Aetiology and Prevalence of Paediatric Diarrhoea across Public Health Care Facilities in Gauteng Province

A mini-dissertation submitted by

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DECLARATION

I declare that the mini-dissertation hereby submitted to the Sefako Makgatho Health Sciences University, for the degree of Master of Pharmacy, in the School of Pharmacy has not previously been submitted by me for a degree at this or any other university; that it is my work in design and execution, and that all material contained herein has been duly acknowledged.

______________________________  __05/12/2018_____
Mametja, K.M (Miss)              Date
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<table>
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<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AIDS</td>
<td>Acquired Immune Deficiency Syndrome</td>
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<td>AGE</td>
<td>Acute Gastroenteritis</td>
</tr>
<tr>
<td>CDC</td>
<td>The Centers for Disease Control and Prevention</td>
</tr>
<tr>
<td>CHCs</td>
<td>Community Health Centres</td>
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<tr>
<td>DHS</td>
<td>Demographic Health Survey</td>
</tr>
<tr>
<td>DRC</td>
<td>Democratic Republic of the Congo</td>
</tr>
<tr>
<td>ECDC</td>
<td>European Centre for Disease Prevention and Control</td>
</tr>
<tr>
<td>EML</td>
<td>Essential Medicines List</td>
</tr>
<tr>
<td>ENAABLERS</td>
<td>Enhancing Appropriate Antimicrobial And Vaccine Use Via mobile Health And Other Techniques In The Republic of South Africa</td>
</tr>
<tr>
<td>EPI</td>
<td>Expanded Program on Immunization</td>
</tr>
<tr>
<td>E.coli</td>
<td><em>Escherichia coli</em></td>
</tr>
<tr>
<td>GIT</td>
<td>Gastrointestinal Tract</td>
</tr>
<tr>
<td>HIV</td>
<td>Human Immunodeficiency Virus</td>
</tr>
<tr>
<td>MURIA</td>
<td>Medicines Utilisation Research in Africa</td>
</tr>
<tr>
<td>NDOH</td>
<td>National Department of Health</td>
</tr>
<tr>
<td>NHI</td>
<td>National Health Insurance</td>
</tr>
<tr>
<td>ORS</td>
<td>Oral Rehydration Solution</td>
</tr>
<tr>
<td>ORT</td>
<td>Oral Rehydration Therapy</td>
</tr>
<tr>
<td>PPS</td>
<td>Point Prevalence Survey</td>
</tr>
<tr>
<td>PSTG/EML</td>
<td>Primary Standard Treatment Guideline/ Essential Medicines Lists</td>
</tr>
<tr>
<td>PSTG</td>
<td>Paediatric Standard Treatment Guidelines</td>
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<tr>
<td>SA</td>
<td>South Africa</td>
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<tr>
<td>SMU</td>
<td>Sefako Makgatho Health Sciences University</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>--------------</td>
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</tr>
<tr>
<td>SMUREC</td>
<td>Sefako Makgatho Health Sciences University Research and Ethics Committee</td>
</tr>
<tr>
<td>STGs</td>
<td>Standard Treatment Guidelines</td>
</tr>
<tr>
<td>SSA</td>
<td>Statistics South Africa</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
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<td>UNICEF</td>
<td>The United Nations Children’s Fund</td>
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ABSTRACT

Background: Paediatric diarrhoea is one of the main causes of morbidity and mortality in developing countries. A South African inquiry representative at national level recorded statistics for South Africa and stated that diarrhoea claims over 20% of lives of paediatrics under five. Early diagnosis can prevent severe hospitalization or death due to severe cases of diarrhoeal episodes. However, improved and specific interventions to reduce diarrhoea need better understanding of the aetiology and diagnosis of paediatric diarrhoea.

Objective: To describe the aetiology of paediatric diarrhoea and to determine the point prevalence of paediatric diarrhoea across public health care facilities in Gauteng province. Also to determine which diagnostic criteria are being used for paediatric diarrhoea.

Method: This study was a quantitative, observational and descriptive study using a point prevalence survey (PPS) design. The patients’ files from community health care centres and district hospitals were reviewed retrospectively and prospectively, respectively.

Results: The paediatric diarrhoea prevalence during the PPS was found to be 18.04% (n=133). Out of the 24 patients that presented with paediatric diarrhoea, only 18 patients presented with diarrhoea as their main diagnosis. This study has shown that out of 133 patients, 51.1% were males and 6.8% paediatric patient’s gender was undocumented. Paediatric diarrhoea was mostly seen in the first two years of life and the diagnostic approach was mainly based on the Integrated Management of Childhood Illness (IMCI) guidelines.

Conclusion: In conclusion, this study found that the main aetiology of paediatric diarrhoea in Gauteng could be due to rotavirus. This is because majority of the paediatric diarrhoea patients presented with watery diarrhoea, which according to previous research, is most likely due to a rotavirus infection. In this study blood cultures were not conducted for every patient that presented with paediatric diarrhoea, which limited knowledge associated with the epidemiology and aetiology of diarrhoea. The need for uniform diagnostic criteria to be adopted by the public health care facilities was identified from this study.

Keywords: Paediatric, Aetiology, Prevalence, Diagnostic Criteria, Diarrhoea, Public Health Care Facilities, Gauteng Province
1.1 INTRODUCTION

The introduction chapter describes the background and the rationale for this study. The primary and secondary research questions are provided, followed by the aim and objectives of the study. Furthermore, the purpose of conducting the study is described and an outline of the dissertation concludes the chapter.

In this dissertation, the term “paediatric” refers to all children of 12 years or younger, but older than one month.

1.2 BACKGROUND AND RATIONALE FOR THE STUDY

Diarrhoea is among the main causes of mortality in paediatrics globally, being the second leading disease after acute respiratory illnesses such as pneumonia (World Health Organization (WHO), 2013). Diarrhoea in paediatric individuals is associated with approximately 1.3 million deaths per year, with most occurring in developing countries (Mokomane, Kasvosve, de Melo, Pernica & Goldfarb, 2018). On average, children in developing countries have a greater chance of suffering from diarrhoea, even up to more than three times per year. Even with a half century of advanced management of paediatric diarrhoea, public health initiatives and improved diagnostic tools and criteria diarrhoea is still claiming lives in the paediatric population (WHO, 2013).

Ethiopia, India, Nigeria, Pakistan, China and the Democratic Republic of the Congo (DRC) are six countries that account for approximately 50% of the global paediatric mortality (Pour, Koyfman & Runyon, 2012). The mortality rate due to diarrhoea has dramatically decreased over the last 30 years as a result of the introduction of oral rehydration solution (ORS). In addition, the WHO largely led educational programs about paediatric diarrhoea, and diarrhoea-related annual mortality reduced from 13.6 to 4.9 deaths per 1000 paediatrics (Pour et al., 2012).

Evidence has proven the effectiveness of large scale therapy programmes of diarrhoea and dehydration worldwide, whereby, a 67% decrease in paediatric mortality was seen in Brazil from 1980 - 1989 and a 74% decrease of paediatric mortality was seen in Egypt from 1981 to 1990. This was achieved by a better awareness approach and the use of ORS.
(Santosham, Chandran, Fitzwater, Fischer-Walker, Baqui & Black, 2010). In 2012, Guarino and colleagues reported that global diarrhoea-associated paediatric mortality remained stable for approximately five years, even though the programs were a success the mortality rates in the paediatric population remained too high (Guarino, Dupont, Gorelov, Gottrand, Lee, Lin, Vecchio, Nguyen & Salazar-Lindo, 2012). The incorporation of the diarrhoea-control plan of action into the Integrated Management of Childhood Illness (IMCI) led to some deviations in community programming and training of health care professionals specific to diarrhoea management (Keusch, Fontaine, Bhargava, Boschi-Pinto, Bhutta, Gotuzzo, Rivera, Chow, Shahid-Salles, & Laxminarayan, 2006). This then pushed the emergency general practitioners to the front lines of public health, hence the need for medical professionals in the paediatric setting to be able to succinctly identify the general diarrhoeal disease aetiology while detecting and managing any electrolyte or fluid disturbances (Pour et al., 2012).

A child from Africa is more likely to experience more than five episodes of diarrhoea per year and of those identified, 80 000 die from diarrhoea, accounting for 25% to 75% of childhood illnesses (Tambe et al., 2015). Lack of proper interventions and a high poverty rate has led to a 4% paediatric mortality increase in Africa from 2000 to 2008 (Black, Cousens, Johnson, Lawn, Rudan, Bassani, Jha, Campbell, Walker, Cibulskis, Eisele, Liu & Mathers, 2008; Bouree, 2007). Diarrhoea occurs mostly in paediatrics, specifically because they are a susceptible age group. Many of these mortality events occur in Africa and South Asia which is quite alarming, because the disease is simply managed by ORS (Walker, Rudan & Liu, 2013).

In South Africa (SA), diarrhoea is one of the diseases accounting for the highest levels of morbidity and mortality in paediatrics of less than five years of age. A South African inquiry representative at National level recorded statistics for SA and stated that diarrhoea claims over 20% of paediatrics under-five lives (Statistics South Africa, 2012). However, other reports estimate the burden to be between 8% and 13% (Liu, Johnson, Cousens, Perin, Scott, Lawn, Rudan, Campbell, Cibulskis, Li, Mathers & Black 2012; Dorrington, Bradshaw & Laubscher, 2014). Researchers have alluded that the occurrence of diarrhoea in children is commonly seen in poor informal settlements characterised by an unclean, non-hygienic environment that lack sanitation, as well as over-congestion, insufficient clean water provision, poverty, undernourishment and the overall poor health status of these children (Oketcho, Karimuribo, Nyaruhucha, & Taybali, 2012; Unger, 2013). There is a direct relation between the high rates of diarrhoea and the socio-economic status of a country. In 2010, statistics showed that there were 60 000 episodes of childhood diarrhoea per month, and
in the same year 9 000 diarrhoeal related death cases were reported (Oketcho et al., 2012). Worst-case scenarios are mostly seen in communities that are underprivileged. Moreover, children living in poor communities are ten times more at risk of dying from diarrhoea than those staying in urban areas (Statistics South Africa, 2012). In addition, the presence of persistent diarrhoea can also contribute to the severity of the diarrhoeal condition and the child’s nutritional status, because of the loss of appetite and decreased absorption of nutrients in the gastrointestinal tract (GIT). Persistent diarrhoea is more prevalent in children infected with HIV and the mortality rate is much higher than in non-infected children (The United Nations Children's Fund (UNICEF), 2012).

The diagnosis of diarrhoea is based on full clinical examination, anamnesis and adequate laboratory analyses. Data on the diuresis, appearance and frequency of stools, fever, vomiting, abdominal pain, as well as acceptance and tolerance of food accompanied by other complaints are obtained from the guardian or parents, or the paediatric patient if of older age. It is of equal importance to acquire information regarding the consumption of unsafe water or food as well as the presence of identical difficulties in the paediatric surroundings (collective, family). During physical examination, which ought to be comprehensive, the consciousness level and degree of dehydration should be given special attention, not forgetting other related complications, which could be either extra-intestinal or intestinal (Radlović, Leković, Vuletić, Radlović & Simić, 2015)

According to the Paediatric Standard Treatment Guidelines (PSTGs) and Essential Medicines List (EML) for SA (2013), assessment of shock and dehydration should be performed at four hour intervals when diagnosing paediatric diarrhoea. The commonly alleged statement that specific examinations are not obligatory in most of the paediatric diarrhoea cases, because acute diarrhoea is self-limiting and resolves without initiating any specific therapy, may reduce the ability to provide more prompt resolutions of signs and symptoms with the appropriate directed treatment and prevent potential post-infectious sequelae (Riddle, DuPont & Connor, 2016). In addition, suitable identification of causative agents may assist in tailoring therapy, such as, administering supportive therapies, avoiding the use of antimicrobials for parasitic protozoan microorganisms or antibiotics for viral microorganisms and proper use of antibiotics for bacterial microorganisms. As signs and symptoms of acute diarrhoea are variable, efforts to diagnose possible causative classes or agents are subjective at best and have some level of imprecision because of symptom overlap. Even though the features of clinical presentation may be helpful in differentiating protozoan from bacterial causes, they are usually considered unreliable indicators of the possible responsible pathogen (Riddle et al., 2016).
Most symptoms of diarrhoea overlap with the diagnosis of acute gastroenteritis (AGE). AGE is an infectious disease characterized by acute diarrhoea, with or without vomiting, nausea, abdominal pain and fever. The clinicians are presented with a challenge, due to the similarity of the two conditions. They are required to have an increased attentiveness and have to make evidence-based decisions in practise. Moreover, the terms acute diarrhoea and AGE are usually used synonymously in practice, hence the necessity to consider, non-infectious causes of diarrhea, such as systemic conditions or medication effects (Pour, Koyfman & Runyon, 2013). This research therefore aimed to describe the aetiology and prevalence of paediatric diarrhoea, as well as the diagnostic criteria used across public health care facilities in SA.

1.3 RESEARCH QUESTIONS

The study posed two questions:

Primary research question:

• What was the aetiology and prevalence of paediatric diarrhoea across public health care facilities in Gauteng province?

Secondary research question:

• Which diagnostic criteria were followed for paediatric diarrhoea across public health care facilities in Gauteng province?

1.4 AIM OF THE STUDY

• The aim of the study was to describe the aetiology and prevalence of paediatric diarrhoea across public health care facilities in Gauteng province.

1.5 OBJECTIVES OF THE STUDY

The objectives of the study were as follows:

• To describe the aetiology of paediatric diarrhoea across public health care facilities in Gauteng province.

• To determine the point prevalence of paediatric diarrhoea across public health care facilities in Gauteng province.
To determine which diagnostic criteria are being followed for paediatric diarrhoea across public health care facilities in Gauteng province.

1.6 IMPORTANCE OF THE STUDY

Paediatric diarrhoea could be due to many reasons, some of them include poor environmental conditions, poor nutritional status and diseases that increase susceptibility to severe dehydration and diarrhoea in children such as HIV/AIDS (UNICEF, 2012). At present, the exact amount of paediatric diarrhoea burden in South Africa is unknown, though, it is still known that diarrhoea is one of the top causes of morbidity and mortality in paediatrics in South Africa (Chola, Michalow, Tugendhaft & Hofman, 2015). Diarrhoeal illness incidence greatly differs with the child’s age and weather seasons. Mostly, paediatric diarrhoea in South Africa is caused by either viral or bacterial agents, although, HIV patients usually present with protozoan agents. In the summer months, A great amount of cases are due to bacterial enteropathogens and rotavirus is the causative agent that is mostly seen in winter months (Awotiwon, Pillay-van Wyk, Dhansay, Day & Bradshaw, 2016). In addition, a study was carried out between 2009 and 2013 in South Africa and it was found that the norovirus GII4 was predominant in children (≤ 5 years) that presented with gastroenteritis and hospitalised (Munjita, 2015). In 2009, South Africa introduced the rotavirus vaccinations at age 6 and 14 weeks, into the Expanded Program on Immunization (EPI).

There have not been any systematic reviews on national representative incidence, prevalence and severity of the diarrhoeal illnesses in South Africa (Awotiwon et al., 2016). Proper history taking is key in determining the common cause of paediatric diarrhoea and the diagnosing process. History taking should comprise of diarrhoea frequency and duration, the presence of mucus or blood in the stool, bile stained vomits, previous use of ORS. In addition, aspects such as immunisation status, past and current illnesses, medications and related side effect and presence of immune compromising diseases such as HIV, asthma, should also be part of the history taking (Cooke, 2010).

This study was part of an overarching study titled ENAABLERS (Enhancing Appropriate Antimicrobial And Vaccine Use Via mobile Health And Other Techniques In The Republic of South Africa). A web-based application was developed in SA for continuous PPS purpose. Since there is shortage of technological interventions in public health care facilities, the National Department of Health (NDOH) established the Ministerial Advisory Committee on Health Care Benefits for National Health Insurance (NHI). One of the responsibilities of this committee was to develop a national database of all the current health
services. This guides the health professionals in implementing relevant interventions, as well as to initiate new information and technological techniques (NDOH, 2017), which will be of great use in ensuring uniform data across SA.

This study mainly focused on the aetiology, prevalence and diagnostic criteria used to diagnose paediatric diarrhoea in Gauteng’s public health care facilities. This was achieved by visiting public health facilities (district hospitals and community health centres) in the Gauteng province where patient’s medical folders were prospectively and retrospectively reviewed. This approach ensured that the study population represented the population in Gauteng province, hoping to see the common aetiology trend. Hence the aim was to describe the aetiology and prevalence of paediatric diarrhoea across public health care facilities in Gauteng.

1.7 OUTLINE OF THE DISSERTATION

This dissertation comprises of five chapters. Chapter 1 consists of background and rationale for the study followed by research questions (primary and secondary research questions), together with aim and objectives and concluded by a synopsis of the importance of the study. Chapter 2 reviews literature pertaining to paediatric diarrhoea. It consists of the definition of diarrhoea, aetiology of paediatric diarrhoea internationally and nationally, transmission of paediatric diarrhoea, diarrhoeal subtypes. This is followed by a discussion of the prevalence of paediatric diarrhoea, diagnostic diarrhoea for paediatric diarrhoea and concludes with diarrhoeal management. Chapter 3 outlines the method used in this study. This chapter includes the background of methodology, study site, study design, study population and sample, sample selection and sample size and data collection. It further elaborates on the pilot study, data entry and analysis, reliability and validity, bias and ethical considerations. Chapter 4 presents the results and a discussion by means of a manuscript. Finally, Chapter 5 is the conclusion chapter and consists of the limitations of the study, recommendations for possible future studies and a conclusion.
In 2013 the WHO has alluded that diarrhoea is among the top causes of mortality in paediatrics globally and that it is the second leading disease after acute respiratory illnesses such as pneumonia. Previous research has proven that paediatric diarrhoea is more prevalent in developing countries than developed countries. In response to the global burden, the WHO introduced educational programs to the public about paediatric diarrhoea and diarrhoea-related after which the annual mortality reduced from 13.6 to 4.9 deaths per 1000 paediatrics. In addition, ORS was introduced and the paediatric mortality rate vastly decreased. However, even with the implementation of advanced management of paediatric diarrhoea, public health initiatives and improved diagnostic tools and criteria, paediatric diarrhoea is still claiming lives in the paediatric population.

Possible causative agents should always be taken into consideration when diagnosing a patient presenting with diarrhoea. Dehydration, fever, nausea, vomiting, sunken eyes, and abdominal pain are just the few symptoms that patients can present with when consulting. These symptoms can be present in other conditions such as AGE, there is hence a need for clinicians to consider all possible factors that could lead to paediatric diarrhoea before initiating any therapy for a patient.

This study aimed to describe the possible aetiological agents and find out how prevalent paediatric diarrhoea is in the Gauteng province. Even though diagnosing paediatric diarrhoea could be challenging due to overlapping symptoms, the diagnostic criteria used in the health facilities should be uniform across the province.
CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

This literature review chapter presents an extensive review of the research topic and consists of subdivided sections. The chapter begins with the definition of the term diarrhoea, followed by the possible aetiology of paediatric diarrhoea and the transmission thereof. Furthermore, it outlines the diarrhoeal subtypes, prevalence of paediatric diarrhoea and concludes with possible management of paediatric diarrhoea.

2.2 DIARRHOEA DEFINITION

Diarrhoea is a Greek word, which means to flow through. Diarrhoea is defined as the frequent passage of unformed or abnormal liquid gastric contents via the bowel, even though there is variability in the regularity of passing stools, once daily can be considered normal in children (Whyte & Jenkins, 2012). WHO (2009), furthermore describes diarrhoea as the passing of loose or watery stools three or more times per day, for more than two days. However, most patients do not define their diarrhoea based on their defecation frequency, but rather on the consistency of the faecal matter (Guandalini & Vaziri, 2011).

Stool output could also be dependent on the type of diet one is on, for instance, 100-200g/day is approximately the normal stool for a person on typical Western diet. However, people consuming high fibre content diet may present with faecal matter weight of 300 g/day or more, but with normal stool consistency which does not necessarily indicate diarrhoea. Hence, stool consistency, defecation frequency and stool weight combined should be considered when defining diarrhoea (Marsh, 1992). Generally, there is a balance between the absorption and excretion of electrolytes and water in the gastrointestinal system, and the interruption of this balance results in diarrhoea (Whyte et al., 2012).

2.3 AETIOLOGY OF PAEDIATRIC DIARRHOEA

Segen's Medical Dictionary (2012) defines aetiology as knowledge branch concerned with causes of specific phenomena, particularly a medical science branch that is concerned with the origins and causes of diseases.
In developing countries, diarrhoea is considered common, especially in communities with limited access of or lack of safe water and poor hygiene and sanitation. Whereby, other diseases such as malnutrition, cancer & HIV just to mention a few, may contribute to children susceptibility of contracting diarrhoea in developing countries. These factors may lead to negative economic effects and major disease burden, as a result of lower quality of life, loss of work, burdensome medical costs and high mortality rate (Saeed, Abd & Sandstrom, 2015). However, it should also be noted that both infectious and non-infectious agents might cause diarrhoea in children (Ramlal, 2015).

### 2.3.1 Infectious diarrhoea and transmission

Paediatric diarrhoea can be caused by several causative agents that are transmitted via different modes. Individuals living in developing countries with poor access to sanitation, safe water, or hygiene infrastructure are at an increased risk of exposure to bacterial, viral, and parasitic infections (Arvelo, Kim, Creek, Legwaila, Puhr, Johnston, Masunge, Davis, Mintz & Bowen, 2015). In 2014, UNICEF stated that infectious diseases such as diarrhoea causes a high rate of mortality (UNICEF, 2014). The epidemiology of enteric pathogens that cause diarrhoea suggests that most infections are acquired from food, water and hand contact and can be prevented by simple rules of personal hygiene and safer food preparation. Among the contributors to diarrhoea, the child’s age, the household health environment and mothers’ age and level of education play important roles. However, the fact that the aetiological agents are not usually known by the time of treatment initiation has led to a high rate of antibiotics misuse, which drove to a generation of major antibiotic resistance problem in Sudan (Saeed et al., 2015).

Diarrhoea can be caused by viruses (Rotavirus, Norovirus, Enteric adenovirus), bacteria (Campylobacter jejuni, non-typhoid Salmonella sp, Enteropathogenic Escherichia coli (E. coli), Enterotoxigenic E. coli, Shigella spp., Salmonella typhi, and Vibrio cholera) and protozoa (Cryptosporidium parvum, Giardia lamblia and Entamoeba histolytica) (Kaiser & Surawicz, 2012). One of the microorganisms that can be considered as an aetiological agent for many diseases is Escherichia coli, that includes some illnesses that affect the gastrointestinal unit and urinary tract. The diarrhoeagenic E. coli (DEC) has six classes of strains and are based on their virulence factors and consist of six groups, namely: enteropathogenic E. coli (EPEC), enteroaggregative E. coli (EAggEC), enterotoxigenic E. coli (ETEC), enterohaemorrhagic E. coli (EHEC), diffuse adhering E. coli (DAEC), and enteroinvasive E. coli (EIEC) (Nataro & Kaper, 1998). These classes of pathogens can be found in combination or individually (Kaiser et al., 2012).
The manifestation of these agents differs between developing and developed countries. In developed countries, the episodes of diarrhoea cases are approximately 70%, in which 40% are of viral origin (rotavirus), bacterial cases are about 10–20% and of protozoal origin are less than 10%. Similarly, the prevalence of diarrhoea in developing countries also varies from country to country. For instance, there are many cases of cholera in India and Southeast Asia, whereas in Africa, rotavirus is the most prominent pathogen. Rotavirus causes approximately 28-49% cases of paediatric diarrhoea in Ethiopia but only 14% of cases in Tanzania. Nevertheless, in SA the pathogen that is mostly seen in paediatric diarrhoea is rotavirus, ranging from 14–34% of cases in Johannesburg, 20–55% in Durban and 18% in Cape Town. It has also been evident that the incidence of infectious pediatric diarrhea is associated with change in seasons. This association is mostly seen with rotavirus infection, which is classically defined in temperature climates of dry winter months (Cooke, 2010).

Diarrhoea could be of non-infectious and infectious origin. Non-infectious diarrhoea could be as a result of irritable bowel syndrome, fecal impaction, inflammatory bowel disease, ischemic bowel disease, partial small bowel obstruction, food allergies, lactulose/glucose intolerance and drug induced diarrhoea e.g. antibiotics, just to mention a few. However, infectious diarrhoea is caused by organisms such as viruses, protozoa helminths and bacteria (Keusch et al., 2006). Most of the organisms such as E. coli, rotavirus and cholera are transmitted through the fecal oral route. Faecal oral transmission frequently occurs through direct drinking of sewage contaminated water, preparation and consumption of unhygienic food, crop irrigation with raw sewage or grey water and direct intake ingestion of sewage-contaminated water. However, rotavirus transmission can be through formites left on surfaces or close person-to-person contact (Sanyaolu, Groetz, Gillam, Patel, Oyeleke, Oseni, Nguyen, Fragale, Gussen, Forbes & O’Leary, 2018).

2.4 DIARRHOEAL SUBTYPES

Diarrhoea has two main subtypes, namely: acute diarrhoea and chronic diarrhoea. Acute diarrhoea is divided into acute watery diarrhoea, persistent diarrhoea and bloody diarrhoea. This type of diarrhoea is associated with great fluid loss which leads to dehydration and it is mostly caused by Rotavirus, Vibrio cholerae and Escherichia coli. Dysentery or bloody diarrhoea is usually caused by Shigella sp. and the main symptom is visible blood in the stools. Persistent diarrhoea lasts for 14 or more days and may possibly have non-bloody or bloody stools. In addition, persistent diarrhoea commonly affect paediatrics with HIV or in malnourished paediatrics. However, chronic diarrhoea is a persistent and the individual usually presents with no weight loss, bleeding and abdominal pains or fatigue. The primarily
caused by dietary complications such as excessive caffeine intake or lactose deficiency and a rarely caused by intestinal parasites (WHO, 2009).

2.4.1 Acute watery diarrhoea

This subtype commonly starts abruptly, lasting for no longer than fourteen days (in which most of these cases last for seven days or less) and is accompanied by the frequent passing of watery or loose stools with no blood. However, there is a possibility of other symptoms such as, vomiting and fever to follow (Frank-Briggs, 2012). Pathogens that are most commonly responsible for acute watery diarrhoea, especially in developing countries, are *Escherichia coli* (E.coli), Rotavirus, Cryptosporidium, *Shigella*, enterotoxigenic organisms and *Campylobacter jejuni*, though, some cases reported that *Salmonella* and *Vibrio cholera* are common causes of paediatric diarrhoea. Dehydration can occur following an episode of acute watery diarrhoea, which can then lead to malnutrition. Hence, death in acute watery diarrhoea is due to critical dehydration (Frank-Briggs, 2012).

2.4.2 Dysentery

It is also known as bloody diarrhoea. This subtype is characterised by the presence of blood in the loose stool, usually following nutrient loss and intestinal damage in an infected person. The significant cause of this subtype is the bacteria, *Shigella*, which can cause a life-threatening episode of diarrhoea (WHO, 2009).

2.4.3 Persistent diarrhoea

It is a diarrhoea subtype that occurs abruptly, although it does not usually last for long periods (usually for ± 14 days). Initially persistent diarrhoea can present as either dysentery or acute watery diarrhoea, whereby significant weight loss is one of the major symptoms in these patients and they are at a higher risk of experiencing dehydration. Although persistent diarrhoea is not cause by a specific pathogen, *Shigella*, E. coli and Cryptosporidium can be some of the common causes. This type of diarrhoea must not be confused with chronic diarrhoea, which is the occurrence of diarrhoea for a long period due to factors that are non-infectious e.g. gluten sensitivity, or genetic metabolic disorders (Frank-Briggs, 2012).
2.5 PREVALENCE OF PAEDIATRIC DIARRHOEA

The risk factors associated with paediatric diarrhoea in developed countries are not well described, even though diarrhoea is still one of the main causes of paediatric morbidity and mortality (Bahartha & AlEzzi, 2016).

2.5.1 Socioeconomic factors

Socioeconomic status is reported as a contributing factor to the prevalence of paediatric diarrhoea and other diseases. Similar to the socioeconomic conditions, self-efficacy is also believed to influence the living conditions of patients and considered important in predicting health promotion behaviors. Hence, the concept that family income is a significant social element to an individual’s health (Oliveira, Oliveira, Bezerra, Silva, Melo & Joventino, 2016).

According to Diouf, Tabatabai, Rudolph & Marx (2014), diarrhoea is mostly seen in the first two years of life and the prevalence of paediatric diarrhoea depends on the complex interaction between socio economic status and the demographics of the paediatric patients (Mengistie, Berhane & Worku, 2013). Several researchers also highlighted that the prevalence of paediatric diarrhoea is more noticeable in children between 6 and 59 months of age (Okethcho et al., 2012; Mengistie et al., 2013; Mihrete, Alemie & Teferra, 2014). A study carried out in India also confirmed that there is a higher diarrhoeal prevalence rate in children with malnutrition. However, the prevalence rate varies due to the difference in poverty, food availability, accessibility of medical services, socio economic status, as well as the data collection period (Gupta, 2014).

In 2016 Woldu, Bitew and Gizaw stated that paediatric individuals in poor economic families are at a higher risk of developing diarrhoea than their counterparts. This could be because families with a higher income are able to use soap for hand-washing and aqua-guard in their households to prevent water microbial contamination and they may build toilets. While, lower income families are prone to develop the disease due to the fact that they cannot afford these facilities (Woldu et al., 2016).

2.5.2 Environmental factors

Environmental factors caused more than 40% of the global burden disease, mostly affecting the paediatrics of less than five years and these individuals make up approximately 10% of the global population. Poor safe water, hygiene and sanitation access account for roughly 88% of global disease burden caused by paediatric diarrhoea. For instance, it is globally known that many reported cases of diarrhoea are due to the faecal-oral contamination. Safe
water supply, hygiene and sanitation are proven to be good preventive interventions for morbidity and mortality of paediatric patients under five years of age (Mohammed & Zungu 2016).

A study conducted in Ethiopia established that environmental factors contribute to the prevalence of paediatric diarrhoea, especially under five years. Furthermore, the results shown that paediatric diarrhoea has various environmental factors, specifically related to lack of knowledge of diarrhoea aetiology and inadequate improved handwashing and sanitation facilities. This shows the significance of environmental wellbeing as a factor of child health (Mohammed & Zungu, 2016). In addition, Okethcho et al., (2012) described that the increased diarrhoeal prevalence was mainly as a result of informal setting surrounding the paediatric individuals and frequent exposure to infectious enteric pathogens, usually in a form of being exposed to faecal matters while crawling and playing. Paediatric diarrhoea is reported to be more prevalent in younger paediatric individuals living in informal settlements. This could be the reason why paediatric individuals in such settlements were four times more likely to die from the diarrhoea than the rest of the paediatric population, contributing to a mortality burden (Kyobutungi, Ziraba, Ezeh & Ye, 2008).

2.6 DIAGNOSTIC CRITERIA FOR PAEDIATRIC DIARRHOEA

During diagnostic evaluation of paediatric diarrhoea, the most significant diagnostic phase is the clinical evaluation of dehydration severity. In addition, when clinically presenting with infectious diarrhoea, differential diagnoses and possible complications should be taken into consideration during further diagnostic evaluations (Koletzko & Osterrieder, 2009).

2.6.1 Medical History and Physical Examination

Paediatric diarrhoea should be based on the previous medical history of the patient, complete clinical evaluation and suitable laboratory investigations. Information should be provided by parents or guardian or by the paediatric patient itself if of older age (Radlović, Leković, Vuletić, Radlović & Simić, 2015). The patients history should include the following: How frequent does the patient urinate, how often does the patient have bowel movements, if the patient is vomiting, and if vomiting is interfering with the child’s ability to keep down solid food and fluids, the nature of the stools (e.g., whether mucus or blood is present), the kind of emesis (e.g. if bile is present), duration of the diarrhoeal episode, the mental status of the patient, any accompanying medical conditions, the presence of fever, any recent
exposure to a potentially compromised or untreated water (any travel history), whether oral rehydration management has been tried but with no success (Churgay & Aftab, 2012).

Following history taking, physical assessment also needs to be part of the diagnostic process as it provides supplementary information to identifying the cause of diarrhoea. Findings such as lymphadenopathy or recent loss of weight could be due to malignancy or chronic infection. In addition, eye conditions such as exophthalmia or episcleritis may indicate the presence of hyperthyroidism or inflammatory bowel disease (IBD) respectively and the presence of anal fistulae could indicate Chrohn’s disease. Also, an itchy blistering rash also known as Dermatitis herpetiformis, is present in 15-25% patients diagnosed celiac disease (Juckett & Trivedi, 2011).

![IMCI Assessment and Classification of Paediatric Diarrhoea](image)

**Figure 2.7.1.a:** IMCI Assessment and Classification of Paediatric Diarrhoea

As mentioned in section 2.2, stool consistency, defecation frequency and stool weight combined could assist in defining diarrhoea. Information such as travel history should also be considered during the diagnostic process. For instance, a patient who previously travelled to the tropics could present with diarrhoea but with an increased list of diagnostic possibilities, though with no exception for common causes. Likewise, a patient who previously travelled to Africa may present with ulcerative colitis but not amoebic/parasitic dysentery (Juckett & Trivedi, 2011). Physical examination should be all-inclusive and special attention should be given to the level of consciousness, degree of dehydration and other complications, either extraintestinal or intestinal should get special attention (Radlović et al., 2015).
The weight of the paediatric patient should be measured during the diarrhoeal episode and after treatment, to retrospectively measure the degree of dehydration. Multiple medical organization have different dehydration scales, whereby they use signs and symptoms to evaluate the degree of clinical dehydration. Even though, the diagnosis could be inaccurate, general classifications of dehydration are defined as nothing less than 3 - 5 percent of body loss (Churgay & Aftab, 2012). In addition to physical assessment of hyper motility (bowel sounds), abdomen for surgical scars, tenderness (inflammation or infection) and neoplastic masses, rectal examination is equally important and should include faecal occult blood testing (Juckett & Trivedi, 2011). Figures 2.7.1.a and 2.7.2.b, indicate how health providers should assess and classify a diseased paediatric patient (IMCI booklet, 2014).
Table 2.7.1: Red Flags in a Paediatric Patient with Diarrhoea Justifying the Need for Physician Evaluation

| Guardian report of sunken eyes and decreased tearing, |
| Dry mucous membranes and/or decreased urine output, |
| Fever ≥ 38°C in infants less than three months and ≥ 39°C in children of three - 36 months of age, |
| Frequent and significant events of diarrhoea, |
| Premature birth history, |
| Pre-existing disease or chronic medical conditions, |
| Any psychological status changes (e.g., lethargy, apathy, irritability), |
| Insistent vomiting, |
| Poor reaction to the oral rehydration treatment or incapacity of the guardian to give enough therapy, |
| Persistent evidence of blood in the stool, and |
| Young age (younger than six months) or low body weight (≤ 8kg) |

2.6.2 Paediatric Diarrhoea Diagnostic Approach

The Integrated Management of Childhood Illness (IMCI) strategy was created to reduce morbidity and mortality in paediatrics under 5 years of age. The main aim is to improve disease management of serious and common diseases at primary health care level and was implemented in South Africa in 1997. These guidelines were developed by WHO/UNICEF, to provide effective and simple means to prevent and treat the leading causes of life-threatening and death in paediatrics (Sallam, El-Mazary, Osman & Bahaa, 2016). When evaluating a paediatric patient, the combined signs and symptoms can lead to a disease classification and not necessarily a specific diagnosis. The strategical plan consists of an approach for assessing paediatric nutritional and immunization status. This approach is intended for usage by outpatients with inadequate clinical background, inadequate diagnostic equipment, limited treatment, and limited opportunities to carry out complicated medical procedures (Horwood, Vermaak, Rollins, Haskins, Nkosi & Qazi, 2009).

2.6.2.1. Integrated Management of Childhood Illness (IMCI)

The public health care facilities in Gauteng province use the IMCI diagnostic approach. IMCI is a strategy that aims to achieve child development and survival, a crucial practice of the Convention on the Rights of the Child. This strategy is based on human rights, which guarantees that all children receive health care and access health care regardless of their surrounding environment. This strategy is instigated to address any gaps in skill,
knowledge, and community practices concerning the health of the children, illness recognition, home management of the diseased child, and suitable behaviour of seeking health care (Ketsela, Habimana, Martines, Mbewe, Williams, Sabiiti, Thiam, Narayanan & Bahl, 2008). The IMCI strategy consists of both preventative and curative interventions directed at enhancing health practices at health care facilities. This strategy consists of three major components:

- Integrated management of health care staff through delivery of locally adjusted guidelines on activities and IMCI to promote their use;
- Health system that strengthens the overall health care system essential for effective childhood illness management; and
- Enhancement of community and family health care practices.

The target of IMCI clinical guidelines is children up to five years of age, because this age group has shown to bear the highest burden of mortality rate due to common childhood diseases (Gera, Shah, Garner, Richardson & Sachdev, 2016). A child with any general danger sign requires urgent attention, which includes; complete assessment, administration of pre-referral treatment and urgent referral. These clinical recommendations are established from a syndromic, evidence-based approach to disease event management and emphasize effective, rational and affordable use of diagnostic tools and drugs. It takes proper training of health care providers and well-established guidelines to systematically evaluate common clinical signs and symptoms, which ultimately leads to effective and rational actions. Approach like this can assist in diagnosing the clinical illness, evaluating the severity of the illness, and implementing rational health care actions for the child’s well-being, e.g. manage at home, managing the child within available resources and when required, refer the child immediately. With persistent diarrhoea, the patient presents with no dehydration and no history of weight loss, but with severe persistent diarrhoea, the patient presents with dehydration and history of weight loss (Gera et al., 2016).

2.6.3 Clinical features of Paediatric Diarrhoea

Diarrhoea clinical manifestations include loose stools, fever, vomiting, abdominal cramps and anorexia. Usually, vomiting followed by diarrhoea might be the early indication in paediatrics, or vice versa. However, if the paediatric patient present with emesis, the physician must consider other possible diagnosis, such as metabolic disorders, gastrointestinal obstruction, diabetes, meningitis, urinary tract infections, meningitis and
ingestion. The emesis characteristics such as, such as intensity, colour, and frequency, also the relationship to feedings, usually lead to the most possible diagnosis. Viruses causes most of the paediatric diarrhoea cases worldwide (Granado-Villar, Sautu & Granados, 2012).

Typical gastroenteritis caused by rotavirus is seen by either the onset of vomit, which usually lasts for 24-48 hours together with or followed by fever of greater than 37ºC, just after the first phase follows the onset of watery diarrhoea and will last for roughly 3–8 days. It should also be noted that the clinical presentation of rotavirus varies from child to child. A study conducted in SA, has shown that rotavirus infections are capable of causing dehydration with up to 10-20 bowel movements in just 24 hours and usually accompanied by abdominal pain. Some children presented with a runny nose and cough (Seheri, Page, Mawela, Mphahlele & Steele, 2012).

In a study carried out in Sudan, 437 children with diarrhoea participated. Whereby, 2% presented with bloody diarrhoea and 98 % of the children presented with watery diarrhoea. In addition, 53% of the children presented with fever, the most common microorganisms were rotavirus and shigellosis. Dehydration was present in 60% of the children and in 55% of the children vomiting was also evident. The bacterial infections tended to occur during summer and autumn season, viral infections during winter and parasitic infections were evident only in the rainy season (Saeed et al., 2015).

A diagnostic questionnaire for diarrhoeal diseases was developed for Dr. Von Hauner Children’s Hospital. All clinical features paediatric patients presented with, were included in the questionnaire. Irrespective of the causative agent, most patients presented with loose stools, sometimes accompanied by blood after an incubation interval of one to seven days. Fever and vomiting were noted in most of the patients with loose stools. Vomiting could be present for a maximum of 48 hours and usually resolve after few hours of adequate rehydration. Diarrhoea in these patients stopped in two to seven days after adequate management. Symptoms such as shock and dehydration will depend on the degree of electrolytes and fluid loss. Complications that were rare included pre-renal azotaemia accompanied by toxic and/or intussusception and/or hypovolaemic shock as a sign of severe dehydration (Koletzko et al., 2009).

In SA, assessment of dehydration and shock should be performed at four hour interval when diagnosing paediatric diarrhoea (PSTGs/EML, 2013). Anderson (2010), advised health care professionals to pay more attention to recent evidence based literature in diagnostic and
treatment guidelines during practice, because the manifestation of paediatric diarrhoea and gastroenteritis can be similar.

### 2.7 DIARRHOEAL MANAGEMENT OF PAEDIATRIC DIARRHOEA

The main goals of therapy in paediatric diarrhoea are to prevent and maintain hydration, manage any underlying causes, alleviate the symptoms, decrease the severity and duration of diarrhoea (Peter & Umar, 2018). The main symptomatic management of acute infectious diarrhoea, specifically in paediatric patients at high risk for dehydration, is to continue feeding and provide rehydration, where possible (Faure, 2013). Diarroheal preventative measures include cholera, rotavirus, measles and typhoid vaccination; vitamin A and zinc micronutrient supplementation, management of comorbidities e.g. HIV, education and promotion of breastfeeding, sanitation, hygiene and clean water provision. The first line therapy of diarrhoea is oral rehydration solution, continual nourishment, as well as better health care provision and management (UNICEF & WHO, 2009). In addition, antibiotics should be administered to children suffering from life-threatening infections and other intestinal infections such as cholera and dysentery. It is extremely important that the guardians of these children are educated on hygiene, sanitation and nutritious feeding, ultimately aiming to decrease diarrhoea caused morbidity and mortality. Diarrhoea morbidity is increased in HIV positive children, however the treatment of diarrhoea for HIV positive paediatrics is generally the same as for HIV uninfected patients, even though lactose and monosaccharide intolerances are more frequently seen in this population (WHO, 2005).

Some interventions can be justified for some of the specific diagnosis, for instance if there is lack of resources or if a certain diagnosis is strongly suspected excluding life-threatening conditions. A patient who presents with malabsorption due to traveler diarrhoea could be given metronidazole (Flagyl) empirically to cure possible giardiasis. Similarly, bile acid resins can be given empirically to confirm possible bile acid malabsorption. With that being said, it is still significant for follow-up to be performed for patients treated empirically because they may initially respond to the treatment only to relapse or they may not respond at all (Juckett & Trivedi, 2011).
2.7.1 Non-Pharmacological Management of Paediatric Diarrhoea

2.7.1.1 Preventative measures

Handwashing

A meta-analysis of 30 researches have shown that the improvement of hand hygiene caused the reduction of gastrointestinal diseases by 31 percent (19 to 42, 95% confidence interval). It has been proven that antibacterial soap provided slight additional benefit when compared to the benefit of using a regular soap. In addition, a study found that an improved hand hygiene reduced the prevalence of diarrhoea in general, but had slight effect on rotavirus transmission (Churgay & Aftab, 2012). There is no major difference between industrialised and developing countries rotavirus infection rate. Practicing good hygiene like access to clean water, good hand washing and sanitation has proven to be partially effective in controlling rotavirus caused diarrhoea. Although, rotavirus vaccines are currently considered as the most effective intervention to either control or reduce the prevalence of diarrhoeal disease (Seheri et al., 2012)

Rotavirus vaccine

The rotavirus vaccines comes as a live vaccine and it is administered orally. The Prevention’s Advisory Committee on Immunization Practices and Centers for Disease Control (CDC) suggests vaccination routinely at two, four, and six months of age. Although, patients that are hypersensitive to the vaccines, present with severe combined immunodeficiency and gastrointestinal tract congenital malformation and contraindicated from receiving rotavirus vaccine. After ingesting the virus, the live virus is eliminated through the stool of about 25 percent of infants who were given the vaccine and, there is a high possibility of transmission to unvaccinated patient (Rotarix [package insert, 2011 & Patel, López-Collada & Bulhões, 2011]). Currently, Rotateq (pentavalent bovine-human reassortant vaccine) and Rotarix (monovalent human vaccine) are the two main rotavirus vaccines that are available in South Africa. Fortunately there have not been any increased risk of intussusception at 30 and 42-day intervals associated with these vaccines. However, it has been recorded that in Mexico, Rotarix vaccination would prevent 663 childhood deaths and 11,551 hospitalizations from rotavirus while leading to 41 additional hospitalisations and two additional deaths from intussusception (Patel et al., 2011).


2.7.2 Pharmacological Management of Paediatric Diarrhoea

Anti-diarrhoeals

Generally, antidiarrhoeal medications should not be used in children with acute diarrhoea because they can interfere with elimination of infectious agents from the gastrointestinal tract. Loperamide, also known as Imodium, slows the gastrointestinal motility and can hinder water and electrolyte movement throughout the bowel. Even though loperamide is usually used in older children for gastroenteritis, there is inadequate evidence to support its use. As a result, loperamide is not suggested in children of less than two years and older children are at a higher risk of nausea, constipation and central nervous system depression (Churgay & Aftab, 2012).

Probiotics

Probiotics can be considered essential in lessening immune response from foreign antigens in children presenting with diarrhoea. Even though probiotics are microorganisms, they do not colonize the digestive tract and are eradicated within one to two hours after ingestion from the digestive tract (Churgay & Aftab, 2012). Currently, the possibility of any interaction between medications and probiotics is still unknown. In most of the countries, probiotics are available over the counter and convenient to use because they can be administered orally and at home. General practitioners usually recommend probiotics because they limit the duration of diarrhoeal episode. In a Cochrane review, 63 studies came to the conclusion that probiotics have the ability to reduce the duration of diarrhoeal episode by roughly one day and only when used in combination with an ORS. However, the review did not stipulate of any superior probiotics (Allen, Martinez, Gregorio & Dans, 2010). However, inpatients who presented with acute gastroenteritis, a meta-analysis of Lactobacillus treatment proved that the treatment reduced diarrhoeal duration by 0.7 days and was able to reduce the occurrence of diarrhoea by 1.6 stools on day 2 of treatment. Although, there was no evident effect on the number of inpatients, the duration of fever or on fever, vomiting duration or on vomiting (Churgay & Aftab, 2012).

2.8 CONCLUSION

The WHO define diarrhoea as the frequent passing of watery stools three or more times a day, for more than two days (WHO, 2009). Diarrhoea is caused by infectious organisms such as viruses, bacteria, protozoa and helminths and are mainly transmitted through the faecal oral route. Although, Ramlal (2015) stated that both infectious and non-infectious
agents might cause diarrhoea in children, diarrhoea in communities with limited access of or lack of safe water and poor sanitation and hygiene is considered common (Kaiser & Surawicz, 2012). In addition, the prevalence of paediatric diarrhoea depends on the complex interaction between socio economic status and the demographics of the children (Mengistie, Berhane & Worku, 2013). Diarrhoeal preventative measures include cholera, rotavirus, measles and typhoid vaccination; vitamin A and zinc micronutrient supplementation, management of comorbidities e.g. HIV, education and promotion of breastfeeding, sanitation, hygiene and clean water provision. The first line therapy of diarrhoea is oral rehydration solution, continual nourishment, as well as better health care provision and management (UNICEF & WHO, 2009).

2.9 SUMMARY

In this chapter, a comprehensive review of literature relating to paediatric diarrhoea was done. All aspects including the definition of diarrhoea, possible aetiology of paediatric diarrhoea, possible route of transmission of microorganisms and different types of diarrhoea were discussed. Furthermore, the incidence/prevalence of paediatric diarrhoea and possible diagnostic approaches were also discussed. Furthermore, possible management of paediatric diarrhoea was also stated, including preventative measures such as vaccination. The following chapter describes the methodology employed for this study.
3.1 INTRODUCTION

This chapter comprises of study methods employed in the research project. It begins by discussing the background to the study methodology, study sites, study design and study period. It provides information on the study population, that is, the inclusion criteria, the exclusion criteria, sample size and the sample selection used. Furthermore, this chapter explains the process of data collection and data collection instruments, followed by statistical analysis in relation to sample size and statistical considerations, and a pilot study description. The researcher also discusses the reliability and validity of the collected data, as well as bias with regards to this study. The chapter concludes with a discussion of the ethical considerations for this study.

3.2 BACKGROUND TO THE METHODOLOGY

The study was part of a large study project titled ENAABLERS (Enhancing Appropriate Antimicrobial And Vaccine Use Via mobile Health And Other Techniques In The Republic of South Africa). A web-based application was developed in SA for continuous PPS (Point Prevalence Survey) purpose. The web-based application does not only allow anonymous patient data entry, but also makes it possible to enter data directly in the application through any mobile device connected to the web. The web-based application used the strongest encryption available, namely: Algorithm-256 (SHA-256) and Advance Encryption standard-265 (AES-256). The level of encryption in the web-based application was similar to those used in international banks.

The data backup entailed both manual and active backups, which used the same encryption as the database. To reduce possibility of data mitigation failure, the data was kept in different geographic sites. The industry leader in cloud services, Amazon Web Services (AWS), powered the infrastructure and was trusted by competent organizations such as Pfizer, CDC and the DOW Jones. Each time the data was accessed, it was logged and time-stamped. Although, in an unlikely case, a log-file could be provided. The database could only be accessed by authorized users. The application was protected by various passwords and these passwords were secured by double encrypted password technology. The raw data was exported in a JavaScript object notation (.Json), comma separated values (.cvs) and texts formats to Microsoft Excel for statistical purposes and for the data to be analysed.
In addition, sensitive data of the patient was not stored within the ENAABLERS application (APP). Confidentiality of the patient was maintained by using an anonymous coding system build directly into the ENAABLERS APP.

The instruments used in this study were developed in Botswana from which this study’s sheets were adapted. This study adopted the PPS method, whereby investigations needed to be carried out within a specific period of time. Point Prevalence Surveys (PPS) are reputable antimicrobial surveillance methods, whereby, the prescribing of antimicrobial in hospitals are monitored. Data validation, capturing and reporting were done using a web-based application in the Global Point Prevalence Survey of Antimicrobial Consumption and Resistance (Global PPS). In 2015, the web-based application granted the global PPS to be used by 335 hospitals in 53 countries.

Paediatric diarrhoea aetiology and prevalence was described using the information retrieved from the patient’s medical folders. Although, the patients presented with a variety of symptoms, there were specific symptoms that could be related to a certain microorganism e.g. a patient with bloody diarrhoea could possibly be infected with *Shigella*, likewise with acute paediatric diarrhoea, the causative agents could possibly be *Escherichia coli* (E.coli), *Rotavirus*, *Cryptosporodium*, *Shigella*, *enterotoxigenic* organisms or *Campylobacter jejuni*, just to mention a few. Patient symptoms could be good indicators of a certain microorganism but are not the best. Since this study was a observational study, the researcher did not communicate with the patients or health care workers. The researcher captured all data relevant to the study from patient files in the District hospitals and the CHCs (Community Health Centres).

### 3.3 STUDY SITE

The study took place in three districts of Gauteng province, South Africa. Gauteng province is the smallest province out of the nine, however, in 2017 Statistics South Africa (SSA) has reported that it has the largest population density. By 2017, approximately 25.3% of the South Africa population lived in Gauteng and this provincial population is significantly affected by international as well inter-provincial migration patterns (Statistics South Africa, 2017). Figure 3.3a shows the African map, South African map and Gauteng province map, respectively.
Three district hospitals and five (CHCs) were purposively and conveniently selected. The three district hospitals chosen have the largest bed capacity and these represented the remaining health care facilities in Gauteng province. The chosen CHCs feed into the respective district hospitals selected. Selecting a district hospital and CHCs within close proximity to one another will assist with the logistics and resources available for the research. Table 3.3 shows the study sites and the date at which data was collected.
### Table 3.3: Health care facilities and the dates at which data was collected

<table>
<thead>
<tr>
<th>District</th>
<th>Name health care facility</th>
<th>Date of data collection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>West Rand District</strong></td>
<td>Dr Yusuf Dadoo district hospital</td>
<td>25/05/2018</td>
</tr>
<tr>
<td></td>
<td>Mohlakeng CHC</td>
<td>15/05/2018</td>
</tr>
<tr>
<td><strong>Ekurheleni district</strong></td>
<td>Bertha Gxowa district hospital</td>
<td>09/05/2018</td>
</tr>
<tr>
<td></td>
<td>Goba CHC</td>
<td>21/05/2018</td>
</tr>
<tr>
<td></td>
<td>Phola CHC</td>
<td>17/05/2018</td>
</tr>
<tr>
<td><strong>Tshwane District</strong></td>
<td>Jubilee district hospital</td>
<td>14/05/2018</td>
</tr>
<tr>
<td></td>
<td>Laudium CHC</td>
<td>16/05/2018</td>
</tr>
<tr>
<td></td>
<td>Soshanguve CHC</td>
<td>18/05/2018</td>
</tr>
<tr>
<td></td>
<td>Stanza Bopape CHC</td>
<td>24/05/2018</td>
</tr>
<tr>
<td><strong>Sedibeng district</strong></td>
<td>Boipatong CHC</td>
<td>22/05/2018</td>
</tr>
</tbody>
</table>

### 3.4 STUDY DESIGN

This study was a quantitative, observational and descriptive study, using a point prevalence survey (PPS) study design. The patients’ files were prospectively and retrospectively reviewed. The medical files for paediatric patients who visited the CHCs the day prior to survey were retrospectively reviewed, whereas a prospective survey of patients’ files for paediatric patients in the district hospital was done on the day of the survey.

#### 3.4.1 Quantitative research

Quantitative research defines the phenomena using numerical information analysed by mathematical based approaches, particularly statistics. In addition, it can be generally described as empirical research on a human problem or social phenomenon, testing a concept entailing variables that are measured with numbers and analysed with statistics, to be able to determine if the concept predicts or explains phenomena of interest (Yilmaz, 2013). In 2010, Babbie further described the main aim of this type of research, which is to establish the link between a dependent (outcome) variable and an independent variable within a population (Babbie, 2010). In this study, the independent variable is the amount of paediatric patients presenting with diarrhoea and the dependent variable or outcome would be the most common causative agent of paediatric diarrhoea in the Gauteng province.
3.4.2 Observational research

An observational study is considered a scientific inquiry tool when it consists of the four aspects, namely: developed study purpose, which is systematically planned, is systematically and linked to overall propositions not only presented as showcasing a collection of interesting curiosities, and lastly is subjected to controls or checks on reliability and validity (Zikmund, Babin, Carr & Griffin, 2013). The definition of scientific observation is a systematic process of keeping record of the behavioural patterns of objects, human beings and witnessed occurrences. During the observational research there should be no communication with or questioning of people. (Zikmund et al., 2013). For the purpose of this research, the medical folders of paediatric patients presenting with diarrhoea as a symptom or the main diagnosis were observed.

3.4.3 Descriptive research

The purpose of a descriptive study is to simply describe the desired features of the sample to be studied. A descriptive study may generalise findings from a typical sample to a bigger target population like in cross-sectional survey. The mutual feature among the descriptive study designs is that there is only one single sample without any comparison group (Omair, 2016). This study aimed to describe the aetiology of paediatric diarrhoea across public health care facilities in Gauteng province.

3.4.4 Prospective study

This research was both prospective and retrospective. A prospective study is a study design used to assess the relationship between a hypothesised cause and an illness by selecting both unexposed and exposed subjects (or non-intervention and intervention groups) and then following them for the period of study (Segen's Medical Dictionary, 2011).

3.4.5 Retrospective study

A retrospective study design looks backwards and inspects experiences to supposed risk or safety factors regarding to an outcome that is developed at the beginning of the study. In a retrospective study design, the researcher begins the study at which follow-up has already been accomplished. The eligible subjects are retrospectively identified, cohort is collected and exposures are evaluated at baseline. Thereafter, the following illness occurrence or death is studied during the historical observation duration (Euser, Zoccali, Jager & Dekker, 2009).
A pilot PPS was conducted in 2017 at Doctor George Mukhari Academic Hospital (DGMAH) in Gauteng (Dlamini, 2016). The findings of which were used to refine the PPS forms for this study. The PPS forms (Appendices 1 - 3) were used to quantify and describe the aetiology and prevalence of paediatric diarrhoea across public health care facilities in Gauteng province. These PPS data collection instruments (Appendices 1 - 3) were then incorporated into a mobile health (mHealth) application, Knack®.

3.5 STUDY POPULATION AND SAMPLE

No sampling was required, as this was a PPS design. The following applies to the study population:

CHCs:

Files of all the paediatric patients that visited the CHC the day prior to survey were retrospectively reviewed.

District hospitals:

At the selected hospitals, all patients in the paediatric wards at 08:00 on the day of survey were prospectively included. Data from patient files were collected at one point in time from the paediatric in-patient wards. All data collection at the district hospitals was not necessarily done on the same day, however collection of data for a selected ward in a hospital was completed on the day the survey started, thus all patient files in a single ward was completely surveyed on that specific day.
3.6 SAMPLE SELECTION AND SAMPLE SIZE

Table 3.6: Inclusion and exclusion criteria for patient selection:

<table>
<thead>
<tr>
<th>HEALTH CARE FACILITY</th>
<th>INCLUSION CRITERIA</th>
<th>EXCLUSION CRITERIA</th>
</tr>
</thead>
</table>
| CHCs (Retrospective aspect) | • All paediatric patients who visited the CHC a day prior to the intended survey, that presented with diarrhoea either as their main diagnosis or as a symptom of any other disease  
• All paediatric patients 12 years or younger, but older than one month. | • All paediatric patients that visited the CHC any other day than a day prior to the data collection.  
• All paediatric patients that did not present with diarrhoea.  
• All paediatric patients younger than one month or above 12 years of age. |
| District hospitals (Prospective aspect) | • All paediatric in-patients admitted to the paediatric wards at least the previous day and still in the ward at 08:00 on the morning of survey, who presented with diarrhoea as the main diagnosis or as a symptom.  
• All paediatric patients 12 years or younger, but older than one month. | • All paediatric patients that did not present with diarrhoea.  
• All paediatric patients younger than one month or above 12 years of age.  
• Paediatric patients that were admitted to the paediatric ICU or neonatal ICU.  
• All paediatric out-patients regardless of the fact that they presented with diarrhoea.  
• All patients who were admitted to the ward after commencement of the survey, 08:00 am on the day of survey. |

The sample comprised of all paediatric patients’ files reviewed at both the CHCs and district hospitals on the respective day of sampling, with a minimum sample size of 384 files for both district hospitals and CHCs. A two-sided 95% confidence interval for the prevalence (percentage) of paediatric diarrhoea was within ± 5% of the percentage and was calculated from the sample. It was assumed that the prevalence is of the order of 50%. The sample size calculation was done on nQuery Advisor (Statistical Solutions Ltd, Cork, Ireland) Release 7.0, and was based on the large sample normal approximation of the binomial distribution.

3.7 DATA COLLECTION

3.7.1 Data collection period

Data collection began after ethical clearance and relevant permission from SMUREC and study sites were granted. Data was collected in May 2018. Data was only collected on working
week days (Monday to Friday) not on weekends, nor public holidays. Since the study followed a PPS design, data collection in each CHC or specific paediatric ward in a hospital was completed on the day of survey, as explained in Section 3.4.

Data was collected by the researcher with assistance from fellow MPharm students that form part of the ENAABLERs project, described in Section 3.6.4. All of the mentioned data collectors received training for a week (26th February - 2nd of March 2018) on antimicrobial stewardship which was also part of the mobile health (mHealth) application, Knack®, utilization training. The mobile health (mHealth) application, Knack®, contained the PPS sheets (Appendices 1-3). The training enabled the data collectors to use Knack® appropriately. The data collectors understood the objectives of the study by receiving the training which resulted in achieving the desired information.

3.7.2 Data collection instruments

In February 2016, main shareholders based in Botswana established the PPS tool from which this study's sheets was adapted. The variables incorporated in the tools were mainly associated with those that were incorporated in the ECDC PPS research, with relevant contribution from WHO (Massele, Tiroyakgosi, Matome, Desta, Muller, Paramadhas, Malone, Kurusa, Didimalang, Moyo & Godman, 2016; ECDC, 2013). These instruments were tested during a pilot study, and in July 2016 the findings were presented at the Medicines Utilisation Research in Africa (MURIA) seminar held in Botswana (Paramadhas, Tiroyakgosi & Godman, 2016). The MURIA seminar was joined by groups of academics from all over Africa, together with contributors from WHO and further refined the tool. The purpose of this joint participation was to have PPS data collection instruments that assisted in bringing about comparable data from different countries across Africa.

The PPS forms refined and adjusted for this study consists of the following three levels (as represented in Appendices 1-3), which were incorporated into the mHealth application, Knack®:

- General CHC or hospital information – to be completed only once upon entry to the specific study site (see Appendix 1).

- Ward data (specifically for hospitals) or CHC section/unit data – was completed at the beginning of the data collection period at 08:00 am on the day of data survey (see Appendix 2).
• Patient data – this data was completed for every paediatric patient that met the inclusion criteria and all data retrieved was mainly from the paediatric patient’s medical record/file (Appendix 3).

3.7.2.1. **ENAABLERS APPLICATION (ENAABLERS APP)**

Point Prevalence Surveys (PPS) are reputable antimicrobial surveillance methods, whereby, the prescribing of antimicrobial in hospitals are monitored. Data validation, capturing and reporting were done using a web-based application in the Global Point Prevalence Survey of Antimicrobial Consumption and Resistance (Global PPS). In 2015, the web-based application granted the global PPS to be used by 335 hospitals in 53 countries.

As part of the ENAABLERS project, a web-based application was developed in SA for continuous PPS purpose. The web-based application does not only allow anonymous patient data entry but also makes it possible to enter data directly in the application through any mobile device connected to the web. The web-based application used the strongest encryption available, namely: Algorithm-256 (SHA-256) and Advance Encryption standard-265 (AES-256). The level of encryption in the web-based application was similar to those used in international banks.

The data backup entailed both manual and active backups, which used the same encryption as the database. To reduce possibility of data mitigation failure, the data was kept in different geographic sites. The industry leader in cloud services, Amazon Web Services (AWS), powered the infrastructure and was trusted by competent organizations such as Pfizer, CDC and the DOW Jones. Each time the data was accessed, it was logged and time-stamped. Although, in an unlikely case, a log-file could be provided. The database could only be accessed by authorized users. The application was protected by various passwords and these passwords were secured by double encrypted password technology. The raw data was exported in a JavaScript object notation (.Json), comma separated values (.cvs) and texts formats to Microsoft Excel for statistical purposes and for the data to be analysed.

In addition, sensitive data of the patient was not stored within the ENAABLERS application. Confidentiality of the patient was maintained by using anonymous coding system build directly into the application.
3.8 PILOT STUDY

According to Polit, Beck and Hungler (2001), a pilot study is a study performed on a small scale which can be carried out mainly for two reasons. It can either show feasibility of a small scale study or as an experimental tool carried out in preparation of a leading study, or to test the reliability and validity of a research instrumental tool.

The findings of the pilot study conducted prior to March 2017 by an SMU researcher (Dlamini, 2016) were discussed during a planned workshop in Scotland in May 2017. These findings were used to refine the data collection sheets for this study. The pilot study further tested the use of the PPS forms in an electronic format using the mobile health application, Knack®, developed specifically for this purpose.

The results from the pilot study were used to ensure the feasibility, reliability and validity of the data collection tools. They also allowed additional corrections and refinement of the application before roll-out across all public sector health facilities.

3.9 DATA ENTRY AND ANALYSIS

The data collected by Knack® was directly exported to Microsoft Excel™ spread sheets. The captured data was cross-checked, which ensured accuracy and enabled corrections to be made before data analysis.

The clinical characteristics and demographics of patients were descriptively summarised by interquartile range, median, standard deviation, mean, minimum and maximum values for continuous variables e.g. age, by frequency counts and percentage calculations for categories variables e.g. gender. The prevalence (percentage) of paediatric diarrhoea was calculated as follows:

$$\text{Prevalence} = \frac{\text{Number of paediatric patients with diarrhoea}}{\text{sample size (total number of medical folders received)}} \times 100\%$$

A 95% confidence interval was calculated for the prevalence. Clinical features included the aetiology of paediatric diarrhoea and diagnostic criteria used. Results were presented in tables, text and graphs. All statistical analysis was performed on SAS (SAS Institute Inc, Cary, NC, USA), Release 9.4. All the statistical tests were two-sided and p-value of ≤ 0.05 (5%) was considered significant.
3.10 RELIABILITY AND VALIDITY

Joppe, (2000) described reliability as a uniform pattern of results seen over time when using the same instrument, along with the same methodology and an exact representation of the total studied population. Data collection commenced only after ensuring that all data collectors were adequately trained and familiarised with the objectives of the study as well as the PPS design and the use of Knack®. The data collection instrument was further tested in a pilot study (Dlamini, 2016), ensuring its reliability and the appropriateness of the research instrument in a South African setting (see Section 5.4.3).

There are two aspects that need to be taken into consideration when looking at validity during data collection, namely: internal and external validity. External validity is defined as the degree in which the obtained outcomes during a study could be generalised in other contexts. Internal validity is defined as the degree in which the design of the study and obtained data will permit the researcher to make correct conclusions about relations found in the data (Leedy & Ormrod, 2001).

Table 3.10.a: Threats to internal validity (Hungler & Pilot, 1997)

<table>
<thead>
<tr>
<th>Threat</th>
<th>Definition</th>
<th>Applicability to current study</th>
<th>What was done to minimize the effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effect size</td>
<td>The failure to interpret the interval and statistical significance of the study</td>
<td>The calculated study variables such as P-values may be misinterpreted (over or under the correct value) due to an incorrect sample size</td>
<td>Assistance from a statistician was sought to accurately express the statistical significance of the obtained data.</td>
</tr>
<tr>
<td>Researcher bias</td>
<td>It is when the researcher has his/her own favorite technique</td>
<td>The researcher may form a prearranged hypothesis that relates to results acquired through several testing procedures.</td>
<td>The mHealth application Knack® was used as the data collection tool across all study sites. Data collection training was provided before commencement of the study.</td>
</tr>
</tbody>
</table>
Table 3.10.b: Threats to external validity (Hungler & Pilot, 1997)

<table>
<thead>
<tr>
<th>Threat</th>
<th>Definition</th>
<th>Applicability to the current study</th>
<th>What will be done to minimize the effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological validity</td>
<td>Refers to the extent in which research results may be generalized across conditions, variables, settings and contexts.</td>
<td>All the collected data and study conclusions depend on the conditions, variables, settings and contexts in which it is obtained in.</td>
<td>Paediatric files from one hospital and two CHCs per province were reviewed, which ensured validity of results from all geographical areas across SA for the paediatric population.</td>
</tr>
<tr>
<td>Population validity</td>
<td>Refers to how a sample group can be extrapolated to represent a larger population.</td>
<td>The available sample may not represent the whole group due to factors. No sampling was required.</td>
<td>This is a PPS. The researcher reviewed all the patient files in the paediatric wards and CHCs included across all nine provinces.</td>
</tr>
</tbody>
</table>

Measures taken to reduce internal validity ensured that the same data collection protocol was followed at all the study sites. This includes the correct use of Knack®, as well as following PPS procedure to obtain data for the specific objectives of the study. Furthermore, all collected data was crosschecked by another researcher for precision. Then assistance from a statistician was sought to accurately express the statistical significance of the obtained data.

In a quantitative study, validity refers to the degree at which a theory is accurately measured. Reliability is also another measure of quality in a quantitative study and refers to the accuracy or precision of an instrument. Which can also mean the extent to which the data collection tool can consistently produce the same results and is utilised in the same environment on repeated times (Heale & Twycross, 2015). Table 3.10.3 summarises the types of validity.
Table 3.10.c: Types of validity

<table>
<thead>
<tr>
<th>Type of validity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content validity</td>
<td>Refers to the degree to which a research data collection tool precisely measures all construct aspects</td>
</tr>
<tr>
<td>Construct validity</td>
<td>Refers to the degree to which a research data collection tool measures the intended construct</td>
</tr>
<tr>
<td>Criterion validity</td>
<td>Refers to the extent to which a research data collection tool is associated to other instruments that measure variables that are the same</td>
</tr>
</tbody>
</table>

- **Content validity**

  This type of validity determines if the data collection tool adequately addresses all the relevant content with respect to the changing variable. Meaning, does the data collection tool cover the concept it was developed for or does the instrument address the entire domain associated with the variable. For this study, content validity of the mobile health application Knack® was achieved by strictly adhering to the study objectives.

- **Face validity**

  This type of validity is a subset of content. This is when the researcher asked their opinion if the developed data collection tool measures the intended concept. Face validity of the mobile health application Knack® itself was ensured by Dlamini N when she performed a pilot study in 2017. The mobile health application Knack® was piloted in all the wards of Dr George Mukhari Hospital in Gauteng province, South Africa. It excluded patients that were admitted on the day of data collection just after 8am. All the omitted aspects that were discovered during data collection were added into the mobile application to facilitate efficient results and adjustments were to respective irregularities to avoid double-barrelled or ambiguities.

**3.11 BIAS**

Bias is described as any systematic imprecisions that can occur that are able to influence the study results leading to deviation of results from the “true findings”, bias can take place at any phase of the study (Pannucci & Wilkens, 2010). Leedy & Ormrod (2001) also alluded that bias can be anything that can influence or deviate the study, leading to the misinterpretation of the captured data.
Bias was limited by the use of Knack® in this study. During data collection, consistency was ensured by strictly using the PPS, in the same manner across all data collection sites. In Table 2 and 3 various techniques were summarised to further minimise the effect of bias on this study.

3.12 ETHICAL CONSIDERATIONS

- Permission

Ethical clearance was requested from the Sefako Makgatho Health Sciences University Research and Ethics Committee (SMUREC), SMUREC number SMUREC/P/314/2017: PG (see Appendix 4), after the School of Pharmacy Research Committee (SOPRC) reviewed the protocol and made recommendations were affected. Permission and approval was also obtained from the General Director of Gauteng Province and National Health Research Database (NHRD) for the CHCs and district hospitals included in the study.

Table 3.12: Study site approval to conduct the survey

<table>
<thead>
<tr>
<th>District</th>
<th>Study site</th>
<th>Appendix number</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Rand District</td>
<td>Dr Yusuf Dadoo district hospital</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Mohlakeng CHC</td>
<td>6</td>
</tr>
<tr>
<td>Ekurheleni district</td>
<td>Bertha Gxowa district hospital</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Goba CHC</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Phola CHC</td>
<td>7</td>
</tr>
<tr>
<td>Tshwane District</td>
<td>Jubilee district hospital</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Laudium CHC</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Soshanguve CHC</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Stanza Bopape CHC</td>
<td>5</td>
</tr>
<tr>
<td>Sedibeng district</td>
<td>Boipatong CHC</td>
<td>11</td>
</tr>
</tbody>
</table>

- Informed consent

There was no interaction with the paediatric patients, as data was collected from the patient’s medical files. No informed consent was required.
• **Anonymity and confidentiality**

Unique study identification numbers were allocated to patients to identify them. The patient's name and personal information were kept confidential throughout the data collection. The mobile Knack® application required a password known only by the trained data collector and no individual patient was identified. All the collected data was safely kept and only accessed by the researcher and supervisors for study purposes, by so doing anonymity and confidentiality was maintained.

3.13 **SUMMARY**

This chapter included the methodology employed for the success of this study. The data collection tool was refined and adjusted for this study and it consisted of three levels represented in Appendices 1-3, which were incorporated into the mHealth application, Knack®. Furthermore, it consists of the description of the system used by Knack®. In conclusion, all aspects included in ethical considerations were fully discussed. The following chapter will be discussing the results obtained during data collection.
4.1 INTRODUCTION

This chapter is presented in the form of a manuscript and includes the results of the study, and a discussion thereof. The manuscript will be submitted for publication to The Pediatric Infectious Disease Journal, a peer-reviewed journal. This chapter concludes with a summary.

MANUSCRIPT FOR PUBLICATION

A call for uniform diagnostic criteria in public health care facilities

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ABSTRACT

Background: Paediatric diarrhoea is one of the main causes of morbidity and mortality in developing countries. A South African inquiry representative at national level recorded statistics for South Africa and stated that diarrhoea claims over 20% of lives of paediatrics under five. Early diagnosis can prevent severe hospitalization or death due to severe cases of diarrhoeal episodes. However, improved and specific interventions to reduce diarrhoea need better understanding of the aetiology and diagnosis of paediatric diarrhoea.

Objective: To describe the aetiology of paediatric diarrhoea and to determine the point prevalence of paediatric diarrhoea across public health care facilities in Gauteng province. Also to determine which diagnostic criteria are being used for paediatric diarrhoea.

Method: This study was a quantitative, observational and descriptive study using a point prevalence survey (PPS) design. The patients’ files from community health care centres and district hospitals were reviewed retrospectively and prospectively, respectively.

Results: The paediatric diarrhoea prevalence during the PPS was found to be 18.04% (n=133). Out of the 24 patients that presented with paediatric diarrhoea, only 18 patients presented with diarrhoea as their main diagnosis. This study has shown that out of 133 patients, 51.1% were males and 6.8% paediatric patient’s gender was undocumented. Paediatric diarrhoea was mostly seen in the first two years of life and the diagnostic approach was mainly based on the Integrated Management of Childhood Illness (IMCI) guidelines.

Conclusion: In conclusion, this study found that the main aetiology of paediatric diarrhoea in Gauteng could be due to rotavirus. This is because majority of the paediatric diarrhoea patients presented with watery diarrhoea, which according to previous research, is most likely due to a rotavirus infection. In this study blood cultures were not conducted for every patient that presented with paediatric diarrhoea, which limited knowledge associated with the epidemiology and aetiology of diarrhoea. The need for uniform diagnostic criteria to be adopted by the public health care facilities was identified from this study.

Keywords: Paediatric, Aetiology, Prevalence, Diagnostic Criteria, Diarrhoea, Public Health Care Facilities, Gauteng Province
Introduction

The global burden of diarrhoea is less than 5% (4.1%) of the world’s disease (Das, Salam & Bhutta, 2014), in addition, it is the third leading cause of paediatric mortality in developing countries and claims approximately 0.75 million paediatric lives per year worldwide (Liu, Johnson, Cousens, Perin, Scott, Lawn, Rudan, Campbell, Cibulskis, Li, Mathers & Black, 2012; World Health Organization (WHO), 2012). Diarrhoea is diagnosed when an individual presents with at least three or more watery stools per day (Sanyaolu, Groetz, Gillam, Patel, Oyeleke, Oseni, 2016). It occurs mostly in paediatrics, especially those in their first two years of life, because they are a susceptible age group (UNICEF, 2012). The aetiology of paediatric diarrhoea includes a variety of parasites, bacterial pathogens and enteric viruses. However, the leading causative agent of paediatric diarrhoea is Rotavirus (Wardlaw, Salama, Brocklehurst, Chopra & Mason, 2010).

Socioeconomic factors play a great role in the prevalence of communicable illnesses by means of their indirect association with the access to proper health care facilities, adequate safe water, quality of life, access to adequate safe water supply, environmental sanitation and knowledge about disease prevention (Ganguly, Sharma & Bunker, 2015). A study conducted in South Africa has also revealed that paediatrics living in poverty states were ten times more likely to die from diarrhoea than their more advantaged counterparts (Chola, Michalow, Tugendhaft & Hofman, 2015).

The Integrated Management of Childhood Illness (IMCI) strategy was created to reduce morbidity and mortality in paediatrics under five years of age. These guidelines were developed by WHO/UNICEF, to provide an effective and simple means to prevent and treat the leading causes of life-threatening illnesses and death, which includes paediatric diarrhoea (Sallam, El-Mazary, Osman & Bahaa, 2016). The diagnosis of paediatric diarrhoea should be based on the previous medical history of the patient, complete clinical evaluation and suitable laboratory investigations. Information should be provided by parents or guardian or by the paediatric patient itself if of older age (Radlović, Leković, Vuletić, Radlović & Simić, 2015).

In 2009, the WHO outlined the therapeutic goals of acute diarrhoea, which includes: dehydration prevention, management of dehydration, possible nutritional harm prevention and to decrease the severity and duration of diarrhoea and future occurrences of diarrhoeal episodes (Faure, 2013). Diarrhoeal preventative measures include cholera, rotavirus, measles and Typhoid Vaccination; vitamin A and Zinc micronutrient supplementation, management of comorbidities e.g. HIV, education and promotion of breastfeeding, sanitation, hygiene and
clean water provision. The first line therapy of diarrhoea is oral rehydration solution (ORS), continual nourishment, as well as better health care provision and management (UNICEF & WHO, 2009). In 2016, Statistics South Africa reported that diarrhoea accounts for approximately 2.0% of deaths in the national paediatric population. In addition, Gauteng province was one of the provinces that had a reduction in paediatric individuals under five diarrhoea mortality rates and diarrhoea mortality rate in Gauteng province was estimated to be 1.7% in 2016/2017 (Statistics South Africa, 2016).

There is a paucity in literature with regards to the prevalence of paediatric diarrhoea in public health care facilities in Gauteng province. With this paper we provide possible paediatric diarrhoeal aetiology and an overview of diarrhoea prevalence across public health facilities, as well as a description of the diagnostic criteria used in the Gauteng province.

Methods

Study design and period

This study was a quantitative, observational and descriptive study, using a point prevalence survey (PPS) study design. Data was collected both retrospectively and prospectively in May 2018 from patient files.

Systematic review

A systematic review of studies relating to paediatric diarrhoea in public health care facilities was conducted, with studies published between January 2014 and December 2018 being included. The main outcomes had to associate with either paediatric diarrhoea, aetiology of paediatric diarrhoea, prevalence of paediatric diarrhoea or diagnostic criteria used in public health facilities. The following search terms were used: paediatric, diarrhoea, paediatric diarrhoea, aetiology, aetiology of paediatric diarrhoea, prevalence, prevalence of paediatric diarrhoea, diagnostic criteria, public health care facilities; with studies limited to English language. Review articles, as well as those specific to individuals over 12 years and younger than one month were excluded. The principal researcher (M.K.M) read the previous research along with the research team and decided on the relevant papers to be used in this study (Figure 1).
Figure 1: Outcome of the Systematic Review

Materials and methods

Study sites

The study took place in three districts of Gauteng province, South Africa. Gauteng province is the smallest province out of the nine, however, in 2017 Statistics South Africa (SSA) has reported that it has the largest population density. By 2017, approximately 25.3% of South Africa population lived in Gauteng and this provincial population is significantly affected by international as well inter-provincial migration patterns (Statistics South Africa, 2017). Figure 2 shows the location of the different health care facilities in the districts surveyed in Gauteng province.
Three district hospitals and seven CHCs were purposively and conveniently selected. The three district hospitals chosen have the largest bed capacity and these represented the remaining health care facilities in Gauteng province. The chosen CHCs feed into the respective district hospitals selected. Selecting a district hospital and CHC within close proximity to one another assisted with the logistics and resources available for the research. Table 1 shows the selected study sites per district.
Table 1: Study Sites

<table>
<thead>
<tr>
<th>District</th>
<th>Health care facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Rand</td>
<td>District hospital 1</td>
</tr>
<tr>
<td></td>
<td>CHC 1</td>
</tr>
<tr>
<td>Ekurheleni</td>
<td>District hospital 2</td>
</tr>
<tr>
<td></td>
<td>CHC 2</td>
</tr>
<tr>
<td></td>
<td>CHC 3</td>
</tr>
<tr>
<td>Tshwane</td>
<td>District hospital 3</td>
</tr>
<tr>
<td></td>
<td>CHC 4</td>
</tr>
<tr>
<td></td>
<td>CHC 5</td>
</tr>
<tr>
<td></td>
<td>CHC 6</td>
</tr>
<tr>
<td>Sedibeng</td>
<td>CHC 7</td>
</tr>
</tbody>
</table>

Study population and sample

No sampling was required, as this was a PPS design. The following applies to the study population:

Community Health Centres: Files of all the paediatric patients that visited the CHC the day prior to survey were retrospectively reviewed.

District hospitals: At the selected hospitals, all patients in the paediatric wards at 08:00 on the day of survey were prospectively included. Data from patient files were collected at one point in time from the paediatric in-patient wards. All data collection at the district hospitals was not necessarily done on the same day, however collection of data for a selected ward in a hospital was completed on the day the survey started, thus all patient files in a single ward was completely surveyed on that specific day.

Data collection and data collection instruments

In February 2016, researchers based in Botswana established the PPS tool from which this study’s data collection instrument was adapted (Massele, Tiroyakgosi, Matome, Desta, Muller, Paramadhas, Malone, Kurusa, Didimalang, Moyo & Godman, 2016; ECDC, 2013). The variables incorporated in the tools were mainly associated with those that were incorporated in the ECDC PPS research, with relevant contribution from WHO (Massele et al., 2016; ECDC, 2013). These instruments were tested during a pilot study, and in July 2016 the findings were presented at the Medicines Utilisation Research in Africa (MURIA) seminar held in Botswana.
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(Paramadhas, Tiroyakgosi & Godman, 2016). The MURIA seminar was joined by groups of academics from all over Africa, together with contributors from WHO who further refined the tool. The purpose of this joint participation was to have PPS data collection instruments that assisted in bringing about comparable data from different countries across Africa.

The PPS forms refined and adjusted for this study consists of three levels, namely: the general CHC or hospital information (to be completed only once upon entry to the specific study sites), Ward data (specifically for hospitals) or CHC section/unit data (completed at the beginning of the data collection period at 08:00 am on the day of data survey) and Patient data (this data was completed for every paediatric patient that met the inclusion criteria and all data retrieved was mainly from the paediatric patient's medical record/file). All of these levels were incorporated into the mobile health (mHealth) application, Knack®.

**Compliance to the guideline**

The compliance of the public health care facilities with regards to diagnosis of paediatric diarrhoea to the STG/EML cannot be evaluated. This is because the latest child patient health record primary health care booklet used by the CHCs to record the patients' medical history is not the same for all the sites and furthermore does not guide health professionals on how to diagnose paediatric diarrhoea. Hence, the compliance was evaluated using guidelines developed by WHO (IMCI guidelines, 2014). The IMCI guidelines state that the diagnosis of paediatric diarrhoea should include: the assessment of dehydration, duration as well as the presence of blood in stool.

However, the STG/EML also included the assessment of shock, which is done by determining the capillary filling time, weak/rapid pulse rate, level of consciousness, blood pressure and pulse volume. Table 2 indicates the classification of dehydration according to IMCI and if the patients presented with two or more of the following symptoms for both classifications they should be treated as guided.

**Table 2: Dehydration classification- performed after shock assessment**

<table>
<thead>
<tr>
<th>Severe dehydration</th>
<th>Some dehydration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunken eyes</td>
<td>Thirsty, eager to drink</td>
</tr>
<tr>
<td>Unconscious</td>
<td>Irritable</td>
</tr>
<tr>
<td>Drinking poorly</td>
<td>Sunken eyes</td>
</tr>
<tr>
<td>Very slow skin pinch ≥2 seconds</td>
<td>Slow skin pinch &lt; 2 seconds</td>
</tr>
</tbody>
</table>
In addition, the duration of the diarrhoea episode (days) should be recorded, as this indicates whether the patient has persistent diarrhoea or not. Lastly, the presence of blood in the stool is also significant, because where present the paediatric individual needs to be immediately initiated on antibiotics.

**Statistical analysis**

The data collected by Knack® was directly exported to Microsoft Excel™ spread sheets. The captured data was cross-checked, which ensured accuracy and enabled corrections to be made before data analysis.

The clinical characteristics and demographics of patients were descriptively summarised by interquartile range, median, standard deviation, mean, minimum and maximum values for continuous variables e.g. age, by frequency counts and percentage calculations for categories variables e.g. gender. The prevalence (percentage) of paediatric diarrhoea was calculated as follows:

\[
\text{Prevalence} = \frac{\text{Number of paediatric patients with diarrhoea}}{\text{sample size (total number of medical folders received)}} \times 100\%
\]

A 95% confidence interval was calculated for the prevalence. Clinical features included the aetiology of paediatric diarrhoea and diagnostic criteria used. Results were presented in tables, text and graphs. All statistical analysis was performed on SAS (SAS Institute Inc, Cary, NC, USA), Release 9.4. All the statistical tests were two-sided and p-value of ≤ 0.05 (5%) was considered significant.

**Ethical considerations**

Ethical clearance was received from the Sefako Makgatho Health Sciences University Research and Ethics Committee (SMUREC), SMUREC number SMUREC/P/314/2017: PG,. Permission and approval was also obtained from the General Director of Gauteng Province and National Health Research Database (NHRD) for the CHCs and district hospitals included in the study.
Results

Systematic review

A total number of 31,100 papers were identified on the database. Through the insertion of additional search terms, the number was then refined to 16,200 (Fig 1). Finally, 289 papers remained for review after completing the eligibility evaluation.

Study demographics

A total of 133 paediatric individuals were surveyed, of those, more than half (51.1%) were males. The ages of the patients were classified using the terminology established by the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD). Therefore, the study consisted of the following percentages: infants (32%, $n=43$), toddlers (18%, $n=24$), early childhood (28%, $n=37$) and middle childhood (22%, $n=29$). However, 92.5% medical folders of these patients did not document if the patient was in daycare/school. Only (15%, $n=20$) patients were HIV positive and of those 20 patients 85% were on HAART. The median age of the patients was 23 months (interquartile range (IQR) 7-48 months, range 1-144 month) and the mean age was 35.6 months (standard deviation (SD) 37.76; mode 48). Table 3 depicts the patients demographics.
Table 3: Patient demographics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Number of patients at CHC</th>
<th>Number of patients at district hospitals</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of research participants</td>
<td>91 (68%)</td>
<td>42 (32%)</td>
<td>133</td>
</tr>
<tr>
<td></td>
<td>SD: 36.35</td>
<td>SD: 41.09</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>44</td>
<td>24</td>
<td>68</td>
</tr>
<tr>
<td>Female</td>
<td>38</td>
<td>18</td>
<td>56</td>
</tr>
<tr>
<td>Undocumented</td>
<td>9</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>Patients presenting with diarrhoea</td>
<td>14 (58.3%)</td>
<td>10 (41.7%)</td>
<td>24</td>
</tr>
<tr>
<td>Age (months)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>35.37</td>
<td>36.36</td>
<td>133</td>
</tr>
<tr>
<td>Median</td>
<td>24</td>
<td>16</td>
<td>133</td>
</tr>
<tr>
<td>Infant (birth to 12 months)</td>
<td>32</td>
<td>11</td>
<td>43</td>
</tr>
<tr>
<td>Toddler (13 months to 2 years)</td>
<td>12</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>Early childhood (2-5 years)</td>
<td>27</td>
<td>10</td>
<td>37</td>
</tr>
<tr>
<td>Middle childhood (6-11 years)</td>
<td>20</td>
<td>9</td>
<td>29</td>
</tr>
<tr>
<td>At day-care</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>2 (1.5%)</td>
<td>2 (1.5%)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>3 (2.6%)</td>
<td>3 (2.6%)</td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>86 (64.7%)</td>
<td>37 (27.8%)</td>
<td></td>
</tr>
<tr>
<td>HIV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>12 (9.0%)</td>
<td>8 (6.0%)</td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>25 (18.8%)</td>
<td>18 (13.5%)</td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>54 (40.6%)</td>
<td>16 (12.0%)</td>
<td></td>
</tr>
<tr>
<td>Is the patient on HAART (n=20)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>10 (50%)</td>
<td>7 (35%)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>2 (10%)</td>
<td>1 (5%)</td>
<td></td>
</tr>
</tbody>
</table>

Prevalence of paediatric diarrhoea

Diarrhoea prevalence among paediatric patients under the age of 12 at the health facilities surveyed was based on the information written in the medical folders of these patients. Prevalence was slightly higher in girls (58.3%; 14). In addition, the prevalence of diarrhoea was greatest in early childhood. Diarrhoea prevalence stratified by age group and district, is indicated in Figure 3, whereby, the highest prevalence was seen among early-childhood in Tshwane district. However, the highest prevalence amongst infants (<12 months) was seen in Tshwane and West rand districts. This could be due to the fact that only one CHC was surveyed in Sedibeng district.
Abbreviations used: NICHD= ages were categorised according to paediatric terminology developed by the Eunice Kennedy Shriver National Institute of Child Health and Human

**Figure 3: Diarrhoea prevalence among paediatrics under 12 years by age and district in Gauteng, South Africa, 2018**

**The aetiology and diagnosis of paediatric diarrhoea**

A large number (75%; 21) of the 24 patients presenting with diarrhea, had it documented as their primary diagnosis. Of these, the majority (87.5%; 18) presented with watery diarrhoea, (4.2%, 1) presented with dysentery and (8.3%; 2) was undocumented. Figure 4 depicts the percentage distribution of paediatric patients by duration of diarrhoea (days) and also indicates that none of the patients presented with persistent diarrhoea.
Compliance to the diagnostic criteria for paediatric diarrhoea

The diagnostic criteria used in the public health care facilities was adopted from the WHO IMCI guidelines. Out of ten study sites, only seven study sites had paediatric patients with diarrhoea. The overall compliance to all the seven components of the diagnostic criteria (fever, dehydration, diarrhoea duration (days), number of stool in the previous 24 hours, vomiting, urine volume and stool consistency) was achieved in just over half (56.07%) of the seven study sites where paediatric diarrhoea was diagnosed (Table 4). The only study site that was compliant to all the diagnostic criteria was district hospital 2. In addition, every patient was assessed for dehydration, fever, vomiting and fever at all the study sites.
Table 4: Overall compliance to the IMCI guidelines of each study site

<table>
<thead>
<tr>
<th>Study sites</th>
<th>Total Overall Percentage compliance to IMCI guidelines (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHC 1</td>
<td>64.29</td>
</tr>
<tr>
<td>CHC 2</td>
<td>85.71</td>
</tr>
<tr>
<td>CHC 3</td>
<td>0.00</td>
</tr>
<tr>
<td>CHC 4</td>
<td>85.71</td>
</tr>
<tr>
<td>CHC 5</td>
<td>0.00</td>
</tr>
<tr>
<td>CHC 6</td>
<td>71.43</td>
</tr>
<tr>
<td>CHC 7</td>
<td>0.00</td>
</tr>
<tr>
<td>District Hospital 1</td>
<td>71.43</td>
</tr>
<tr>
<td>District Hospital 2</td>
<td>82.14</td>
</tr>
<tr>
<td>District Hospital 3</td>
<td>100.00</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>37.87</td>
</tr>
<tr>
<td>Average</td>
<td>56.07</td>
</tr>
</tbody>
</table>

Figure 5 indicates the patient diarrhoeal characteristics that were recorded in the patients’ medical folders. All of the study sites evaluated the patients’ stool consistency by asking if the stool was pasty or watery and it was found that 91.7% of the patients’ stool consistency was watery.

Figure 5: Diarrhoeal characteristics recorded for paediatric patients presenting with diarrhoea
Discussion

In 2016, the South African Demographic Health Survey (DHS) has found that 63% of under-five paediatric patients reported to a health facility with diarrhoea and 8% under five patients died due to diarrhoea (DHS, 2016). The main aim of this study was to describe the aetiology and prevalence of paediatric diarrhoea across public health care facilities in Gauteng province as well as to determine the paediatric diarrhoea diagnostic criteria used in the public health facilities in Gauteng province.

This study has found that 87.5% of the patients presented with watery diarrhoea, which was assumed to be due to rotavirus infections, generally because of the signs paediatric patients presented with, such as subclinical illness or moderate watery diarrhoea of limited period to frequent profuse diarrhoea along with fever and vomiting (Parashar, Nelson & Kang, 2014). In addition, only 4.2% of patients presented with dysentery. Whereby, according to the Global Enteric Multicenter study (GEMS) conducted in developing countries, the most suspected causative agent for this type of diarrhoea could be Shigella species (Kotloff, Nataro, Blackwelder, Nasrin, Farag & Panchalingam et al, 2013).

It is highly recommended that effective antibiotic management should be initiated within 48 hours, due to the fact that Shigella species are associated with moderate-to-severe diarrhoea and high mortality (Williams & Berkley, 2017). In addition, it has been found that the prevalence of paediatric diarrhoea in Gauteng province was 18.04%, which is similar to the results seen in other studies such as Page, Kruger, Seheri, Peenze, Quan, Groome & Madhi (2015) and Mapaseka, Dewar, van der Merwe, Geyer, Tumbo, Zweygarth, Bos, Esona, Steele & Sommerfelt (2010).

The prevalence of paediatric diarrhoea in Gauteng province is low, which could be due to the self-limiting nature of paediatric diarrhoea as well as guardians initiating the individuals with home-made fluid replacement (Granado-Villar, Sautu & Granados, 2012). However, it can be even further decreased by introducing good hygienic programs in these communities and by better interaction between primary health care givers and the mothers, regardless of their education level, thus decreasing the frequency and severity of future episodes.

The identification of paediatric diarrhoea causative agents need to be accurate in diagnosing paediatric diarrhoea. This greatly assist in surveillance programs that are carried out to know which causative agents are most prevalent in which areas, as well as to establish tailored prevention intervention, vaccination strategies and empiric management strategies
Paediatric patients are still dying in Gauteng province due to diarrhoeal disease and one of the reasons could be the significant non-compliance to both IMCI and STGs in diagnosing paediatric diarrhoea. This finding is similar to that of a study by Reddy, Patrick & Stephen (2016).

This study found that the diagnostic criteria of paediatric diarrhoea in public health care facilities was evaluated using the paediatrics STD/EML, as well as the IMCI guidelines established by WHO. Both guidelines stated that the diagnosis of diarrhoea should consist of the assessment of dehydration, severity as well as the presence of blood in stool. In developing countries, there is a shortage in laboratory capacity to diagnose and treat paediatric diarrhoea. This lack of diagnostic capacity significantly limited knowledge associated with the epidemiology and aetiology of diarrhoea in the study sites (Liu, Platts-Mills, Juma, Kabir, Nkeze, Okoi, Operario, Uddin, Ahmed, Alonso, Antonio, Becker, Blackwelder, Beiman, Farugue, Fields, Grantz, Hague & Houpt, 2016).

Limitations

The paper-based system used in the public health facilities to record patient’s medical history is a disadvantage, due to the inadequate storage for all the medical folders, leading to some medical folders getting lost in the process, therefore, compromising data access. The accuracy of data depended on information recorded within the medical records, therefore, any omission of relevant data limited the study analysis process. Since laboratory investigations were not performed, the aetiology of paediatric diarrhoea was concluded using the signs and symptoms of the patient. This study consisted of a limited number of study sites, which means that generalization of results should be done in caution.

Recommendations

The use of mobile applications developed by the health care system can be convenient for evaluating and diagnosing paediatric diarrhoea as well as ensuring uniform diagnostic criteria patterns across all the CHCs. Improved quality surveillance with the use of mobile applications, as well as provision of regular training to health professionals about paediatric diarrhoea diagnosis should be implemented. Guardians/mothers of the paediatric patients should always be counselled about the importance of rotavirus vaccines, good sanitation and hygiene to further decrease the prevalence.
Conclusion

The aim of the study was to describe the aetiology and prevalence of paediatric diarrhoea across public health care facilities in Gauteng province. The aetiology of paediatric diarrhoea was described by the use of signs and symptoms of the patients, which revealed that most of the patients suffered from watery diarrhoea. Whereby, according to previous research, is most likely due to a rotavirus infection. In addition, this study revealed that the prevalence of paediatric diarrhoea is low in Gauteng province. This could also further be decreased by introducing good hygienic programs in these communities and by better education from primary health care professionals to caregivers. Compliance to the IMCI guidelines was not fully met by either the CHCs or district hospitals. Whereby, non-compliance was mainly due to diagnosis inconsistencies that were seen within a facility or across the surveyed study sites. Uniform diagnostic criteria need to be adopted by the public health care facilities to improve the early and correct diagnosis and management of paediatric diarrhoea. This study demonstrated a snapshot of the current situation in Gauteng, however, additional research including study sites in other provinces would allow for a more comprehensive understanding of the aetiology and prevalence of paediatric diarrhoea and the diagnostic criteria used in South Africa.

References


21. Scharf RJ, Deboer MD & Guerrant RL. 2014. Recent advances in understanding the longterm sequelae of childhood infectious diarrhea. Current Infectious Disease
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CHAPTER 5
LIMITATIONS, RECOMMENDATIONS AND CONCLUSIONS

5.1 INTRODUCTION

This chapter consists of limitations and recommendations followed by a conclusion. A summary for the study ends this chapter.

5.2 LIMITATIONS OF THE STUDY

5.2.1 Retrospective aspect

Study site and population: The seven CHCs and the population surveyed in Gauteng province does not provide the complete representation of the diagnostic patterns in the country. Hence, generalisation of results for the population of South Africa cannot be done.

Record keeping: The accuracy of data greatly depended on the information recorded in the medical records. It was found that some of the relevant information such as gender was omitted, which limits the study analysis process. The public health care facilities use a paper-based system to record patient’s medical history. However, most of the study sites did not have adequate storage for all the medical folders, which leads to some medical folders getting lost in the process. In addition, one CHC used a “single sheet of paper” to record the patients’ medical history, which makes it more difficult to store. This was a limitation as we could not access all the medical records of the patients that came for consultation the day prior to the survey.

Laboratory investigations: Laboratory investigations were not performed for all the population. This was a study limitation, as paediatric diarrhoea causative agents were not identified, which led to diagnosis made mainly by signs and symptoms. Therefore, further studies which will take these limitations into consideration, are needed.

5.2.2 Prospective aspect

Study site and population: The three district hospitals' population surveyed in Gauteng province does not provide the complete representation of the diagnostic patterns in the province.
**Study design:** The study consisted of a limited number of study sites, which means that generalization of results should be done with caution. The accuracy of the data furthermore greatly depended on the information recorded in the medical records, which could have been incomplete and limited the study analysis process.

**Laboratory investigations:** Laboratory investigations were not performed for all the population. This was a study limitation, as paediatric diarrhoea causative agents were not identified which led to diagnosis made mainly by signs and symptoms. Therefore, further studies which will take these limitations into consideration, are needed.

### 5.3 RECOMMENDATIONS

The public health care system has developed mobile applications, which can be significant in the process of evaluating and diagnosing paediatric diarrhoea. In addition, these mobile applications are readily available and because of this they can be convenient for the health providers. However, to ensure that the diagnostic criteria patterns are uniform across all the CHCs, improved quality surveillance with the use of mobile applications as well as provision of regular training of health professionals about paediatric diarrhoea diagnosis should be implemented. Furthermore, care givers of the paediatric patients should always be counselled about the importance of rotavirus vaccines, good sanitation and hygiene to further decrease the prevalence. This study demonstrated a snapshot of the current situation in Gauteng, however, additional research including study sites in other provinces would allow for a more comprehensive understanding of the aetiology and prevalence of paediatric diarrhoea and the diagnostic criteria used in South Africa.

### 5.4 CONCLUSION

The aim of the study was to describe the aetiology and prevalence of paediatric diarrhoea across public health care facilities in Gauteng province. The aetiology of paediatric diarrhoea was mainly recorded by the use of signs and symptoms of the patients, which revealed that most of the patients suffered from watery diarrhoea. Whereby, according to previous research, is most likely due to a rotavirus infection, which primarily originates in communities that lack good hygiene and sanitation. In this study laboratory investigations were not conducted for every patient that presented with paediatric diarrhoea due to economic constraints.
This study revealed that the prevalence of paediatric diarrhoea is low in Gauteng province. However, it could further be decreased by introducing good hygienic programs together with education. Paediatric diarrhoea was mostly seen in the early childhood and the diagnostic approach was mainly based on the IMCI guidelines. Compliance to the IMCI guidelines was not met by either the CHCs or district hospitals. Whereby, non-compliance was mainly due to diagnosis inconsistencies that were seen within a facility or across the surveyed study sites. The need for uniform diagnostic criteria to be adopted by the public health care facilities was identified from this study.
REFERENCES


References


References


References


## APPENDICES

**Appendix 1: Community Health Centre or Hospital Data**

### PART 1 – COMMUNITY HEALTH CENTRE or HOSPITAL DATA

Point Prevalence Survey  
*All fields should be completed, no field should be left uncompleted.*

<table>
<thead>
<tr>
<th>Date:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of the Community Health Centre or Hospital:</td>
<td></td>
</tr>
<tr>
<td>Community Health Centre or Hospital Code <em>(Refer to the Hospital Codes/CHC provided in the table below)</em>:</td>
<td></td>
</tr>
<tr>
<td>Level of Healthcare Facility <em>(Choose and circle the correct one)</em></td>
<td>Regional / District / Provincial / CHC</td>
</tr>
<tr>
<td>Full Names of the Data Collector: <em>(Print In capital letters)</em></td>
<td></td>
</tr>
<tr>
<td>Telephone no:</td>
<td></td>
</tr>
<tr>
<td>Cell no:</td>
<td></td>
</tr>
<tr>
<td>Email:</td>
<td></td>
</tr>
<tr>
<td>Hospital/ CHC Name</td>
<td>Hospital/ CHC Code</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Jubilee Hospital [Tshwane District]</td>
<td>TH</td>
</tr>
<tr>
<td>Themba CHC</td>
<td>TC1</td>
</tr>
<tr>
<td>Bertha Gxowa [Ekurhuleni District]</td>
<td>EH</td>
</tr>
<tr>
<td>Jabulane Dumane CHC</td>
<td>EC1</td>
</tr>
<tr>
<td>Ramokonopi CHC</td>
<td>EC2</td>
</tr>
<tr>
<td>Dr. Yusuf Dadoo [West Rand District]</td>
<td>WRH</td>
</tr>
<tr>
<td>Mohlakeng CHC</td>
<td>WRC1</td>
</tr>
<tr>
<td>Bekkersdal CHC</td>
<td>WRC2</td>
</tr>
</tbody>
</table>
Appendix 2: Specific Ward and CHC section data

<table>
<thead>
<tr>
<th>Name of the Hospital</th>
<th>Ward Code/ Speciality</th>
<th>No. of paediatric patients in the ward at 8 am</th>
<th>No. of paediatric patients presenting with diarrhoea</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
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<tr>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
### PART 2 – CHC DATA

**Point Prevalence Survey**

Write the name of the CHC as you state in your hospital. Use the CHC Codes provided on the right side of the sheet. State if the CHC has a particular specialty name as "Burn’s Unit, Coronary Care Unit, Stroke Unit, Spine Unit etc..."

<table>
<thead>
<tr>
<th>Name of the CHC</th>
<th>Section/unit in CHC</th>
<th>Number of pediatric files collected a day prior to the survey</th>
<th>Number of pediatric patients that presented with diarrhea</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

### NAME OF THE WARD / CHC

<table>
<thead>
<tr>
<th>NAME OF THE WARD / CHC</th>
<th>WARD / CHC CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Paediatric Departments</td>
<td></td>
</tr>
<tr>
<td>Paediatric Medical Ward</td>
<td>PMW</td>
</tr>
<tr>
<td>Community Healthcare Centre</td>
<td>CHC</td>
</tr>
</tbody>
</table>
## Appendix 3: Patient data

### PART 1 - PATIENT DATA

#### Point Prevalence Survey

**Section 1** - To be completed for all admitted patients in hospital and patient files from CHC

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital/CHC Code:</td>
<td></td>
</tr>
<tr>
<td>Ward Code:</td>
<td></td>
</tr>
<tr>
<td>Patient Code:</td>
<td></td>
</tr>
<tr>
<td>Admission Date:</td>
<td></td>
</tr>
<tr>
<td>Age:</td>
<td></td>
</tr>
<tr>
<td>Sex:</td>
<td></td>
</tr>
<tr>
<td>Prior Hospitalization:</td>
<td></td>
</tr>
<tr>
<td>Antibiotic use last 90 days?</td>
<td></td>
</tr>
<tr>
<td>Duration of Use:</td>
<td></td>
</tr>
<tr>
<td>HIV:</td>
<td></td>
</tr>
<tr>
<td>Name of last Antibiotics:</td>
<td></td>
</tr>
<tr>
<td>Abbreviate</td>
<td></td>
</tr>
<tr>
<td>CD4 Count:</td>
<td></td>
</tr>
<tr>
<td>On HAART:</td>
<td></td>
</tr>
<tr>
<td>Diarrhoea present now?</td>
<td></td>
</tr>
</tbody>
</table>

*(If you answered “Yes” then fill Section 2 below)*

#### Section 2 - To be completed only for patients presenting with diarrhoea

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of diarrhoea:</td>
<td></td>
</tr>
<tr>
<td>Number of stools for the past 24 hours?</td>
<td></td>
</tr>
<tr>
<td>Stool consistency?</td>
<td></td>
</tr>
<tr>
<td>Blood in stool:</td>
<td></td>
</tr>
<tr>
<td>Vomiting:</td>
<td></td>
</tr>
<tr>
<td>If yes, how many times:</td>
<td></td>
</tr>
<tr>
<td>Fever:</td>
<td></td>
</tr>
<tr>
<td>Dehydrated</td>
<td></td>
</tr>
<tr>
<td>Medication taken in the past 24 hours:</td>
<td></td>
</tr>
<tr>
<td>Any pre-existing disease other than HIV?:</td>
<td></td>
</tr>
<tr>
<td>Urine:</td>
<td></td>
</tr>
<tr>
<td>Day-care/ school:</td>
<td></td>
</tr>
<tr>
<td>If yes, what kind:</td>
<td></td>
</tr>
</tbody>
</table>
### Indication/Diagnosis Code as per site for antimicrobial use (based on ECDC list)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNS</td>
<td>refers to infections of the central nervous system</td>
</tr>
<tr>
<td>EYE</td>
<td>refers to eye infections, e.g. endophthalmitis</td>
</tr>
<tr>
<td>ENT</td>
<td>refers to infections of ear, nose, throat, larynx and mouth</td>
</tr>
<tr>
<td>BRON</td>
<td>Acute bronchitis or exacerbations of chronic bronchitis</td>
</tr>
<tr>
<td>PNEU</td>
<td>Pneumonia</td>
</tr>
<tr>
<td>CVS</td>
<td>Cardiovascular infections: endocarditis, vascular graft</td>
</tr>
<tr>
<td>GI</td>
<td>Gastrointestinal infections (e.g. salmonellosis, antibiotic-associated diarrhoea)</td>
</tr>
<tr>
<td>IA</td>
<td>Intra-abdominal sepsis, including hepatobiliary</td>
</tr>
<tr>
<td>SST</td>
<td>Cellulitis, wound, and deep soft tissue not involving bone</td>
</tr>
<tr>
<td>BJ</td>
<td>Septic arthritis (including prosthetic joint), osteomyelitis</td>
</tr>
<tr>
<td>CYS</td>
<td>Symptomatic lower urinary tract infection, e.g. cystitis</td>
</tr>
<tr>
<td>PYE</td>
<td>Symptomatic upper urinary tract infection, e.g. pyelonephritis</td>
</tr>
<tr>
<td>ASB</td>
<td>Asymptomatic bacteriuria</td>
</tr>
<tr>
<td>OBGY</td>
<td>Obstetric or gynaecological infections, e.g. STDs in women</td>
</tr>
<tr>
<td>GUM</td>
<td>Prostatitis, epididymo-orchitis, and STD in men</td>
</tr>
<tr>
<td>BAC</td>
<td>Laboratory-confirmed bacteraemia</td>
</tr>
<tr>
<td>CSEP</td>
<td>Clinical sepsis (suspected bloodstream infection without lab confirmation/results are not available, no blood cultures collected or negative blood culture), excluding febrile neutropenia</td>
</tr>
<tr>
<td>FN</td>
<td>Febrile neutropenia or other form of manifestation of infection in immunocompromised host, e.g. HIV, chemotherapy, etc., with no clear anatomical site</td>
</tr>
<tr>
<td>SIRS</td>
<td>Systemic inflammatory response with no clear anatomical site</td>
</tr>
<tr>
<td>UND</td>
<td>Completely undefined; site with no systemic inflammation</td>
</tr>
<tr>
<td>NA</td>
<td>Not applicable; for antimicrobial use other than treatment</td>
</tr>
</tbody>
</table>
Appendices

Appendix 4: SMUREC Clearance Certificate

Sefako Makgatho Health Sciences University
Research & Postgraduate Studies Directorate
Sefako Makgatho University Research Ethics Committee
(SMUREC)

Molotlegi Street, Ga-Rankuwa 0208
Tel: (012) 521 5617/3696 | fax: (012) 521 3749
Email: lorato.phiri@smu.ac.za
P.O. Box 163 Medunsa 0204

APPROVAL NOTICE - NEW APPLICATION

02 November 2017
Miss KM Mametja
Department of Pharmacy
P.O Box 218
Medunsa, 0204

MEETING: 09/2017
SMUREC Ethics Reference Number: SMUREC/P/314/2017: PG

The New Application received on 18 October 2017, was reviewed by members of Sefako Makgatho University Research Ethics Committee 02 November 2017 and was approved on 02 November 2017.

Title: Aetiology and prevalence of paediatric diarrhea across public health care facilities in Gauteng Province

Researcher: Miss KM Mametja
Supervisor: Miss L Malan
Co-supervisor: Prof N Schellack
Department: Pharmacy
School: Pharmacy
Degree: M Pharm

Please note the following information about your approved research protocol:

Approval Period: 02 November 2017 – 02 November 2018

Please remember to use your protocol number (SMUREC/P/314/2017: PG) on any documents or correspondence with the REC concerning your research protocol.

Please note that the REC has the prerogative and authority to ask further questions, seek additional information, require further modification, or monitor the conduct of your research and the consent process.

After Ethical Review: Please note a template of the progress report is obtainable in the Research Office and should be submitted to the Committee before the year has expired. The Committee will then consider the continuation of the project for a further year (if necessary). Annually a number of projects may be selected randomly for an external audit. Translation of the consent document in the language applicable to the study participants should be submitted.

International Organisation: (ICRG0008691), Institutional Review Board (IRB000010386) Expiry date: 09 December 2018, Federal Wide Assurance (FWA000025943) Expiry date: 03 March 2021 and NHREC No: REC 210408-003

Sincerely
PROF GA OGLINBANJO
CHAIRPERSON SMUREC

Date: 01/11/2017

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Appendix 5: Tshwane District Clearance Certificate

Gauteng Province
Republic of South Africa

Enquiries: Dr. Robert Oyedipe
Tel: +27 11 451 9036
E-mail: Robert.Oyedipe@gauteng.gov.za

Tshwane Research Committee: Clearance Certificate

Meeting: 07/2017
Project Number: 38/2018
NHCD Reference Number: GP_201802_005

Topic: Appropriate Antimicrobial and Vaccine Use Via Mobile Health and Other Techniques in the Republic of South Africa

Principal Investigator: Professor Natalie Schellack
Professor Marion Bennie

Co-Investigator:
Professor Johanne Meyer
Dr. Adrian Brink
Professor Mark Mendelson
Professor Bryan Godman
Mr. Danie Kruger
Dr. Marilyn Lennon
Dr. Aramj Baker
Dr. Samantha Alvareza-Madrazo
Professor Debra Goff

Facility:
Stanza Bopape CHC
Laudium CHC
Jubilee District Hospital
Soshanguve CHC
Tshwane District Hospital

Name of the Department: Sefako Makgatho Health Sciences University

NB: THIS OFFICE REQUEST A FULL REPORT ON THE OUTCOME OF THE RESEARCH DONE AND NOTE THAT RESUBMISSION OF THE PROTOCOL BY RESEARCHER(S) IS REQUIRED IF THERE IS DEPARTURE FROM THE PROTOCOL PROCEDURES AS APPROVED BY THE COMMITTEE.

Decision of the Committee: APPROVED

Dr. Robert Oyedipe
Acting Chairperson: Tshwane Research Committee
Date: 24/05/18

Mr. Pitsi Mothomone
Chief Director: Tshwane District Health
Date: 20/05/18
Appendix 6: West Rand District Clearance Certificate

Gauteng Province
Republic of South Africa

GP_201802_005
Prof Natalie Schellack

RE: PERMISSION TO CONDUCT RESEARCH IN WEST RAND DISTRICT.

Your correspondence on the above matter refers.
Thank you for your request to conduct research in West Rand District in determining appropriate use of antimicrobials and vaccines.

Permission is hereby granted to you to conduct research in PHC clinics in West Rand. I am anticipating that you will conduct your research with the knowledge of all relevant Managers in respective clinic and Sub-district.

You are expected to share the findings and recommendations with the district in order to improve service delivery to people of west rand.

I hope you find the above in order.

Yours faithfully,

MS PULENG MUSO
DIRECTOR
WRDCA
DATE: 07-02-2018
Appendices

Appendix 7: Ekurhuleni District Clearance Certificate

City of Ekurhuleni

EKURHULENI RESEARCH CLEARANCE CERTIFICATE

Research Project Title: Appropriate Antimicrobial and Vaccine Use via Mobile Health and other Techniques in the Republic of South Africa.

NHRD No: GP_201802_005

Research Project Number: 08/03/2018-08

Name of Researcher(s): Prof Natalie Schellack

Division/institution/Company: Sefako Makgatho Health Science University

DECISION TAKEN BY THE EKURHULENI HEALTH DISTRICT RESEARCH COMMITTEE (EHDRG)

- This document certifies that the above research project has been fully approved by the EHDRG. The researcher(s) may therefore commence with the intended research project.

- Note that the researcher will be expected to present the research findings of the proposed research project at the annual Ekurhuleni Research Conference.

- The research committee wishes the researcher(s) the best of success.

Dr. J. Sefura

Deputy Chairperson: Ekurhuleni Metropolitan Municipality

Dated: 08/03/2018

Dr. S. Tellegen

Chairperson: Gauteng Department of Health (Ekurhuleni Region)

Dated: 08/03/2018
Appendices

Appendix 8: Bertha Gxowa Hospital Clearance Letter

EKURHULENI HEALTH DISTRICT
BERTHA GXOWA HOSPITAL
OFFICE OF THE CHIEF EXECUTIVE OFFICER

Enquiries: Dr. N. Mtshali
Tel no: 010 344 2907
E-mail: Nokwethemba.Hadebe@gauteng.gov.za

28 March 2018

To: All Managers

RE: Research on the Appropriate Antimicrobial and Vaccine Use Via mobile Health and Other Techniques in the Republic of South Africa

Please note that Ms. Natalie Schellack would like to conduct research at Bertha Gxowa Hospital as detailed below.

1. TITLE OF RESEARCH PROJECT

Research on the Appropriate Antimicrobial and Vaccine Use Via mobile Health and Other Techniques in the Republic of South Africa.

2. AIM OF THE STUDY

The overarching aim of this study is to develop sustainable innovations to improve the rational use of AMs and vaccines in SA in order to reduce AMR and its devastating health consequences. AMR is a major threat to the sustainability of the health care system.

3. OBJECTIVES OF THE STUDY

- To describe and quantify how AMs are currently utilised in selected public sector hospitals and PHC centres in SA
- To determine how mHealth techniques can be used to monitor AM utilisation in selected public sector hospitals and PHC centres in SA
- To assess current programmes among public sector hospitals and PHC centres to improve AM prescribing as part of AMSPs and pharmacy and therapeutics committee (PTC) activities
- To develop interventions, including mHealth techniques, to enhance the role and activities of AMSPs and PTGs
- To measure prescriber compliance to STGs for ID in public sector hospitals and PHC centres in SA
- To develop interventions, including mHealth techniques, to monitor and enhance prescribing compliance to STGs
- To determine the utilisation, uptake and timeliness of vaccines (EPI and seasonal influenza) in selected public and private sector facilities across SA, as part of an AMS strategy to reduce AMR
- To develop interventions, including mHealth techniques, that can be used to enhance the appropriate use of vaccines in selected public and private sector facilities across SA

Private Bag x 1035, Germiston 1400 – C/O Angus and Joubert Street – Germiston 1400
All findings and recommendations based on the study should be discussed with the Chief Executive Officer in order to maintain confidentiality in the Hospital.

Approved by

DR N.N. MTSHALI-HADEBE
CHIEF EXECUTIVE OFFICER
BERTHA-OKOWA HOSPITAL
DATE: 23/09/2016
Appendices

Appendix 9: Jubilee Hospital Clearance Certificate

Annexure 1

Declaration of intent from the clinic manager or hospital CEO

I give preliminary permission to Miss K M Masega (name of researcher) to do his or her research on [research topic] in [name of clinic] or [name of CHC] or Jubilee District [name of hospital].

I know that the final approval will be from the Tshwane/Metsweding Regional Research Ethics Committee and that this is only to indicate that the clinic/hospital is willing to assist.

[Approval is given with an understanding that results will be shared with the hospital management.]

[Signature]

[Date]
Appendices

Appendix 10: Dr Yusuf Dadoo Hospital Clearance Certificate

Annexure 1

Declaration of intent from the clinic manager or hospital CEO

I give preliminary permission (name of researcher) to do his or her

Aetiology and prevalence of preterm birth at
dr. yusuf dadoo hospital (research topic) in
gauteng province

(name of clinic) or

(name of CHC) or

D. Yusuf Dadoo Hospital (name of hospital).

I know that the final approval will be from the Tshwane Regional Research Ethics Committee and that
this is only to indicate that the clinic/hospital is willing to assist.

Other comments or conditions prescribed by the clinic or CHC manager or hospital CEO:

[Signature]
Clinic Manager/CHC Manager/CEO

2019/04/23
Date
Appendices

Appendix 11: Sedibeng District Clearance Certificate

TO: PROF. N. SCHELLACK
SEFAKO MAKGATHO UNIVERSITY

FROM: MS. S. HLHAHANE
DIRECTOR SEDIBENG DHS

DATE: 25 APRIL 2018

SUBJECT: PERMISSION TO CONDUCT RESEARCH – APPROPRIATE ANTIMICROBIAL AND VACCINE USE VIA mobile HEALTH AND OTHER TECHNIQUES IN THE REPUBLIC OF SOUTH AFRICA.

Please be informed that permission has been granted for you to carry out the abovementioned research at Boipatong CHC. It is noted that you have already obtained Provincial Ethics Committee as well as the Sefako Makgatho University Research Ethics Clearance.

Kindly note that a copy of the report on the findings (especially) that concerns Sedibeng District must be submitted to the Director’s office at the completion of the study.

This permission is also subject to the conditions stated in the protocol and any change in design and methodology must be communicated to the District Director.

We wish you success in your research endeavours.

MS. S. HLHAHANE
DIRECTOR SEDIBENG DHS
DATE: 25/04/2018

RESEARCH PROPOSAL DETAILS: GP_201802_005

Sedibeng DHS, Cnr Frikkie Meyer & Pasteur BLVD, Private Bag X 023 Vanderbijlpark