attendants.

3. Organisation:

- Separate areas following two key principles:
  i.) Isolation of the entire facility from other public structures (dispensary, school, market);
  ii.) Separation of patients (contaminated area) from the "neutral area" (not contaminated);

- Patient and staff flow should accommodate the following:
  i.) An entry/observation ward;
  ii.) Provision for administering Oral Rehydration Salts (ORS);
  iii.) A ward for patients who are recovering;
  iv.) Storeroom(s), staff room;

- Prevention and hygiene:
  - Washing and cleaning areas, laundry area;
  - Convenient hand washing stations;
  - Water treatment, preparation of chlorine solutions;
  - Kitchen (where feasible);

- Environment and waste:
  - Toilets (latrines);
  - Safe waste disposal (incinerator, dustbins);
  - Morgue;

- Security:
  - Watchman for information and patient flow control;
  - Fences;

- Protection of stocks (food, drugs, supplies).

4. Infection Control:

- At the entry/exit points;
  - i.) The most important time for spraying feet is upon entrance to and exit from the centre, in order to avoid contamination in and out of the Centre;
  - ii.) Footbaths are not efficient as disinfectants, as they become dirty quickly. Therefore spraying is preferred;
  - iii.) Sprayers adapted to resist strong concentrations of chlorine should be used;

- At admission:
  - i.) Patients and care-givers should enter through the patient entrance area, where their feet and shoes will be disinfected with 0.5% chlorine solution;
  - ii.) Dip the clothes of the patient into 0.05% solution for 30 minutes, then rinse with clean water and dry under the sun;
  - iii.) Restrict and control movements into and within the wards, as much as possible;
  - iv.) Establish hand-washing stations with chlorinated water and soap;
  - v.) Restrict admission and care to one caretaker per patient;

- In the health-care facility:
  - i.) Enough water to cover daily needs of patients (50 litres/person);
  - ii.) Provision of safe water: Where applicable, water storage tanks should be cleaned regularly and the quality of water should be sampled periodically to check for bacterial contamination;
  - iii.) Safe drinking water: Where safe water is not available, boil water for 5 minutes to render it safe. Alternatively, use water purification units;
  - iv.) Store water in a hygienic environment. Do not allow hands to enter the container. Dispense water from storage container by an

outlet fitted with a closure device or tap. Clean storage containers and water coolers regularly;

v.) Most patient-care areas should be cleaned by wet mopping. The use of a neutral detergent solution improves the quality of cleaning. Any areas visibly contaminated with body fluids should be cleaned immediately with detergent water. Isolation areas with Cholera patients should be cleaned with detergent/disinfectant solution at least daily;

vi.) Waste management: Hospital waste is a potential reservoir of pathogens and requires appropriate, safe and reliable handling. There should be a person responsible for the organisation and management of waste, collection, handling, storage and disposal. Waste management should be conducted in co-ordination with the infection control team;

vii.) Proper disinfection for buckets, latrines, clothes and bedding;

viii.) Patient's bedding and clothing can be disinfected by stirring them for 5 minutes in boiling water. Bedding, including mattresses, can also be disinfected by thorough drying in the sun;

ix.) A special latrine for Cholera patients who can walk, separate from the latrines used by the rest of the patients.

Source: Own research findings

ANNEXURE 13

WORK PROCEDURES FOR THE TREATMENT OF WATER SUPPLIES AT POINT OF USE

During a Cholera outbreak, drinking water supplies need to be treated, or not used if contaminated.

During an emergency treatment, at the point of use, treatment is generally quicker and less expensive to implement than a centralised system.

Some of the most common and simple treatment methods are presented below:

1. **Pre-treatment**

   There are a variety of technologies for treating water at the point of use.

   The methods described below will remove physical and microbiological pollution.

   Water is made safe to drink through a process of disinfection. To be effective, most disinfection processes require the water to be pre-treated first, so that it is free of any suspended particles.

   - **Aeration**

     This brings water into close contact with air, which increases the oxygen content of the water.

     Water can be treated by aeration by householders as follows:

     - Rapidly shake a container part full of water for about five minutes; leave it standing for thirty minutes to allow any suspended particles to settle.

   - **Storage and settlement**
     - When water is allowed to stand undisturbed, and in the dark for a day, more than 50 per cent of the most harmful bacteria will die;
     - Suspended solids and some pathogens will settle to the bottom of the container, removing further risk;
     - Storage for two days reduces contamination.

- **Filtration**

  A filter removes contamination by physically blocking particles, while letting the water pass through.

  - Straining
    - Straining is a simple method of filtration;
    - Pouring water through a clean piece of cotton cloth will remove some of the suspended silt and solids;
    - It is important that a clean cloth is used, as a dirty cloth may introduce additional contaminants into the water.

2. Disinfection

Disinfection destroys all harmful organisms present in water, making it safe to drink.

- Boiling
  - Very effective method, but energy consuming;
  - Bring water to "rolling" boil and held there for 1 minute at sea level, and for 3 minutes at a high altitude;
  - Boiling water (for at least 10 minutes, to destroy pathogens [Department of Water Affairs, 2005:2]);
  - Taste can be improved by aeration, by vigorously shaking the water in a sealed container, after it has been cooled.
- Chemical disinfection.

According to the World Health Organisation (2011a: 487-490):

  - Many chemicals can disinfect water, but chlorine is the most commonly used;
  - When used correctly, chlorine will kill *Vibrio cholerae*;
  - Sources of chlorine for home use: in liquid, powder and tablet form.

    - Vary in size and strength (i.e. how much chlorine they contain);
    - Different quantities are required, depending on the formulation;

- Important to follow manufacturer's instructions for use;
- To prevent misuse, clear instructions must be given to all the users;

- According to the Department of Water Affairs (2005:2):
  - Adding bleach to destroy micro-organisms (one teaspoon per 25 litres of water and allow to stand for at least 2 hours protected from sunlight);
  - Adding chlorine granules (also known as HTH) to destroy micro-organisms (one teaspoon of granules per 200 litres of water, and allow to stand at least 2 hours protected from sunlight).

3. Water storage

- After treatment using these simple methods, water may be re-contaminated if it is put into a dirty container, or it is not properly protected against pollution. Containers used for storing treated water must be properly washed, and the containers covered to prevent contamination (Department of Water Affairs, 2005:2);
- The storage and use of treated water is just as important as the treatment process (World Health Organisation 2011a:489);

- According to World Health Organisation, (2004:47):
  - Storage in a narrow-mouthed vessel with protected dispenser (spigot, spout) is much safer than storage in a wide-mouth vessel;
  - Drinking water should be kept in a clean covered pot or bucket;
  - Pour the water directly from the container;
  - Avoid use of a potentially contaminated article (e.g. cup without handle) to retrieve water;

- Design criteria for water storage vessels:
  - Be constructed of translucent high-density, polyethylene plastic or similar material that is durable, lightweight, non-oxidising, easy to clean, inexpensive, and able to be locally produced;
  - Hold an appropriate standard volume (e.g., 20L) and have a stable base and a sturdy, comfortable handle for easy carrying;

- Have a single opening 5 to 8 cm in diameter with a strong, tightly fitting cover that makes it easy to fill the container and add disinfectant, but it should be difficult to immerse hands or utensils;
- Have a non-rusting durable, cleanable spigot for extracting water;
- Allow air to enter, as water is removed;
- Have volume indicators and illustration of safe-water handling practices displayed on the outside of the vessel.

Source: Own research findings.