UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

The attitudes, perceptions and practices of nurses in Primary Health Care (PHC) clinics within the City of Johannesburg District in the management of antibiotic resistance.

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A dissertation submitted to the Faculty of Health Science, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Master of Pharmacy.

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Declaration

I, Hamna Hasan, declare that this dissertation is my own, unaided work and has not been submitted before for any degree or examination at any other University. All sources that I have used or quoted have been indicated and acknowledged by complete references. This dissertation is being submitted for the Degree of Masters in Pharmacy at the University of the Witwatersrand, Johannesburg.

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Hamna Hasan

10th February 2021 in Johannesburg

Ethics declaration

I, Hamna Hasan, declare that I am registered with the University of the Witwatersrand for the degree in Master of Pharmacy and have read the University's current research ethics guidelines. I accept responsibility for the conduct of the procedures in accordance with the Human Research Ethics Committee (HREC). I have obtained ethical approval from HREC (Appendix L, M190410) to conduct my research as well as approval from the National Department of Health (Appendix M).

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List of abbreviations

AIDS:	Acquired Immune Deficiency Syndrome
CDC:	Centers for Disease Control and Prevention
CHC:	Community Health Centre
CoJ:	City of Johannesburg
CPE:	Carbapenemase-producing enterobacteriaceae
CRP:	C-Reactive protein
Dr.:	Doctor
EDL:	Essential Drug List
FDA:	The Food and Drug Administration
FIDSSA:	Federation of Infectious Diseases Societies of Southern Africa
GARP-SA:	Global Antibiotic Resistance Partnership-South Africa
HREC:	Medical Human Research Ethics Committee
IMCI:	Integrated Management of Childhood Illness
IPC:	Infection Prevention and Control
MCQs:	Multiple-Choice Questions
MIMS:	Monthly Index of Medical Specialities
MRSA:	Methicillin resistant *Staphylococcus aureus*
NDoH:	National Department of Health
%:	Percentage
P:	Participant
PCDT:	Primary Care Drug Therapy
PHC:	Primary Health Care
PHSDSBC:	Public Health and Social Development Sectoral Bargaining Council
PV:	Per Vaginal
QID:	Every 6 hours or 4 times a day
R:	Researcher
REDCap:	Research Electronic Data Capture
SAASP:	South African Antibiotic Stewardship Programme
SAHPRA:	South African Health Products Regulatory Authority
SAMF:	South African Medicines Formulary
STG:	Standard Treatment Guidelines
TB:	Tuberculosis
TDS:	Every 8 hours or 3 times a day

VRE: Vancomycin-resistant enterococci

WHO: World Health Organisation

Abstract

Worldwide, more than 70.00% of micro-organisms are becoming resistant to antibiotics with these numbers increasing annually. The majority of antibiotics are prescribed in Primary Health Care (PHC) clinics and in South Africa most of the population utilises these healthcare clinics. Despite this, there are a limited number of studies done on antibiotic prescribing patterns at the PHC clinics in South Africa.

Aim: This study aims to establish the attitudes, perceptions and practices of nurses in PHC clinics in the management of antibiotic resistance.

Method: This mixed method research study was done by quantitively conducting a survey with 11 prescribing nurses at the PHC clinics, quantitatively reviewing 396 antibiotic prescriptions dispensed in the retrospective three-month study period at seven PHC clinics within the City of Johannesburg and by qualitatively interviewing eight PHC trained prescribing nurses regarding their prescribing practices. Outcomes of the study were reported to each study site education committee for the purposes of review.

Results: The results obtained from the surveys demonstrated that 81.82% of participants agreed that antibiotics are overused in South Africa. Majority (90.91%) of the PHC trained nurse prescribers based their decisions on the PHC antibiogram in patients that have no bacterial culture information while 100.00% of participants based their decision on the PHC STG. Antibiotic stewardship programmes and guidelines are useful for 90.91% of participants with regards to their education on antibiotics.

Across all seven PHC clinics, the diagnosis was not stated in 19.95% of the antibiotic prescriptions while 77.78% of prescriptions had one antibiotic prescribed, 42.17% of antibiotic prescriptions were incomplete while 54.29% of prescriptions had an incorrect drug prescribed and 52.53% of prescriptions were incorrect according to the PHC Standard Treatment Guidelines (STGs). While conducting the interviews it was determined that factors that contribute to resistance are patient related factors such as patients buying antibiotics over-the-counter, patient education, sharing medication and patient compliance as well prescriber related factors such as incorrect prescribing.

Conclusion: Antibiotic related errors such as incomplete prescriptions and incorrect drugs are very common at PHC clinics and these errors contribute to antibiotic resistance. There is an urgent need to improve antibiotic prescribing practices by educating both the PHC prescribing nurses and patients as well as providing resources to the PHC clinics in order to decrease prescribing errors thereby decreasing antibiotic resistance.

Chapter 1: Introduction and literature review
Antibiotic prescribing in South African Primary Healthcare (PHC) clinics.

This literature review was conducted to analyse previous research and to place the research problem in context in order to determine the extent of the antibiotic resistance problem particularly in South African primary healthcare (PHC) clinics. This chapter explored literature from different perspectives and provides a brief outline on antibiotic resistance, guidelines, antibiotic stewardship programmes in South Africa, the PHC system in South Africa, PHC nurse training and antibiotic prescribing patterns at these clinics as well as PHC prescribers attitudes and perceptions towards antibiotic resistance.

1.1 Research Context

Since the discovery of antibiotics in the 1940's, antibiotics have been known to be a "wonder drug" that has revolutionized medicine (Zaman et al., 2017; Chetty et al., 2019). Antibiotics are drugs that are mainly used in the treatment of infections and are a large group of chemical substances such as penicillin which have the ability to inhibit the growth of bacteria or destroy bacteria and are produced by one of two ways: either derived from a micro-organism or similar substance or synthesized by chemical reactions (Kourkouta et al., 2017). They are either bactericidal (kill bacteria) or bacteriostatic (prevents bacterial growth) in low concentrations. They are thus used in the prevention and treatment of a variety of infections. Many infections such as tuberculosis (TB), gonorrhoea and leprosy have been rendered less severe in light of advancements in antibiotic treatments. Antibiotics have also been used for complex medical and surgical procedures such as chemotherapy (NDoH, 2015; Kourkouta et al., 2017). Antibiotics have also assisted in extending life expectancy by altering the outcome of bacterial infections (Ventola, 2015). Current infections necessitate the use of antibiotics which has led to the disturbing reality of antibiotic resistance.

Bacterial resistance to antibiotic agents is continuously rising worldwide, particularly in low to middle income countries such as South Africa (Ayukekbong et al., 2017). Both the United States Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO) have labelled antibiotic resistance a "grave threat to humankind" (Bartlett, 2011).

Antibiotic resistance is the ability of bacteria to survive antibiotic treatment and is gradually increasing all over the world by modern travel of goods, people and animals (CDC, 2012; CDC, 2013; NDoH, 2015). The cause of resistance is a simple process which has two main components: the antibiotic drug which is used to inhibit growth of micro-organisms; and the genetic resistance determinant in micro-organisms selected by the antibiotic drug. Drug resistance will only emerge when the two components of the process come together in an environment, or a host and can then present as a clinical problem (Levy, 1994). The selective resistance genes together with their hosts, will spread and multiply under continued antibiotic selection to amplify and extend the problem to other hosts and other geographic locations (Levy and Marshall, 2004). Resistance is also a phenomenon that occurs over time, as the natural evolution of living organisms will continue developing tolerance to the antibiotic (Davies and Davies, 2010). Incorrect prescribing of antibiotics such as prescribing a low dose of antibiotic for a short period of time, incorrect diagnosis, unnecessary antibiotics, monotherapy instead of combination therapy may also create resistance. The first drug resistant strains initially appeared in hospitals, as most antibiotics were being used in these settings, such as the emergence of sulphonamide-resistant *Streptococcus pyogenes* in military hospitals in the 1930's. Very soon after the introduction of penicillin in the 1940's, penicillin-resistant *Staphylococcus aureus* emerged in civilian hospitals in London (Levy and Marshall, 2004).

There is an alarming increase in the rate of resistance of micro-organisms especially *Streptococcus pneumoniae* which is responsible for community acquired infections and one of the leading causes of death, globally (Bisht et al., 2009). Antibiotic usage and resistance patterns differ from one country to another and naturally the countries that consume the highest number of antibiotics have the highest rates of resistance (Sorensen and Monnet, 2000; Bisht et al., 2009). It has been estimated that at least 700 000 people die annually as a result of antibiotic resistance, and this figure is said to rise to an estimated 10 million people a year by 2050 if no action is taken (O'Neill, 2016). More than 70.00% of micro-organisms are resistant to the antibiotics that are currently used for treatment (USFDA, 2016). Some micro-organisms are resistant to all the antibiotics available for treatment, making them a multidrug resistant strain, which can only be treated with toxic drugs that are associated with increased side-effects experienced by the patient. Treatment of these multidrug resistant organisms is costly, precarious and often unsuccessful (Levy and Marshall, 2004). When antibiotic resistance

occurs, the micro-organisms can become resistant to other structurally similar antibiotics in the class (Avorn et al., 2001).

The science of developing new antibiotics is becoming increasingly difficult as micro-organisms are developing resistance to an ever-growing range of treatments and identification of novel targets in micro-organisms is challenging. It is therefore crucial to preserve existing antibiotics (McKellar and Fendrick, 2014; Chetty et al., 2019). Antibiotic resistance also exacerbates the problem of access: as the more expensive second-line treatments become even more unaffordable to the poorest in the population (Gelband and Duse, 2011). The spread of antibiotic resistant bacteria poses a significant threat to both morbidity and mortality patterns worldwide. The WHO was therefore requested to create an urgent list of all the antibiotic resistant bacteria in order to aid research and development of effective drugs that will combat the resistant bacteria (Tacconelli et al., 2018). To avoid acceleration towards a 'post-antibiotic era', the urgency of intervention cannot be overstated (Chetty et al., 2019).

The emergence of antibiotic resistance resulted in the development of antibiotic management teams in order to address this growing epidemic. In the 1990's, the concept of antibiotic stewardship emerged. Antibiotic stewardship means balancing the individuals need for appropriate treatment and the societies sustained need for effective antibiotic therapy and for healthcare professionals to be responsible in controlling access to antibiotics for all that may need them in the future (Dyar et al., 2017). The goal of antibiotic stewardship should be to achieve the best clinical outcome while minimising the toxicity for the patient (Manning et al., 2016). Evidence has indicated that antibiotic stewardship interventions have reduced the duration of therapy and hospital stays without adversely affecting patient outcomes, potentially resulting in a reduction in colonisation and subsequent infection of patients with multidrug resistant bacteria (Chetty et al., 2019). Such interventions can be achieved by establishing a team of multidisciplinary professionals, which includes clinical pharmacists, who will work together to identify, solve and prevent drug related problems (Viktil and Blix, 2008).

Antibiotic stewardship is conducted primarily by educating and encouraging clinicians to rationally prescribe antibiotics by following evidence-based guidelines, thereby ensuring that the correct antibiotic is prescribed using the correct dose, duration of treatment and route of

administration (Manning et al., 2016). Nurse practitioners play an important role in the prescribing of antibiotics in the PHC setting in South Africa and are therefore in the perfect position to combat resistance. For antibiotic stewardship programmes to reach the height of success, these programmes must involve the views, perspectives and active participation of all nurses (Manning et al., 2016). A pharmacist can contribute significantly to antibiotic stewardship programs by performing a variety of activities. These activities may include the provision of clinical advice as well as being involved in the education and training of other healthcare professionals and the public on the correct and safe use of antibiotics. Globally, pharmacists have shown how important it is to have clinical pharmacists as part of the antibiotic stewardship team, due to their significant contribution to evidence-based decision making (Liaskou et al., 2018). There has been a confirmed improvement in the monitoring and controlling of antibiotics when a pharmacist was part of the antibiotic stewardship team (Hallas, 1996; Gurwitz et al., 2000; Lagnaoui et al., 2000; Al-Eidan et al., 2002; Wickens et al., 2013).

1.2 South Africa's role in antibiotic resistance

The increase in the demand of antibiotics has led to less-effective "off- label" uses of antibiotics (Zaman et al., 2017). The ease of availability of antibiotics, as well as how affordable they are, contribute to the burden of resistance in developing countries such as South Africa (Levy and Marshall, 2004). This poses a significant threat to the public healthcare system as common infections are becoming increasingly difficult to treat. Antibiotic resistance control measures are particularly critical for South Africa, which has a high burden of infectious diseases and among the highest rates of antibiotic resistance in the world (Manderson, 2020).

In South Africa, antibiotic resistance trends have been noticed in pathogens such as *Streptococcus pneumoniae, Haemophilus influenzae, Neisseria meningitidis, Escherichia coli* and *Neisseria gonorrhoea* (Gelband and Duse, 2011). A study conducted in South African public hospitals in 2010, reported that over half of all hospital-acquired *S. aureus* isolated from the blood of sick patients were Methicillin resistant *Staphylococcus aureus* (MRSA) strains (Bamford et al., 2011). At both public and private hospitals in South Africa in 2012, there was a large outbreak of Vancomycin-resistant enterococci (VRE) (NDoH, 2016). Carbapenemase-producing enterobacteriaceae (CPE) has emerged in South African healthcare settings and this

poses the greatest level of threat to patient safety in terms of antibiotic resistance as treatment of CPE commonly requires use of an antibiotic named colistin, which is the last line of antibiotic defence. Carbapenemase-producing enterobacteriaceae has now spread throughout South Africa (NDoH, 2016). A concern in South Africa is regarding resistance to treatment for sexually transmitted infections especially *Neisseria gonorrhoeae* as the rates of gonorrhoea in South Africa are among the highest in the world, and these infections are linked with Human Immunodeficiency Virus (HIV), as the presence of gonorrhoea increases the risk of contracting HIV (Gelband and Duse, 2011).

In South Africa, the National Department of Health (NDoH) has recognised the threat of antibiotic resistance to the country. Hence, in an effort to preserve antibiotics for future use they have drafted multiple frameworks to be implemented in South Africa. In 2011, the Global Antibiotic Resistance Partnership-South Africa (GARP-SA) was formed to obtain a current situational analysis regarding antibiotic resistance in South Africa. The National Antimicrobial Resistance Strategy Framework is an all-inclusive approach that is aimed at tackling antibiotic resistance through accountability, roles and responsibilities. The framework focuses mainly on antibiotic resistant bacteria in clinical and healthcare settings (Ekwanzala et al., 2018; Chetty et al., 2019). The three core pillars of this framework are surveillance, Infection Prevention and Control (IPC) and antimicrobial stewardship, which includes stewardship for micro-organisms such as bacteria, viruses and fungi (Chetty et al., 2019). Another initiative is the South African Antibiotic Stewardship Programme (SAASP) which was formed in 2012, under the auspices of the Federation of Infectious Diseases Societies of Southern Africa (FIDSSA). The goal of this programme was to promote the rational prescribing of antibiotics in South Africa. The SAASP consists of a team of multidisciplinary professionals from both the public (healthcare offered by the government to the citizens of South Africa free of charge) and private healthcare sector (healthcare services that are not funded by the government, a fee usually needs to be paid to access private healthcare), some of which include infectious disease physicians, paediatricians, veterinarians, microbiologists, pharmacists, pharmacologists, intensivists, surgeons and epidemiologists. At national level, the SAASP coordinates and advocates antibiotic stewardship teams that are active in both the public and private healthcare sectors (NDoH, 2016). At provincial level in the Western Cape the antibiotic stewardship teams visit each hospital in the province and provide feedback on the observations (NDoH, 2016).

Restricting the choices of antibiotics through the development and use of formularies and guidelines such as the Essential Drug List (EDL) and Standard Treatment Guidelines (STG) also forms part of antibiotic stewardship in the public sector (Essack et al., 2011). The government has developed a PHC EDL and STG which is evidence based and contains important information that aims to assist the prescribers at the PHC clinics and provide standardised care that satisfies the healthcare needs of majority of the population. The EDL contains a list of medication that is intended to always be present at the healthcare facility while the STGs contains diagnostic criteria, practice guidelines and guidelines on how to manage diseases, when to refer patients as well as possible treatment options. The use of the EDL concurrently with the STGs aims to rationalise drug use and therefore following these guidelines at healthcare facilities in South Africa can reduce prescribing errors that could potentially contribute to antibiotic resistance (Gopalakrishnan et al., 2014). In South Africa, there is no single national guideline for antibiotic stewardship, the EDL and STG constitute national guidance documents for using antibiotics at the different healthcare levels, however, the SAASP has developed algorithmic antibiotic treatment guidelines that can be used at district level (NDoH, 2016). About 80.00% of antibiotics are prescribed in PHC clinics, globally (Gasson et al., 2018). Research in South Africa has also shown that majority of the antibiotics are prescribed at PHC facilities (Manderson, 2020). In South Africa presently, there are no formal antibiotic stewardship activities at district level, outside of district hospitals (NDoH, 2016). Antibiotic stewardship should be prioritised at all healthcare levels with no level of healthcare neglected, as the rational use of antibiotics determines the patient's outcome through the hierarchal sequence of the referral pathway (von Pressentin et al., 2019).

1.3 The primary healthcare system in South Africa

The South African healthcare system consists of the public and private healthcare sectors. A major gap exists between the public and private healthcare sector in South Africa and about 80.00% of the population utilises the public healthcare system while the other 20.00% of the population uses the advanced private healthcare system (Expatica, 2020). The public healthcare system is managed by three levels of government which are national, provincial, and local government. All three levels are overseen and managed by the NDoH. The public healthcare sector is further divided into primary, secondary, and tertiary healthcare services provided through various healthcare facilities (Mahlati and Dlamini, 2015). The public sector comprises of a three-tiered hospital system which are tertiary, regional and district hospitals (Chetty et

al., 2019). Both the local and provincial PHC and Community Health Centre (CHC) clinics provide PHC services. The foundation of South African healthcare delivery in the public sector is through the PHC clinics which are managed either by the local or provincial health authorities (Webb et al., 2019). South Africa has a population of approximately 56 million people, of which it has been estimated that 63.70% of the population makes use of a PHC clinic (Businesstech, 2018). The PHC clinics which provide free services tend to be the most overburdened amongst all the healthcare facilities, therefore many individuals will avoid these clinics if they can afford to visit a private PHC facility (Maillacheruvu and McDuff, 2014). The concept of PHC originated from the WHO and is defined as essential healthcare that is made available to the whole population. In South Africa, PHC clinics aim to provide preventive, curative and rehabilitative treatment to all citizens of the country and are often the first point of contact that patients have with a healthcare professional (WHO, 2019). The PHC clinics are small and the services offered are limited to immunizations, family planning, caring for the sick and screening tests. When a patient falls ill, they first approach the local PHC clinic for assistance. If the condition is serious and cannot be managed by the PHC clinic, the patient will be referred to a CHC or a tertiary hospital as the South African public healthcare follows a hierarchal referral system and access to secondary and tertiary healthcare services is gained through referral from primary level only; this does not apply to emergency cases (Mji et al., 2017).

In private PHC clinics across South Africa doctors prescribe antibiotics. The settings and staff at PHC clinics vary across the world. In many African counties such as South Africa a multidisciplinary team consisting of nurses, full-time doctors, pharmacists and allied health workers are found in CHC clinics which are commonly situated in larger metropolitan areas or rural towns and not in PHC clinics (Bresick et al., 2019). The PHC clinics in South Africa often have a paper-based patient record system and are nurse-driven clinics with doctors doing part-time sessional work for about four to eight hours a week (Webb et al., 2019). Therefore, it is no surprise that in South Africa, 64.70% of the population in public PHC clinics are seen by nurses (Gasson et al., 2018).

1.4 PHC nurse prescribing and training

The National Drug Policy states prescribing of medication above schedule two by nurses shall only be done in accordance with the provisions of the Medicines and Related Substances Act 101 of 1965, to ensure that all health professionals who are involved in diagnosing, prescribing and dispensing of medication are appropriately qualified. Section 22(A) of the Medicine and Related Substances Act (Act 101 of 1965) states "…Any schedule 2, schedule 3, schedule 4, schedule 5 or schedule 6 substance shall not be sold by any person other than...a nurse or a medical practitioner or dentist, who may prescribe only the scheduled substances identified in the schedule for that purpose; compound and dispense the scheduled substances referred to in subparagraph (i) only if he or she is the holder of a license contemplated in section 22C (1) (a). Notwithstanding anything to the contrary contained in this section, no nurse or a person registered under the Health Professions Act, 1974, other than a medical practitioner or dentist, may prescribe a medicine or scheduled substance unless he or she has been authorized to do so by his or her professional council concerned"(MRSA, 1965; Gray, 2014).

In 1997, the Department of Health in association with the South African Nursing Council and other key role players developed some guidelines to assist the individuals responsible for authorization which include the following: The nurse should meet the legal requirements for service "(a) meet all the legal requirements of section 38A of the Nursing Act (No 50 of 1978, as amended)" which states that they should be registered with the South African Nursing Council, be practicing or providing PHC in the service of the Department of Health and in addition to the above they must have successfully completed a course approved by the South African Nursing Council which will enable them to be familiar and meet the following objectives: "Primary Health Care Nursing, Clinical Nursing Science, Health Assessment, Treatment and Care as well as knowledge and competency in: pharmacology, drug-drug relationships, drug-patient relationships, disease profile in a geographical area, signs and symptoms related to the most prevalent conditions in the country, assessment, drug legislation and prescribing." If the nurse complies with all of the above requirements "The authorizing officer shall: (a) issue the authorization to a specific person for a specific place; (b) limit the authorization to a period of two years from date of granting. Currently authorization to prescribe is granted by the Director General of Health (usually the delegate at local level or the medical officer of health at the local authority)" (Geyer, 1998). The nurses that are in the service of the national, provincial, municipal department or perform any health services for

these departments who have received authority from the department may perform, diagnose patients and keep, administer or and/or prescribe medications under the prescribed conditions (SANC, 2005). Resolution 3 of Public Health and Social Development Sectoral Bargaining Council (PHSDSBC) of 2007 indicates that for nurses to be appointed in the PHC stream the R.48 qualification is the mandatory post-basic qualification; however, this is not clearly stated in the occupational specific dispensation (fshealth, 2007). The R.48 license which is a diploma in Clinical Nursing Science, Health Assessment, Treatment and Care and is currently known as the R.48 qualification. The R.48 qualification is specifically designed for nurses working in the PHC setting. This course spans for a period of one year and these nurses become familiar with assessing, diagnosis and treating patients that visit the PHC clinics as well as familiar with the PHC EDL and STG (Sooruth et al., 2015).

There has been an enabling environment due to staff shortages at the PHC clinics and in an attempt to ease the burden created as there is no clear definition of what needs to be performed by which health cadres and this has become a barrier in the training of PHC clinic staff. This can be demonstrated by the National Drug Policy which states that at PHC level prescribing will be based on competency of the nurse instead of the occupation of the nurse (Gray, 2014). The nurses in the PHC service do require specialist training in diagnosis, treatment and care and is essential in provision of patient health management (Uys and Klopper, 2013). It is extremely important that operational managers at PHC clinics ensure that all the professional health nurses and Primary Care Drug Therapy (PCDT) pharmacists who diagnose and prescribe medication are authorized prescribers and if so prescribe within their relevant scope of practice or have valid permits which allow them to acquire, possess, use or supply any specified scheduled medicine (fshealth, 2005).

1.5 Antibiotic prescribing at PHC clinics

Inappropriate prescribing behaviours have been implicated as a major contributor to antibiotic resistance worldwide, while the rational and sparing use of antibiotics may hinder the emergence of antibiotic resistant bacteria and perhaps enable a return of susceptible strains (Farley et al., 2018). Studies conducted at PHC clinics in South Africa show high rates of antibiotic prescribing. A study which investigated unnecessary antibiotic prescribing at PHC clinics found that 78.00% of patients that were sent to a public PHC clinic received an antibiotic

while 67.00% of patients sent to a private general practitioner received an antibiotic even though antibiotics were not clinically indicated for these patients (Blaauw and Lagarde, 2019). This exposes the vulnerable patient to potential complications without any benefits given to the patient (Lushniak, 2014). Another study at private PHC clinics in South Africa found that 72.72% of patients received an antimicrobial (Katende-Kyenda et al., 2007).

Broad-spectrum antibiotics are used by prescribers in PHC clinics to treat suspected cases of both gram-negative and gram-positive bacterial infections and in some cases, antibiotics are prescribed for patients even though they do not require antibiotics for treatment (Chem et al., 2018). About 80.00% of prescriptions in PHC clinics contain systemic antibiotics and were most frequently prescribed for respiratory tract infections even though these infections are known to be predominately viral infections which do not require antibiotics (Truter, 2015). The implications of antibiotic errors depend on the severity of the error and can include gastrointestinal disturbances, renal or liver failure.

According to the PHC EDL, antibiotics can be used for many conditions such as skin conditions, sexually transmitted infections, respiratory infections, along with many other infections (NDoH, 2018). A study conducted by Costelloe et al. (2010) found that when antibiotics were prescribed to an individual in PHC clinics, resistance was developed mainly in the urinary and respiratory tract which could influence patients for up to 12 months. Thus, it is the responsibility of the healthcare professionals in PHC clinics to balance prescribing and not to make any antibiotic related errors by following the EDL and STG. Pharmacists are well positioned to educate and inform health policies and guidelines relating to the safe and effective use of all medicines. Within the healthcare team responsible for antibiotic management, the pharmacist will be able to determine prescribing errors that can contribute to ongoing resistance.

1.6 Attitudes and perceptions of healthcare providers towards antibiotic resistance

Incorrect antibiotic prescribing has been linked to the attitudes and perceptions of healthcare providers (Adorka et al., 2013). Psychological theories illustrate that prescribers' beliefs in the

consequences of antibiotic resistance and the perceived expectation to receive an antibiotic from the patient all influence the prescriber's decision to prescribe an antibiotic at the end of the consultation (Farley et al., 2018). Many prescribers attribute increasing antibiotic resistance rates to be caused by poor patient compliance to antibiotic treatment and from excessive antibiotic use (McCullough et al., 2015).

In a study conducted by Farley et al. (2018) to determine the knowledge, attitudes and perceptions among primary care prescribers in South Africa; the participants were mostly doctors and the PHC healthcare providers that participated in the study belonged to the private PHC sector. In South Africa, there are no studies conducted to determine the attitudes and perceptions of public PHC workers on antibiotic resistance, however, a study was conducted to determine if future antibiotic prescribers are adequately trained. The results of the study found that only 33.00% of final-year South African medical students felt confident in prescribing antibiotics whilst the majority (95.00%) of them felt they needed more education on the appropriate use of antibiotics (Wasserman et al., 2017). A study conducted in Spain, demonstrated an alarming finding as the majority of the nursing students had a low level of knowledge regarding antibiotic stewardship. The students were aware of this deficiency in training and agreed that the current nursing curriculum should be revised to contain more training on antibiotics and infection control (Rábano-Blanco et al., 2019). A study was conducted in South Africa to determine the knowledge, attitudes and perceptions of final year undergraduate health professional students (doctors, nurses and pharmacists) on antimicrobial resistance. The results of the study depicted that the mean correct knowledge score was significantly lower for nursing students when compared to medical and pharmacy students (Singh, 2016). The attitudes and perceptions of healthcare professionals can be changed by providing them with further education and training regarding antibiotic stewardship.

1.7 Relevance and importance of the research

In many developing countries such as South Africa, sanitation is poor and antibiotics are used to decrease morbidity and mortality associated with food-borne and other poverty-related infections (Rossolini et al., 2014). Poor hand hygiene, sanitation and poor infection control measures contribute to the spread of bacteria both within and outside healthcare facilities. In South Africa, many of the second-and third-line antibiotics are not available, making the

potential of resistance to first line antibiotics considerably greater (Bisht et al., 2009). The limited number of antibiotics is increasingly becoming inadequate for treating infections. The budget for medication is often limited and this prevents access to more effective antibiotics (Ainsa and Levy, 2002). In South Africa, TB is rife and often exists as a co-morbidity with HIV which could lead to the patient being on multiple drugs and lowers immunity which leads to the patient getting sick faster (Bloom and Murray, 1992). Immunocompromised individuals are more susceptible to developing bacterial infections which require antibiotic treatment. A study conducted by Ndihokubwayo et al. (2013) states that challenges related to antibiotic resistance and its magnitude in South Africa and other African countries is hindered by lack of a surveillance system.

Due to the large number of antibiotics prescribed at PHC clinics there is a need to establish protocols on the prescription and administration of antibiotics (Babalola et al., 2011). Despite this, there are a limited number of studies done surveying drug management programs, appropriate antibiotic use, drug prescribing and monitoring programs at these outpatient facilities (Cox et al., 2017). The national health sector's response to antibiotic resistance has not always focused its attention to PHC but often focuses on tertiary hospitals, laboratory detection and surveillance (WHO, 2018). Current antibiotic studies conducted in South Africa focus on antibiotic prescribing and interventions in private tertiary hospitals, private PHC clinics and are conducted in other provinces and settings such as rural areas and focus on the knowledge, attitudes and perceptions of the PHC prescribers which were mainly private PHC doctors (Katende-Kyenda et al., 2007; Brink et al., 2016; Farley et al., 2018; Gasson et al., 2018). This highlights the gap in research and the need for studies to be conducted on antibiotic use in public PHC clinics.

The decreasing efficacy of antibiotics is driven by numerous factors, many of which can be tackled through well-functioning PHC clinics (WHO, 2018). Public PHC clinics in South Africa have limited resources and the number of healthcare providers such as doctors and nurses are disproportionate to the number of patients that utilise these clinics. The WHO estimates that only 30.00% of South African physicians work in PHC clinics despite majority of the population utilising these clinics (Keeton, 2010). According to records from South African public PHC facilities, nearly 500 patients visit a PHC clinic daily (Masango-

Makgobela et al., 2013). Antibiotic stewardship is challenging in general, however, it becomes even more challenging when resources, guidelines, antibiotic susceptibility testing, drugs, policies and formal programs are limited as in the South African PHC clinics (Cox et al., 2017). For many patients, PHC clinics are the first point of contact with a health care professional, which in many instances, is a nurse (Nunu and Munyewende, 2017). Nurses in PHC clinics do demonstrate knowledge regarding antibiotic stewardship, however, they often wish to obtain more education and training concerning the rational use of antibiotics and would value clear antibiotic guidelines in order to improve their prescribing practices (Farley et al., 2018). The PHC EDL, when compared to a hospital EDL, does not have a quick reference appendix dedicated to the rational use of antimicrobials that is in line with stewardship policies. For any intervention to be successfully implemented one requires data on the antibiotic prescribing patterns and associated factors (Chem et al., 2018). In addition to the information being valuable for antibiotic stewardship interventions by conducting research on antibiotic use in PHC clinics, this information is important to inform government decision-making processes with regards to antibiotic stewardship establishments (Chetty et al., 2019).

1.8. Aim and objectives

1.8.1. Aim

This study aims to establish the attitudes, perceptions and practices of nurses in PHC clinics in the management of antibiotic resistance.

1.8.2. Objectives

1.8.2.1. To determine the attitudes, perceptions and practices of nurses towards antibiotic stewardship in various PHC clinics.

1.8.2.2. To establish the antibiotic prescribing practices of nurses in PHC clinics through a retrospective analysis.

1.8.2.3. To explore the circumstances responsible for determining the attitudes and perceptions of prescribing nurses in PHC clinics.

Chapter 2: Research methods

This chapter starts by providing an overview of the research design used for the study. The section that follows highlights and explains the study site, study design including information on instrumentation, population and sampling, study procedure, data analysis, reliability and validity of the study and ethical consideration.

A mixed method research design was used to collect both quantitative (objectives 1 and 2) and qualitative data (objective 3). A mixed method approach was used to collect data and meet the objectives of the study, as mixing quantitative and qualitative data provides a better understanding of data compared to either approach used alone (Creswell and Plano Clark, 2011). The study is divided into two phases, as is depicted in Figure 2.1 which provides an overview of the research design used for the study.

In this study an explanatory sequential design was used. The explanatory design is a mixed methods design in which the researcher begins by collecting the quantitative data (phase 1). Phase 1 included a survey on the attitudes, perceptions and practices of the PHC trained prescribing nurses as well as a cross-sectional retrospective analysis of patient prescriptions to determine the prevalence of antibiotic related errors at the PHC clinics, this data was analysed and followed up on specific results with qualitative data (phase 2). The second phase comprised of qualitative semi-structured interviews which were conducted with the PHC trained prescribing nurses for the purposes of explaining the initial results from phase 1 in-depth. This method allows the researcher to interpret the influence of the qualitative data on the outcomes of the quantitative data.

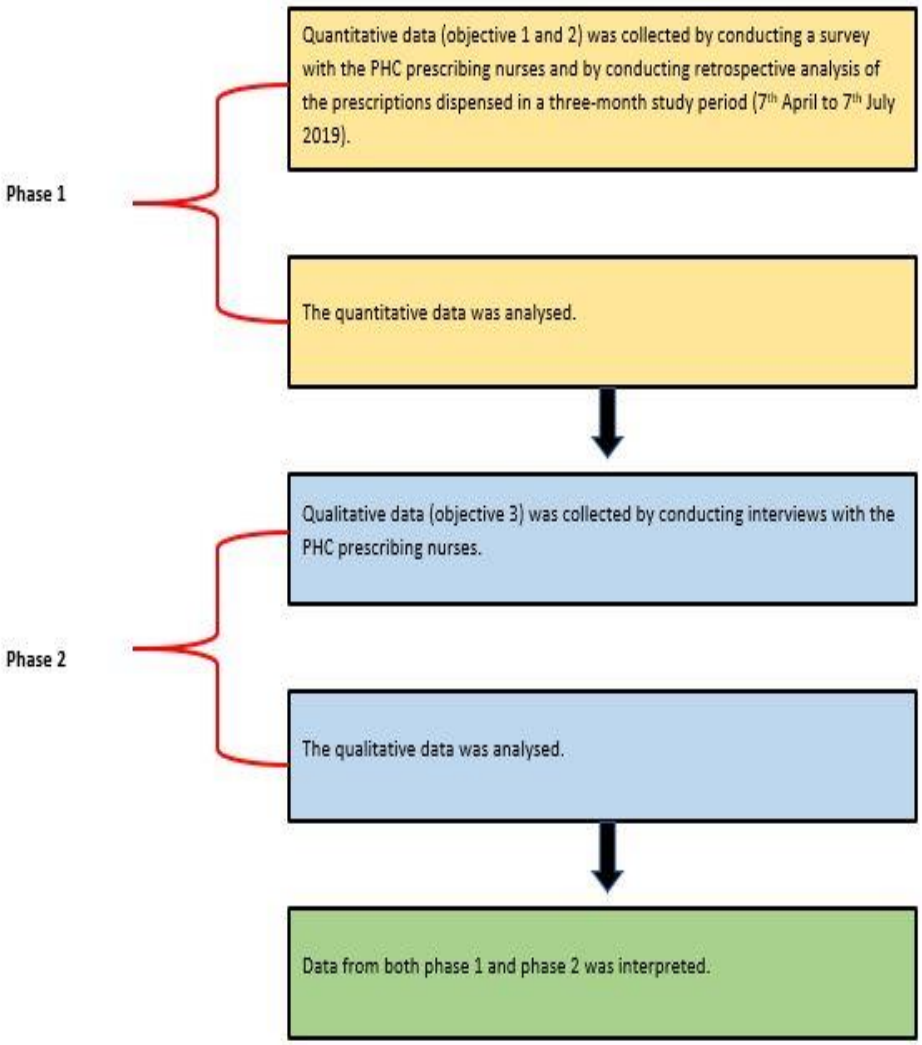


Figure 2.1.Overview of the research design

2.1 Study sites

The study sites selected included local authority PHC clinics from regions (A-G) within the City of Johannesburg district. A map depicting the regions (A-G) within the City of Johannesburg in which a clinic was chosen can be seen in Appendix A. The City of Johannesburg Metropolitan Municipalities clinic list was reviewed online; and each clinic was allocated a number. An Excel random number generator tool was used to randomly select seven different local government clinics as there are seven regions within the City of Johannesburg and therefore one clinic was selected in reach region in order to provide a representative sample of the entire district. Only local authority PHC clinics were included as study sites due to their uniform management in terms of the types of staff employed at the PHC clinics and the way

they are operated. These seven PHC clinics were used as the study sites for phase 1 and phase 2 of the study.

Phase 1: Quantitative data collection

2.2 Objective 1- To determine the attitudes, perceptions and practices of nurses towards antibiotic stewardship in various PHC clinics.

2.2.1 Study design and instrumentation

A cross-sectional quantitative analysis of the attitudes, perceptions and practices of the nurses practicing at the study sites was conducted using a survey. The study tool used to determine the attitude, perceptions and practices of nurses, was adapted from surveys conducted by Abbo et al. (2012) and Farley et al. (2018). Permission was granted by both Abbo et al. (2012) and Farley et al. (2018) via email to use these research tools (Appendix B). In order to determine the attitudes, perceptions and practices of nurses in the management of antibiotic resistance at the selected seven PHC clinics, the survey by Abbo et al. (2012) which was conducted in a hospital was adapted to the South African PHC context with changes made to the following parameters: the study site was an outpatient facility, American reference material such as UpToDate and the Sanford guide was changed to South African reference material available to the PHC nurses, such as the South African Medicines Formulary (SAMF) and PHC EDL and STGs. The surveys by Abbo et al. (2012) and Farley et al. (2018) were designed after discussions with doctors, microbiologists, clinical pharmacists and behavioural scientists; and thereafter were validated for reliability. The survey comprised of 11 sections with about 60 sub-questions in total (Appendix C). Questions one to question five comprised of demographic questions. Questions six to nine were 5-point Likert scale questions of varying themes concerning antibiotic stewardship. The 5-point Likert scale, depending on the question ranged from either strongly agree to strongly disagree, from very useful to never useful and from never to always. Questions six to ten of the survey had sub-questions in order to gain more information to determine the attitudes and perceptions of the nurses in the PHC clinics towards antibiotics. The survey included questions asking the participants about their prescribing to determine which factors influenced their decision to select an antibiotic. Questions relating to the use of educational tools and technology by the nurses when prescribing were included in the survey to determine how accessible these sources are at the PHC clinics. In addition, the survey determined the prescribing nurses' perceptions of antibiotic use, stewardship and

resistance. These questions aimed to determine if the prescribing nurses at the PHC clinics are aware of antibiotic resistance and what they perceive as the main contributors to the problem.

2.2.1.1 Validating the tool

The tool was validated by conducting a pilot study in order to garner reliability and validity of the tool and to determine if the tool could be adapted to the South African healthcare context. Crosby Clinic was randomly selected as the clinic to conduct the pilot study, using an Excel random number generator. This clinic was selected as the pilot site as it is a PHC setting of the necessary inclusion criteria for assessment. At Crosby Clinic there were only two nurses that met the inclusion criteria for the study. Purposive sampling was used for the pilot study and these two nurses participated in the study. The two nurses that participated in the pilot study are of an appropriate sample size as the actual sample size for the study is small. The two PHC trained prescribing nurses did justice to the pilot study by answering all the questions in the survey. Conducting the pilot study also led to the addition of questions in the survey. Questions such as duties performed by the prescribing nurses at the clinics as well as licensing were added to the survey to obtain more information on the prescribing nurses that participated in the study. These changes were approved by the ethics committee before conducting the surveys at the other study sites (Appendix C).

2.2.2 Population and sampling

Population has been defined by Grove et al. (2013) as, "All the elements that meet certain criteria for inclusion in a given universe." The population for this study therefore consisted of all the PHC trained prescribing nurses in all the PHC clinics within the Southern Gauteng region of South Africa. The accessible population therefore were the PHC trained prescribing nurses in Gauteng within the City of Johannesburg district at the seven randomly selected clinics.

2.2.2.1 Inclusion criteria

The PHC trained prescribing nurses employed at the study sites were included in the study. The PHC trained prescribing nurses had to be registered with the South African Nursing Council. The prescribing nurse was to have a minimum of one year of experience within that

setting. This was to ensure that the nurses have sufficient experience and are familiar with the facilities guidelines and practices so as to not skew the data. Retired prescribing PHC trained nurses were also included in the study if they were contractually employed by the Department of Health and met the study criteria. Nurses in the clinics were invited to participate in the study, if they met these requirements.

2.2.2.2 Exclusion criteria

Prescribers such as doctors and prescribing pharmacists were excluded. University students, interns, community service students, as well as non-prescribing nurses, were also excluded from the study.

2.2.2.3 Sample size and sampling method

The non-probability purposive sampling method was used to survey the nurses in order to determine the attitudes and perceptions of the PHC trained prescribing nurses. This method of sampling was chosen as the research question being addressed is specific to the attitudes and perceptions of the PHC trained prescribing nurses. It was determined that 20 nurses met the study criteria who were employed across all seven clinics selected during the study period (September-October 2019). The non-probability purposive sampling method was used to survey the nurses with the aim to include all 20 nurses.

2.2.3 Study procedure

An information session with all the PHC trained prescribing nurses that met the study inclusion criteria at each PHC clinic was conducted, at a pre-arranged date and time that was convenient for the staff at the clinic. At the information session the study was explained to the nurses and they were provided the opportunity to ask questions regarding the study. All the nurses that wished to participate in the study were provided with a study information document (Appendix D). This document included information on the purpose of the study, a description of the study, the benefits, risks of participating in the study, an approximate time required to complete the survey, as well as the approximate time it will take to complete the study. An informed consent form (Appendix E) was also provided to the participant to read, understand and sign if willing to participate in the study. As the participants were ensured that confidentiality and anonymity

would be maintained, the informed consent form did not require any identifying information. The participants were asked if they preferred a paper-based survey or if they wanted to complete the survey online on REDCap (Research Electronic Data Capture) which is a secure web application used for creating and managing online surveys and databases. Each participant's preference was noted down on a list. In order to maintain confidentiality of the participants no identifying information was required on the survey and each participant was allocated with a number e.g. 1, 2, 3 up to 20. Those participants who preferred a paper-based survey were provided with a hard copy of the survey to complete while those participants who preferred to complete the survey online were emailed a link for the survey. The researcher acquired the email addresses of the participants that preferred to complete the survey online at the information session. Once the emails were sent out, the email addresses were blacked out to maintain confidentiality of the participants. Opening the emailed link and completing the survey implied consent to participate in the survey. When the survey was accessed online, the data collected was anonymous due to the REDCap software which allows no disclosure of the participant's identity. There was no need to send out subsequent emails as reminders as the survey was completed on the same day by the nurse who opted to complete the survey online. Completed surveys were submitted and participants were not provided with an opportunity to amend responses or review other participants surveys. If the participants signature was identifiable the signature was blacked out on the hardcopy to maintain participant confidentiality. Online REDCap survey responses were printed out to have as a reference and for data analysis. The results from the survey were stored on a password-protected device. Only the researcher and the supervisors had access to the raw data thereby, maintaining confidentiality and security of data.

2.2.4 Data analysis

The data from REDCap and from the surveys that were completed on a hardcopy was transcribed onto a Microsoft Office Excel spreadsheet for quantitative statistical analysis. The data was entered once onto Microsoft Excel and checked twice on two different occasions to ensure that the data was entered correctly onto Microsoft Excel 2016.

2.2.5 Statistical analysis

Data was analysed by using frequency to calculate percentages. Descriptive statistics included the use of percentages for categorical variables such as demographics, the attitudes and perceptions of the prescribing nurses, educational resources used by the prescribing PHC trained nurses and selection of antibiotics in patients. Categories like the Likert scale were subcategorised into three groups in order to minimise variation of feedback provided from the participants.

Objective 2: To establish the antibiotic prescribing practices of nurses in PHC clinics through a retrospective analysis.

2.3.1 Study design and instrumentation

A retrospective quantitative study of antibiotic prescribing patterns by nurses in PHC clinics was conducted by reviewing the antibiotic prescriptions dispensed over a period of three-months (7^{th} April-7^{th} July 2019). A retrospective prescription review data collection tool (Appendix F) was completed for each prescription reviewed. This tool evaluated the most common prescribing errors that occur according to literature such as drug-drug interactions, incomplete prescriptions, incorrect drug, overdosing, underdosing, incorrect interval and invalid prescriptions (Karthikeyan et al., 2015). The data collection tool required the following information to be captured: the diagnosis made, number of antibiotics prescribed, whether any samples were taken to be cultured and whether any antibiotic susceptibility tests were conducted. In order to determine if the antibiotic was correctly prescribed, other important information such as dosing, route of administration, intervals and the duration of the antibiotic course was also recorded on the data collection tool.

2.3.2 Population and sampling

2.3.2.1 Inclusion criteria

All prescriptions prescribed by a nurse that contained an antibiotic within the study period were included in the study. Topical antibiotics dispensed in the study period were also included as they too can contribute to antibiotic resistance. All patients that received antibiotics were included in the study regardless of age or gender.

2.3.2.2 Exclusion criteria

Prescriptions where antibiotics were being used prophylactically or for TB were excluded from the study. A prescription that did not contain a signature was also excluded from the study as the researcher was unable to determine whether the prescription was written by a doctor or a nurse and this would constitute as an illegal prescription as no one can be held accountable for prescribing the prescription and therefore cannot be used in the study.

2.3.2.3 Sample size and sampling method

The sample size for the study was calculated based on the number of prescriptions per site using the formula in Equation 3.1 (Daniel, 1999).

Equation 3.1: Sample size calculation

$$\boldsymbol{n} = \frac{Z^2 P(1-P)}{d^2}$$

Where n = sample size,

Z = Z statistic for a level of confidence,

P = expected prevalence or proportion (in proportion of one; if 20%, P =0.2), and

d = precision (in proportion of one, if 5%, d = 0.05).

The calculation assumed a 68.70% prevalence that an antibiotic is prescribed (Gasson et al., 2018). Assuming 5.00% precision at a 95.00% confidence interval gave an initial minimum sample size of 330 prescriptions. Attrition has been accounted for at 20.00% which resulted in the final sample size of 396 antibiotic prescriptions.

To sample the antibiotic prescriptions dispensed over three-months, the seven clinics were selected for a review as per section 2.1 study sites until the required sample size at each clinic was reached. A stratified sampling method was used whereby each stratum was defined by the clinic selected; hence, there were seven strata. The sample size in each clinic was disproportionate as some clinics had more prescriptions dispensed than others. At each clinic,

simple random sampling was used to select antibiotic prescriptions using a random generator tool. This ensured antibiotic prescriptions had an equal chance of being selected.

2.3.3 Study procedure

The archives room at the clinics was accessed based on the permission obtained and each patient file was randomly selected to see if an antibiotic was prescribed for the patient in the study period determined by ethical clearance. If an antibiotic was dispensed by a nurse in the three-month study period, the prescription (which is in the patient file) was allocated a number. The prescription numbers that were generated by the random number generator tool were included in the study. As this was a retrospective study, the researcher did not need the patients' permission to access their files. At the PHC clinics both the nurses and the doctors prescribed antibiotics, all prescriptions written by doctors were excluded from the study. For the prescriptions that were included in the study, a random number was provided to the prescription in order to maintain patient confidentiality e.g. the first patient's prescription reviewed at the PHC clinic in region A was patient number A001 while the second prescription reviewed was patient number A002. The alphabet at the beginning of the number indicated the region that the data was collected at. Information such as the patient's symptoms that aided the nurse in the diagnosis, the final diagnosis made, the International Classification of Disease (ICD 10 code), and other information that may be relevant was recorded on the retrospective review data collection sheet. No identifying patient information was recorded on the retrospective review data collection sheet. A representative sample of prescriptions that was recorded on the corresponding retrospective review data collection tool was used to compare prescription interpretation (if there were any errors on the prescription) between the researcher and a subject expert to compare inter-reliability testing using percentage agreement. As the absolute agreement was above the minimum of 75.00% and closer to 90.00%, the researcher did not require any additional training (Hartmann, 1977; Stemler, 2004; Shweta et al., 2015). The subject expert was consulted when the researcher was unsure and required assistance. The same subject expert was consulted by the researcher for all prescriptions that the researcher was uncertain of, as some prescriptions had no diagnosis indicated on them. In order to determine the diagnosis on the prescriptions with no diagnosis which were included in the study, the research expert was consulted and based on the patient symptoms, vital signs, prescriber notes written and in accordance to the indication of the antibiotics prescribed as well as various reference material such as the SAASP guidelines, SAMF and the PHC STG, an effort was

made to determine what the diagnosis was. The data collected on the retrospective review data collection tool was reviewed for any errors and omissions. Each of the antibiotic prescriptions dispensed (recorded on the data collection tool) in the study period was reviewed to determine if the correct antibiotic was chosen, if the correct dose was provided at the correct interval, if the prescription was complete and if there were any drug interactions. The researcher focused on the above problems on the antibiotic prescriptions as the antibiotic stewardship guidelines state that the correct drug must be provided at the correct time, correct dose and the correct duration in order to prevent antibiotic resistance (Dryden et al., 2011). The treatment prescribed was than compared to the recommended treatment in the PHC STG. Various study materials such as the SAASP guidelines and the Monthly Index of Medical Specialities (MIMS) was consulted when required The SAMF was also checked when analysing the prescriptions in order to determine if the antibiotic was prescribed according to its indication in the SAMF before it was classified.

2.3.4 Data analysis

The information from the prescriptions was entered independently on the retrospective review data collection tool and then transcribed onto Microsoft Office Excel Software 2016. The data entered was double checked to ensure that there were no mistakes while entering the data onto Microsoft Excel 2016. The data was then cleaned and was analysed using Stata 14 (StataCorp, USA).

2.3.5 Statistical analysis

In this retrospective study, frequency and percentages were used to summarize the prevalence of an error. The statistical analysis was descriptive. Categorical outcomes some of which included drug-drug interactions, incomplete prescriptions, incorrect drug and overdosing were reported as frequencies and percentages for each clinic included in the study. Analyses were conducted to determine if there were associations between prescriptions and the clinic type or to assess for any significant differences in the prescription proportions between clinics. For these bivariate analyses, the chi-squared test was used. A p value of < 0.05 was considered statistically significant at a 95.00% level of significance.

Phase 2: Qualitative data collection

2.4 Objective 3: To explore the circumstances responsible for determining the attitudes and perceptions of prescribing nurses in PHC clinics.

2.4.1 Study design and instrumentation

An explorative contextual qualitative research design by means of a semi-structured face-to-face interview was utilised in order to expand on the findings obtained in objective 1 and 2. Face-to-face interviews were used in this study as this allows the interviewer to probe for the question. This was used to provide an in-depth understanding of the attitudes, perceptions and prescribing practices of PHC nurses in the management of antibiotic resistance. The interview guide used in the study by Skodvin et al. (2015) was adapted to the South African PHC healthcare context and therefore questions pertaining specifically to hospitals were removed. Permission was granted from the author of the tool to utilise the tool in the South African context (Appendix G). The questions in the interview were semi-structured, opinionated open-ended questions divided according to headings such as demographics, culture, politics, structure and emotions (Appendix H). These headings in the interview were structured and closely corresponded to the questions in the survey in order to gain more depth and insight of the quantitative results obtained from the survey and the retrospective prescription analysis. Additional probing questions were added onto the interview guide after analysing the quantitative results.

2.4.1.1 Pilot study

A pilot study was conducted by an experienced interviewer to determine if the interview guide could be adapted to the South African PHC healthcare context by interviewing two nurses at Crosby Clinic prior to the commencement of the study. Research indicates that this population size of two nurses was suitable to determine if there are any flaws in the design of the interview guide so that they may be modified and corrected before the study (Abdul Majid et al., 2017). These interviews were audio recorded. The researcher was present during the validation of the interview tool and learned the process of conducting an interview as well as how to build a rapport with the participant and ask probing questions. After the interviews were conducted at Crosby Clinic the recorded interviews were played back and each question was analysed to determine if it was understood by the participant or if the questions in the interview guide needed further refinement.

2.4.2 Population and sampling

The method as detailed in study design for objective 1 as per section 2.2.2. Population and sampling. The same population was used for objectives 1 and 3 as they are complimentary, and the results will form a coherent story.

2.4.2.1 Sample size and sampling method

It was determined that there were only 18 nurses that met the study criteria who were employed across all seven clinics selected during the study period that the interviews were conducted in (January-February 2020). The number of nurses that met the inclusion criteria differed for objectives 1 and 3 as the surveys and interviews were conducted in different months, therefore the number of prescribing nurses varied across the clinics. The non-probability purposive sampling method was used to interview the nurses with the aim to include all 18 prescribing nurses.

2.4.3 Study procedure

An information session with all the nurses that met the study inclusion criteria at each PHC clinic was conducted at a pre-arranged date and time at each PHC. At the information session the study was explained to the nurses and they were provided the opportunity to ask questions regarding the study. The nurses that agreed to participate in the interview were provided with a study information document (Appendix I) to read and understand. The participants also had to read, understand and sign the informed consent form (Appendix J) and the participant informed consent form for recording the interview which gave the researcher permission to audio record the interview, if willing to participate in the study (Appendix K).

The face-to-face interviews were conducted by the researcher at a suitable time for the participants at the PHC clinics and averaged 30 minutes in length per interview. The interviews were one-on-one interviews and were conducted in a room that was specifically dedicated to the study at the PHC facility in order to minimise disturbances and ensure privacy. The interviewer first created a rapport with the nurses so that they were more comfortable in giving their opinions and assured participants that confidentiality will be maintained. Confidentiality

was maintained as there was no identifying information recorded during the interview process and all participants were not identifiable as each participant was allocated a unique number e.g. participant A1 was the first participant in region A. The interviews were recorded with two recording devices to overcome any technical challenges that may be experienced during recording. After each interview was conducted, the interview was played back by the researcher so that subsequent interviews could be improved as suggested by van Teijlingen and Hundley (2001). By conducting semi-structured interviews, the interviewer adapted the interview guide by changing the wording of questions, the time spent on each question and the sequence of the questions based on the requirements for the participant in each interview (Robson, 2002). The interviews were then transcribed verbatim onto a word document and the transcribed copies of the qualitative data was stored on a password-protected device. Field notes were taken and reviewed in combination with transcribed interviews. This data was only accessible to the researcher and supervisors.

2.4.4 Data analysis

There are many ways to approach thematic analysis. In this study the Braun and Clarke's six-step framework was applied (Maguire and Delahunt, 2017). This method was chosen for analysis as it provides a step-by-step guideline for thematic analysis. The interview recordings were subjected to an inductive as well as an essentialist thematic analysis wherein the qualitative data was reviewed and themes or patterns were identified, analysed and reported. The Braun and Clarke's six-step framework was applied as follows:

2.4.4.1 Familiarization with the data

The researcher conducted the interviews and transcribed the data verbatim from the recordings of the interviews. The transcriptions were proofread with assistance from the recordings. All the data was read to grasp and have a better understanding of the participants views.

2.4.4.2 Generalizing initial codes

Once it was made sure that the transcripts were accurately transcribed initial codes were developed by identifying keywords and patterns. These codes were noted in a code book from which the themes and subthemes immerged.

2.4.4.3 Search for/review themes

The researcher refined the themes identified by discarding initial themes that were deemed unnecessary as well as combining themes that were related to and could be grouped together. These themes were compared to abstracts of data to explore if the themes worked in relation to the qualitative data collected.

2.4.4.4 Defining and naming themes

The themes and subthemes were defined, in consultation with study supervisors where an agreement on the final themes and subthemes was determined. All themes connected logically and meaningfully in order to tell a coherent story.

2.4.4.5 Producing the report

A report was produced explaining how the findings met the objectives of the study.

2.5 Self-reflexivity

Self-reflexivity is defined as the process of reflecting on oneself as the researcher in order to provide more effective and unbiased analysis of results. The process involves examining and consciously recognising one's own assumptions and preconceptions as the researcher that may shape the research outcome (Wilkie, 2015). Self-reflexivity is a fundamental part of ensuring the qualitative data collected is transparent and trustworthy therefore all qualitative data needs to be supplemented by reflexive notes (Korstjens and Moser, 2018). The researcher conducted the face-to-face interviews with the participants and as a result the researchers own professional background and experiences may have influenced the way the researcher interacted with participants.

In an attempt to minimise bias, a reflective journal was kept in order to maintain research focus by identifying the researchers own biases, preferences and preconceptions. After each interview was conducted, immediate thoughts of the researcher were written down. This allowed raw data to be captured such as the researchers' feelings, attitudes and responses

without it being transferred onto the data. Bias was further minimised by reflecting on the qualitative data interpretation compared to what heard during the audio playback of the interviews and by discussing the research with supervisors who were impartial to the study.

2.6 Reporting of data to study site

Outcomes of the study were reported to each study site education committee for the purposes of review.

2.7 Reliability, validity and bias

The data obtained in objectives 1, 2 and 3 was entered accurately and compared as comprehensively as possible to currently available data found in existing literature so that the data was interpreted as realistically as possible. The reliability and interpretation of the data was also validated by the supervisors to ensure that there was no bias. The tools used in the study were validated by conducting a pilot study at Crosby Clinic to ensure that they were reliable and valid tools that could be adapted to the South African healthcare context.

2.8 Ethical considerations

Permission to review the records such as the prescriptions and patient files was obtained from the District Management and the National Department of Health (Appendix L). The study performed was a retrospective study and therefore the researcher was not required to obtain patient permission to access their files. All information that was gathered both from nurses by conducting surveys and interviews as well as the clinic records were anonymous and kept confidential throughout the study. The interviews were audio recorded and only the researcher, supervisors and ethics committee, if needed may listen to and have access to the recordings. The prescribing nurses signed an informed consent form agreeing to have the interview recorded before participating in the interview. No identifying information was recorded by the researcher for any of the objectives. The protocol was uploaded on the National Department of Health Research database as per the requirements to use public data. The study only commenced once it was ethically approved by the University of the Witwatersrand Medical

Human Research Ethics Committee (HREC) (No. M190410) (Appendix M). The ethics committee also approved all amendments made during the study (Appendix N).

Chapter 3

The attitude, perceptions and practices of nurses in PHC clinics within the City of Johannesburg District in the management of antibiotic resistance

This chapter depicts findings of the results obtained from the quantitative surveys in accordance with the study objectives and provides an in-depth discussion of the results obtained. The section that follows highlights and explains the participant's demographics, their knowledge, perceptions and attitudes towards antibiotics, reasons for prescribing antibiotics that are not necessary, selection of antibiotics in patients with no bacterial culture information and their opinions on educational resources and suggestions.

3.1 Demographics

Fifty-five percent (11/20) of prescribing nurses participated in the survey across all seven clinics. It was ensured that there was at least one participant from each clinic. A breakdown of the number of prescribing nurses that participated in the study from each clinic can be seen in Appendix O. The demographic portion of the survey aimed to identify the gender, education, years since graduating from their area of speciality, and duties of the prescribing nurses. The PHC clinic in region G is a PHC clinic that focuses primarily on mother and child health. At this clinic there were no PHC trained nurse clinicians or prescribing nurses that had the R.48 license. The nurses at this clinic did, however, prescribe antibiotics and were therefore included in the study as ethical clearance permitted the study to include prescribing nurses who do not yet have the R.48 license (Appendix N). Figure 3.1 provides a summary of the participant demographics.

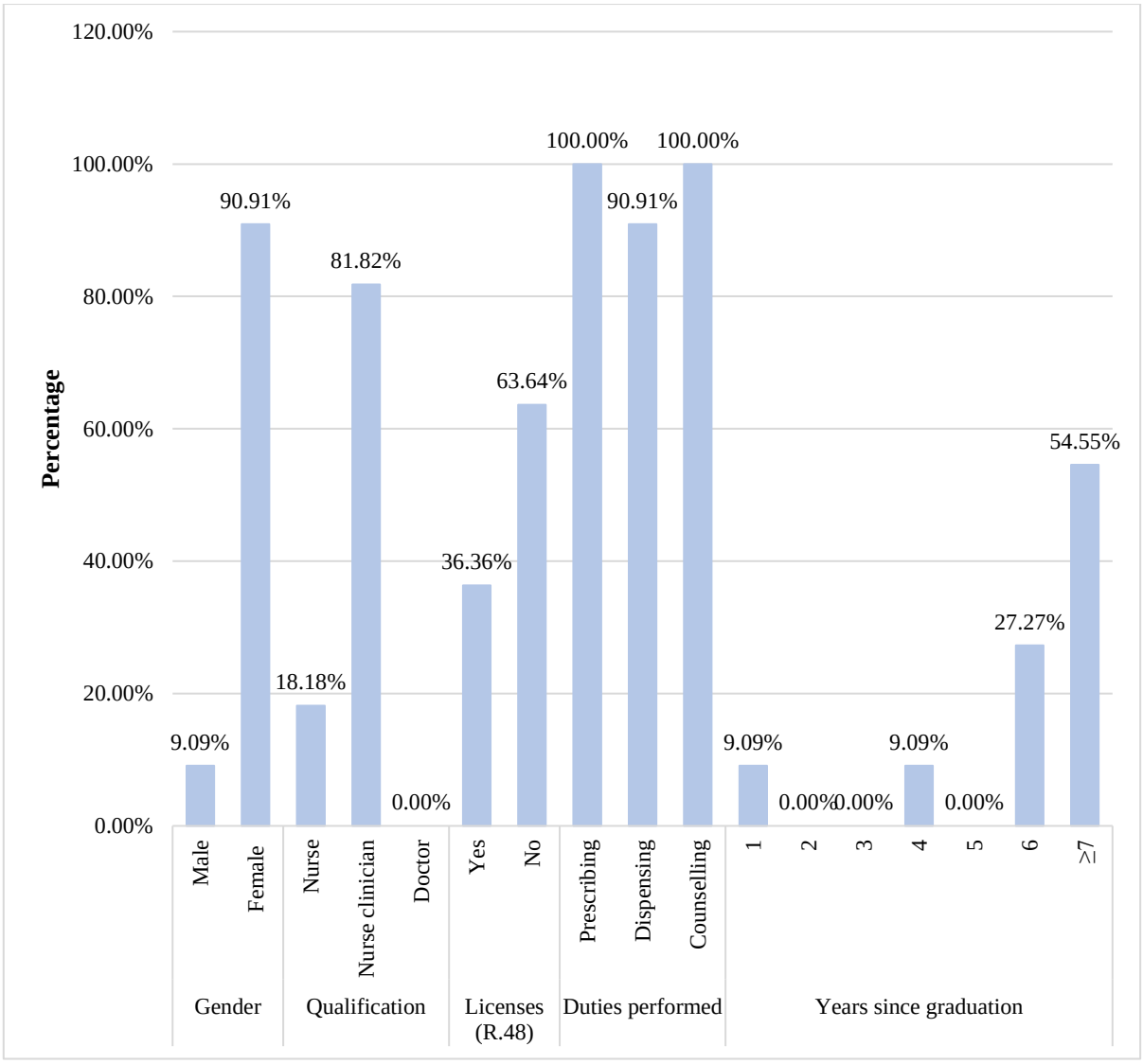


Figure 3.1.Participant demographics

From the survey it was determined that of these 11 prescribing nurses, only 9.09% (n=1) identified as male while the other 90.91% (n=10) identified as female. A study conducted at PHC clinics in South Africa confirms that there are more female nurses (95.80%) as compared to male nurses (4.20%) present at these clinics in South Africa (Sooruth et al., 2015). When looking at the qualification of the prescribing nurses, the participants were asked to choose if they were a nurse, which was explained to the participants as someone who received no PHC training, doctor or a nurse clinician (a nurse that received some sort of PHC training). The results indicated that 81.82% (n=9) of the cohort investigated were nurse clinicians (PHC trained) and 18.18% (n=2) were nurses with no formal PHC training. Only 36.36% (n=4) of nurses had an R.48 license. In a study conducted at PHC clinics in South Africa by Sooruth et al. (2015) it was determined that 59.20% of nurse prescribers had the R.48 qualification. Due

to the large influx of patients utilising PHC clinics as well as the shortage of staff at these PHC clinics in South Africa, professional nurses are employed without having the R.48 qualification. The professional nurses employed receive "on the job' training and learn by gaining experience through orientation and supervision by the professional nurse in charge. A study conducted by Norushe et al. (2004) found that the professional nurses who did receive in-service training at the PHC clinics perceived the training programmes to be inadequate and ineffectively implemented which led to them having decreased job satisfaction. The authors of the study, Norushe et al. (2004) therefore suggested that guidelines to improve in-service training should be implemented. The prescribers all had more than one year of experience in the PHC setting with (n=3) nurses having graduated from their area of speciality six years ago and 54.55% (n=6) of nurses having ≥7 years' experience in the PHC clinic setting. All the nurses surveyed prescribed antibiotics and counselled patients on the use of antibiotics. The dispensing of antibiotics was also predominant with 90.91% (n=10) of nurses providing the prescribed antibiotics to patients as well.

Some of the participants who participated in the survey indicated that they did not have a R.48 qualification but had authorization from the Director General of Health, which allows them to prescribe medication. This letter can be seen in Appendix P. The following statement was received from the Department of Health with regards to prescribing at the PHC clinics, "Section 38A is given to all registered nurses in our facilities to give them permission to diagnose, prescribe and dispense medicines for the conditions listed in the standing orders of the clinic according to the treatment protocols listed below, subject to the limitations imposed by the Regulations to Section 38A of the Nursing Act. Primary Health Care nurses are clinically trained to manage and diagnose. Nonclinical nurses are also trained on adult and child protocol manual and are allowed to manage based on the treatment protocols." This letter indicates that the nurses surveyed in this study were not expected to have an R.48 licence as concessions had been made by the Director General in this matter.

3.2 The knowledge, attitudes and perceptions of prescribing nurses in PHC clinics towards antibiotics used by the PHC system in South Africa

The results of the survey are divided into knowledge, attitude and perceptions of the prescribing nurses at the PHC clinics. The benefits of conducting a survey to determine the knowledge,

attitudes and perceptions of the nurses at the PHC clinics include identifying knowledge gaps, cultural beliefs and behavioural patterns of the nurses at the various PHC clinics. This information may help in identifying the needs, problems and barriers which will assist in future planning. The information obtained from the knowledge, attitude and perception surveys can also help in creating baseline levels and measure changes as a result of the implemented interventions (WHO, 2014). The knowledge, attitudes and perceptions that influences the prescribing nurse's decision to prescribe an antibiotic is summarized as percentages in Table 3.1 and the results are compared to other antibiotic knowledge, attitude and perception studies in the discussion that follows.

Table 3.1.Knowledge, attitudes and perceptions of the prescribing nurses towards antibiotics

		Percentage of nurses Disagree or Strongly Disagree	Percentage of nurses Neutral	Percentage of nurses Agree or Strongly Agree
Knowledge	Antibiotics are overused in South Africa	9.09	9.09	81.82
	Antibiotic resistance is a significant problem in South Africa	0.00	36.36	63.64
	New antibiotics will be in developed in the future that will reduce "resistance"	9.09	72.73	18.18
	Inappropriate use of antibiotics causes antibiotic resistance.	0.00	0.00	100.00
	Patients not finishing their course of antibiotics drives resistance	0.00	0.00	100.00
	Lack of hand disinfection causes the spread of antibiotic resistance	54.55	27.27	18.18
	Inappropriate use of antibiotics can harm patients	0.00	9.09	90.91
	The taking of cultures is important in antibiotic decision making	45.45	0.00	54.55
Perceptions	Antibiotic resistance is not a significant problem at my clinic	36.36	36.36	27.27
	Strong knowledge of antibiotics is important to my healthcare career	0.00	0.00	100.00
	Other nurses overprescribe antibiotics	18.18	36.36	45.45
	Inappropriate use of antibiotics is professionally unethical	0.00	27.27	72.73
	Antibiotic prescribing guidelines and other resources are easily available at my PHC clinic	18.18	9.09	72.73
	Antibiotics are overused in my clinic	36.36	36.36	27.27
Attitude	I am confident that I use antibiotics optimally	9.09	9.09	81.82
	I overprescribe antibiotics	81.82	18.18	0.00
	I would like more feedback on my antibiotic selections	0.00	9.09	90.91
	I would like more information on the appropriate use of antibiotics	0.00	0.00	100.00
	I am less likely to use restricted antibiotics if infectious Disease approval is required	18.18	54.55	27.27
	I feel pressure from patients to prescribe antibiotics	54.55	9.09	36.36
	Interactions with pharmaceutical representatives do not influence my antibiotic selections	45.45	36.36	18.18
	I find prescribing antibiotics difficult	72.73	9.09	18.18
	I give in to patients demand for prescribing antibiotics	90.91	0.00	9.09

3.2.1 The knowledge of prescribing nurses in PHC clinics towards antibiotics used by the PHC system in South Africa

The results obtained from the survey are consistent with the findings of a study done in South Africa by Farley et al. (2018) which studied the knowledge, attitudes and perceptions among primary care prescribers, who were mainly private doctors. All the participants in this study indicated that patients not finishing their course of antibiotics and inappropriate antibiotic use causes resistance compared to 96.00% of participants that agreed that antibiotic resistance is driven by factors such as patient non-adherence in the study by Farley et al. (2018). Another similarity is that 81.80% of prescribers agreed that antibiotics are overused in South Africa while 95.80% of participants agreed to the statement in the study by Farley et al. (2018). Only 18.10% of participants agreed to the statement that new antibiotics will be developed in the future to keep up with the problem of "resistance" even though there is a gap in antibiotic innovation; while 72.70% of the cohort maintained a neutral stance. Most participants disagreed (54.55%) that lack of hand disinfection causes the spread of antibiotic resistance, however, antibiotic resistance can be reduced by implementing interventions such as hand disinfection as the lack of infection prevention and control measures creates an opportunity for resistant bacteria to spread. Better hand hygiene cannot eliminate all infections but because hands contaminated with bacteria cause some infections, practicing better hand hygiene, which is used and implemented broadly in society, would help reduce infections including antibiotic resistant infections (Teska and Gauthier, 2017). There are a few measures that should be implemented to prevent antibiotic resistance such as changing empiric therapy in response to bacterial culture results becoming available, however, 45.40% of prescribers disagreed that the taking of antibiotic bacterial cultures is important in antibiotic decision making while only 54.50% agreed, this demonstrates that the participants require more education on antibiotic resistance (Rábano-Blanco et al., 2019). The nurse prescribers know basic facts on antibiotic resistance such as inappropriate use of antibiotics causes resistance but they require more education on antibiotic resistance and the causes of antibiotic resistance as a minority of participants agreed that there will be more antibiotics developed in the future to keep up with resistance.

3.2.2 The perceptions of prescribing nurses in PHC clinics towards antibiotics used by the PHC system in South Africa

Although most of the participants (63.64%) across all the clinics agreed that antibiotic resistance is a significant problem in South Africa only 27.27% agreed that antibiotics are overused at their clinic. This finding is consistent with the study done in Ethiopia where prescribers were aware of the magnitude of the antibiotic resistance problem globally and nationally, however, only a few participants recognised the problem in their own healthcare facilities (Abera et al., 2014). Some prescribers (45.45%) agreed or strongly agreed that other nurses generally overprescribe antibiotics. Most of the prescribers (72.73%) perceive inappropriate antibiotic use to be unethical. A study by Parsonage et al. (2017) mentions the healthcare professional should either do no harm to the patient; or the least possible harm to reach a beneficial outcome, this should outline the choice between immediate benefit from an antibiotic and the potential lack of therapy available for that patient in the future.

The majority (72.73%) of participants agreed that antibiotic guidelines and other resources are easily available at their clinic while 18.18% disagreed. The prescribers that disagreed that guidelines were easily available at their clinics were both working at the PHC clinic in region D. Efforts should be made to ensure that guidelines and other reference sources are easily available at PHC clinics so not to compromise the quality of care that patients receive due to poor availability of guidelines (Webb et al., 2019).

3.2.3 The attitudes of prescribing nurses in PHC clinics towards antibiotics used by the PHC system in South Africa

Most of the participants (81.82%) were confident that they prescribe antibiotics optimally and 81.82% of participants disagreed that they overprescribe antibiotics. These results are similar to a study by Abbo et al. (2012) where 91.20% of prescribers disagreed that they overprescribe antibiotics. This indicates that the prescribing nurses may be unaware of their own shortcomings and therefore have an overwhelming confidence in their prescribing and feel that the other nurses overprescribe antibiotics (Baadani et al., 2015).

A study has shown that patient expectations or perceived expectation of an antibiotic can influence the prescriber's behaviour (Fletcher-Lartey et al., 2016). In an Australian study almost 40.00% of prescriber's stated they prescribed antibiotics just to meet the patient's expectations. This result is similar to the outcome of this study as 36.36% of nurse prescribers agreed that they felt pressure from patients to prescribe antibiotics, however, most of the participants disagreed (90.91%) to the statement that they give in to patients demands when prescribing antibiotics (Hardy-Holbrook et al., 2013). Prescribers should not give in to patients demands as unnecessary antibiotic use in patients creates resistance which results in patients needing stronger antibiotics; therefore oral antibiotics may become ineffective and the patient will need to switch to intravenous antibiotics or the antibiotic may take longer to work in patients with resistance. There may also come a point where no particular antibiotic will work on the patient (The University of Texas Southwestern Medical Center, 2016).

3.2.3.1 Reasons for prescribing antibiotics that are not necessary

The participants were asked to select reasons as to why they would prescribe antibiotics in patients that they feel do not require antibiotics. The results obtained are reported as percentages in Table 3.2.

Table 3.2.Reasons for prescribing antibiotics that are not necessary

	Percentage of nurses Never or Rarely	**Percentage of nurses Sometimes**	**Percentage of nurses Often or Always**
Antibiotics don't need to be necessary. I just need to think that they may help the patient.	72.73	18.18	9.09
Antibiotics don't harm the patients if they aren't needed	63.64	0.00	36.36
Patients demands and expectation for antibiotics	72.73	0.00	27.27
The patient is ill or immunocompromised	54.55	27.27	18.18
Reassurance when using antibiotics even if it might be the wrong one.	81.82	9.09	9.09
Treat colonisation to prevent infection	45.45	36.36	18.18
Not Applicable – I only prescribe antibiotics when necessary	0.00	9.09	90.91
If other: please specify	None given		

Most of the participants (90.91%) said this question was not applicable to them as they only prescribed antibiotics when they were necessary for the patient. Most (45.45%) participants

disagreed to giving antibiotics in patients who are colonised with bacteria (presence of bacteria in or on the host but not causing any disease in the host such that there is no clinical evidence of infection) to prevent infection; while 36.36% of participants said they sometimes did prescribe it. Overall, the majority of participants never or rarely gave antibiotics just because the patient is ill or immunocompromised (54.55%), if the patient demands and expects an antibiotic (72.73%) or giving antibiotics because of reassurance even if they may be using the wrong one (81.82%).

Although most of the participants stated that this question was not applicable to them as they often or always prescribe antibiotics when necessary they also selected other reasons that they prescribe antibiotics that are not necessary for patients which is contradictory. Only 9.09% of participants indicated that they only prescribe antibiotics when necessary and indicated they never or rarely prescribe antibiotics for the other reasons stated in the question. The results obtained in this study show that 45.45% of prescribers never or rarely prescribe antibiotics if they are not needed to treat colonisation to prevent infection. This result is similar to the study conducted by Abbo et al. (2012) where 44.60% of participants who were also nurses never or rarely prescribed antibiotics to treat colonisation in order to prevent infection. Colonisation of bacteria is a normal process and the bacteria found on areas such as the skin of an individual may sometimes form part of the normal skin flora; although colonisation is not necessarily normal flora. Occasionally, there are bacteria which are not normally regarded as part of the normal flora that can also colonise body areas such as *Pseudomonas aeruginosa*. Even though this bacterium is not part of the normal skin flora, this type of bacteria grows in warm wet conditions of a wound. A study conducted in the United States showed a decrease in the use of antibiotics for prophylaxis and treatment resulted in decreasing rates of colonisation by resistant organisms (Colgan and Powers, 2001).

Although only 36.36% of participants prescribed antibiotics to patients if they are not needed as they believe it does not harm the patient, this was compared to the response in Table 3.1 where 90.91% of the participants felt that inappropriate use of antibiotics always harms patients. In reality, unnecessary use of antibiotics does harm patients as it causes antibiotic resistance and it exposes the patient to the adverse drug reactions that may affect the patient in the future. The majority of the participants never or rarely prescribed antibiotics for patients if

they were not needed even if the patient expects and demands an antibiotic. It is very important for the PHC prescribers to understand why the patient demands an antibiotic. There are several reasons why patients demand and expect antibiotics which include: if they receive an antibiotic it simply validates that they have an illness which can be cured. Patients are also accustomed to receiving antibiotics for minor illnesses which makes them believe that the antibiotics received demonstrated efficacy and are therefore necessary for the illness to be treated (van Hecke et al., 2019). Antibiotics should not be used for viral illnesses even if the patient is ill or immunocompromised such as in the absence of chronic obstructive pulmonary disease, the presence of fever which make the patient appear ill or smoking history which affects the immune system is not an indication for antibiotic therapy (Colgan and Powers, 2001). The prescribing nurses therefore need to be aware on the effects of overprescribing antibiotics in patients and that antibiotics should not be prescribed for patients unless absolutely necessary.

3.2.3.2 Antibiotic prescribing in patients who do not require an antibiotic.

The responses to a question asked is depicted as percentages in Table 3.3.

Table 3.3. Prescribing of antibiotics to patients when they are not needed

Please answer on a scale from always to never Where: Always is ≥90%; Often is > 70%; sometimes is 50%; rarely is <30% and never <10%	**Percentage of nurses Never or Rarely**	**Percentage of nurses Sometimes**	**Percentage of nurses Often or Always**
If a patient expects an antibiotic but you don't think it's absolutely necessary, how often do you prescribe them	90.91	9.09	0.00

The prescribers were asked to select an option based on how often they would prescribe an antibiotic for a patient that expects an antibiotic but they as a prescriber do not think it is absolutely necessary. The majority (90.91%) of participants chose never or rarely as the option while 9.09% said they did this sometimes. This practice of the majority of prescribers never or rarely prescribing antibiotics is correct as prescribers should not prescribe antibiotics unless it is absolutely necessary even if the patient expects an antibiotic as unnecessary prescribing of antibiotics causes resistance.

In Table 3.1 most of the participants disagreed that they felt pressure from patients to prescribe antibiotics, which could be why they do not give antibiotics to patients even if the patient expects an antibiotic. A small percentage of prescribers sometimes prescribed antibiotics even when they are not needed and should be educated not to prescribe antibiotics unless absolutely necessary. Figure 3.2 depicts the participants responses to prescribing antibiotics that are not necessary compared to antibiotics not being needed for the patient, but the patient demands and expects it.

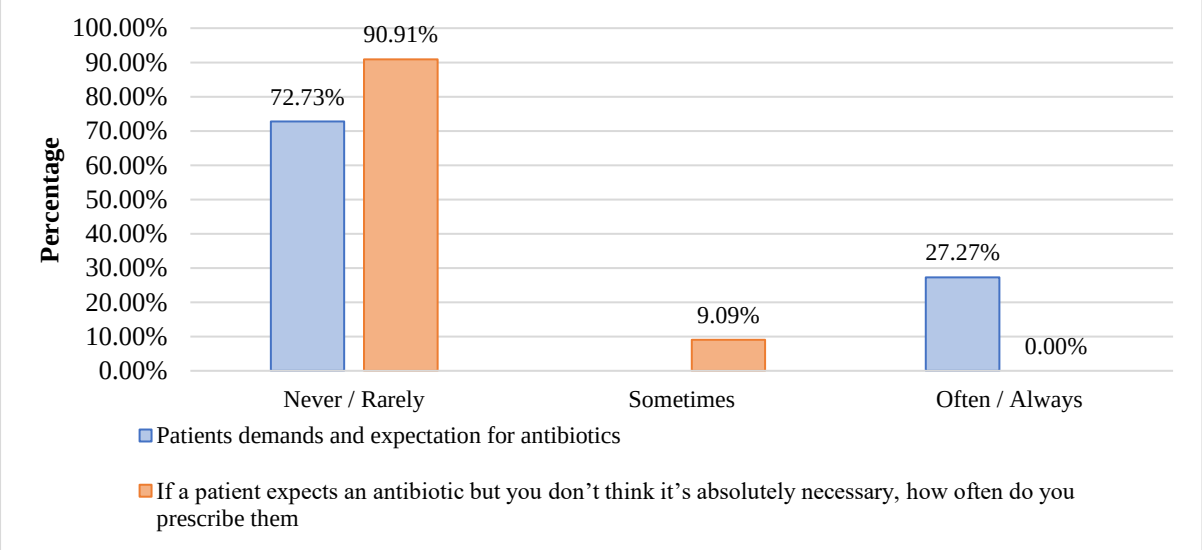


Figure 3.2.Reasons for prescribing antibiotics that are not necessary in patients

The participants indicated that they never or rarely prescribed antibiotics that were not necessary for the patients, however, in patients that demand and expect antibiotics a minority of them often or always prescribed antibiotics as compared to a patient just expecting but not demanding an antibiotic when unnecessary from the prescriber. In the study conducted by Kumar et al. (2003), general practitioners managed their clinical uncertainty by either prescribing or offering to prescribe an antibiotic for the patient. The study by van Hecke et al. (2019) states that patients lose their trust in prescribers that are not confident and knowledgeable in their decisions and keep referring to guidelines. In a study by van Hecke et al. (2019) a few primary care clinicians such as nurses and doctors were confident in managing patient expectations for an antibiotic and they did this by identifying the patients beliefs regarding antibiotics and addressing these beliefs by explaining the potential harms of unnecessary antibiotics to help the patient understand their prescribing decision.

To make nurses more aware of their own shortcomings feedback is important. All the prescribing nurses (100.00%) in the PHC clinics that participated in the survey wanted more information on the appropriate use of antibiotics while most (90.91%) of them wanted feedback on their selections of antibiotics, which demonstrates a positive attitude towards learning. These results are congruent with those of Abbo et al. (2012) where 72.70% of participants wanted more feedback on their antibiotic selections. One of the things that the clinic managers could do and is recommended for them to do as it falls within their responsibilities, is to keep all the staff at the PHC clinics informed and provide feedback. Providing constructive criticism can contribute to growth (Middaugh, 2006).

3.2.3.3 Educational resources that are used by PHC clinic antibiotic prescribers to learn and educate themselves on antibiotics.

The nurses that participated in the study indicated which resources they always find useful to their learning and education on antibiotics and which resources are sometimes, never or rarely useful to them. The results are depicted as percentages in Table 3.4.

Table 3.4.Educational resources that are useful for learning more about antibiotics

	Percentage of nurses Never or Rarely Useful	**Percentage of nurses sometimes**	**Percentage of nurses Often or Always Useful**
Antimicrobial stewardship programmes and guidelines	9.09	0.00	90.91
Antibiotic website	27.27	36.36	36.36
Consultation with colleagues	9.09	45.45	45.45
South African Medicines Formulary (SAMF)	18.18	0.00	81.82
MIMS	18.18	9.09	72.73
Tablet or smartphone apps	45.45	45.45	9.09
Pharmaceutical representatives	63.64	0.00	36.36
Textbooks	0.00	18.18	81.82
Medical journal	27.27	45.45	27.27
PHC Essential Drug List and Standard Treatment Guidelines	0.00	18.18	81.82
Internet website	36.36	27.27	36.36
Please specify internet website:			

The majority of participants (90.91%) indicated that they found antimicrobial stewardship programmes and guidelines often or always useful while 9.09% of the nurses indicated that these resources are rarely or never useful for their learning and education. Additional textbook resources such as the SAMF (81.82%), MIMS (72.73%), the PHC EDL and STGs (81.82%), textbooks (81.82%) were often or always useful for majority of the participants in their learning and education about antibiotics. The SAMF and MIMS are reliable sources of information which are continuously updated and provide information on the different generic names of the medication, the drug-drug interactions, dosage and special prescriber points. The PHC EDL and STGs are not as regularly updated as compared to the other learning resources and may not have all the information for learning when compared to resources such as the SAMF. In the study conducted by Engelbrecht (2010) some nurses indicated that they prefer to use reference books which have diagnostic codes, dosing guidelines, side effects and precautions. One nurse in the study by Engelbrecht (2010) also mentioned that they found the SAMF and the MIMS to be more user friendly.

Antibiotic websites were often or always useful for only 36.36% of the participants. An equal percentage (36.36%) of participants felt that internet websites were often or always useful while 36.36% of participants felt that they were never or rarely useful for their learning and education. Similarly, technological devices such as tablets and smartphones apps were never or rarely useful to 45.45% of the participants while 45.45% found them to be sometimes useful.

The use of internet websites and technology should be encouraged to prescribers as a study done by Fralick et al. (2017) states that an app that had an antibiogram and treatment algorithms helped increase prescriber's knowledge of antimicrobials especially in the context of antibiotic resistance patterns in the area. The findings of the study conducted reinforced the idea that smartphone apps can be beneficial and an innovative means of distributing medical education to prescribers (Fralick et al., 2017). The nurses were also asked if they used internet websites to specify the websites, they would visit to obtain the information on antibiotics. The most common answer by 36.36% of the participants was Google, 9.09% of participants responded to the question by writing searching for journals on Google, 9.09% of participants also used a page called medical information and Multiple-Choice Questions (MCQs) by doctor (Dr.) N.M Noori. A limited number of participants (9.09%) expressed that they do not like technology

while 27.27% of them wrote that they do not use websites or do not use technology and therefore cannot name any websites of value.

Google is the most popular search engine to retrieve information worldwide. The information found on the internet is not regulated it is therefore important for prescribers to carefully and critically evaluate the information found. The efficacy of Google to diagnose an illness correctly was investigated in a study done by Tang and Ng (2006). The study revealed that the correct diagnosis was made in 15 of 26 cases (58.00%; 95.00% confidence interval, 38.00%-77.00%). This encouraging study did not capture if using Google results in unnecessary treatment and the incidence of incorrect diagnosis (Brunetti and Hermes-DeSanti, 2010). Prescribers in PHC clinics should therefore be encouraged to use reliable websites for information. The Food and Drug Administration (FDA), drugdigest, and muschealth websites are recommended as they contain reliable and evidence-based information that prescribers may require on new drugs in the market, prescribing information, adverse drug reactions, as well as drug-drug interactions and other useful information to continue their education and development (Nursing, 2012).

3.2.3.4 Learning from human interactions

In the study done by Abbo et al. (2012) 45.30% of nurse practitioners found pharmaceutical representatives useful. A study conducted in the United Kingdom with student nurses found that 57.00% of the participants felt that pharmaceutical representatives do not always give unbiased information, which is why they may not find the information given by pharmaceutical representatives important to their learning and education on antibiotics (Jutel and Menkes, 2008). In a study conducted in England, a nurse stated the following statement regarding the sources of information used in clinical decision making, “we get a lot from reps, you know, I do read that, but with rather a cautious hat on” (McCaughan et al., 2005). The percentage of prescribing nurses that found pharmaceutical representatives often or always useful was 36.36% in this study, however, in the South African PHC context, a PHC nurse’s idea of a pharmaceutical representative may be anyone from the district pharmacy as they get their medication from there, as opposed to a pharmaceutical representative as someone who promotes medication in America and the United Kingdom. Some (45.45%) of participants found consultation with colleagues often or always helpful while 45.45% found this to be

sometimes useful. A study was conducted in which nurses were observed and the study revealed that when nurses experienced clinical uncertainty in their decision making, they preferred to consult a colleague rather than a textbook (McCaughan et al., 2005). In this study the results demonstrate that the participants prefer to consult textbooks and reference material such as the SAMF, MIMS, and the PHC EDL and STGs as useful sources of information rather than asking a colleague with respect to their learning and education about antibiotics.

3.3 Antibiotic prescribing practices of nurses at the PHC clinics

3.3.1 Selection of antibiotics

The participants were asked about selecting antibiotics in a patient that have no bacterial culture information. The results obtained are expressed as percentages in Table 3.5.

Table 3.5.Selection of antibiotics in patients with no bacterial culture information

	Percentage of nurses Never or Rarely	Percentage of nurses Sometimes	Percentage of nurses Often or Always
I start with broad-spectrum and tailor upon culture results	45.45	18.18	36.36
I base my decisions on the PHC clinic antibiogram	0.00	9.09	90.91
I ask another nurse	18.18	54.55	27.27
I consult the PHC Standard Treatment Guidelines	0.00	0.00	100.00
I use the same 1 or 2 antibiotics	27.27	45.45	27.27

Just under half of all participants (45.45%) indicated that they sometimes use the same one or two antibiotics for all patients that present with no bacterial culture information, while 54.55% of participants indicated they sometimes ask another nurse for advice. Most of the participants (45.45%) never or rarely started with broad-spectrum antibiotics and tailored the antibiotics based on the bacterial culture results, while 36.36% of participants indicated that they often or always did this, however, this is not done at the PHC clinics as these clinics do not take bacterial cultures from patients for antibiotic treatment therefore, antibiotic therapy cannot be tailored for the patient after receiving bacterial culture results. Most (90.91%) of the participants indicated that they often or always based their decisions on the PHC antibiogram, similarly 100.00% of participants consulted the PHC STG for patients that had no bacterial culture information.

Prudent use of antibiotics includes the use of narrow spectrum antibiotics over broad-spectrum antibiotics (Dolk et al., 2018). The PHC STGs have empiric antibiotic treatment which are broad-spectrum antibiotics such as ceftriaxone for treating pyelonephritis, however, as a general measure the STG further states that urine samples should be sent for microscopy, culture and sensitivity testing and the case should be referred (NDoH, 2018). Most of the prescribing nurses stated they use the PHC antibiogram, however, bacterial cultures are not taken at the PHC clinics and the results of diagnostic cultures as well as antibiotic susceptibility tests results are used in the creation of a facility antibiogram (Agency for Healthcare Research and Quality, 2014). The PHC nurses may be using district or hospital antibiograms.

All of the prescribing nurses consult the PHC STG as there is no bacterial culture information available to the nurses at the PHC clinics. By following the PHC STG algorithm the nurses would be prescribing the same one or two antibiotics but 27.27% of the participating nurses never or rarely did this. This contradicts the statement that they all use the PHC STGs when prescribing in patients with no bacterial culture information. All the nurses consult the PHC STG in patients with no bacterial culture information, however, not all of them find the PHC EDL and STG often or always useful to their learning on antibiotics as seen in Table 3.4. There are many benefits for patients, prescribers, health policy makers and supply management staff to use the EDL and STGs. Some of the benefits of using the PHC EDL and STGs include the most effective treatment is prescribed for the patient and there is consistency amongst all PHC clinic prescribers which reduces confusion (Gopalakrishnan et al., 2014). The majority of the drugs in the PHC STG and EDL are also drugs that are usually available at the PHC clinics as compared to using other resources which contain drugs that may not be available at these clinics. Figure 3.3 compares the participant's responses to two questions regarding human interactions such as in Table 3.4 where participants were asked how useful asking a colleague is to their learning of antibiotics compared to how often they ask another nurse when selecting antibiotics in patients with no bacterial culture information.

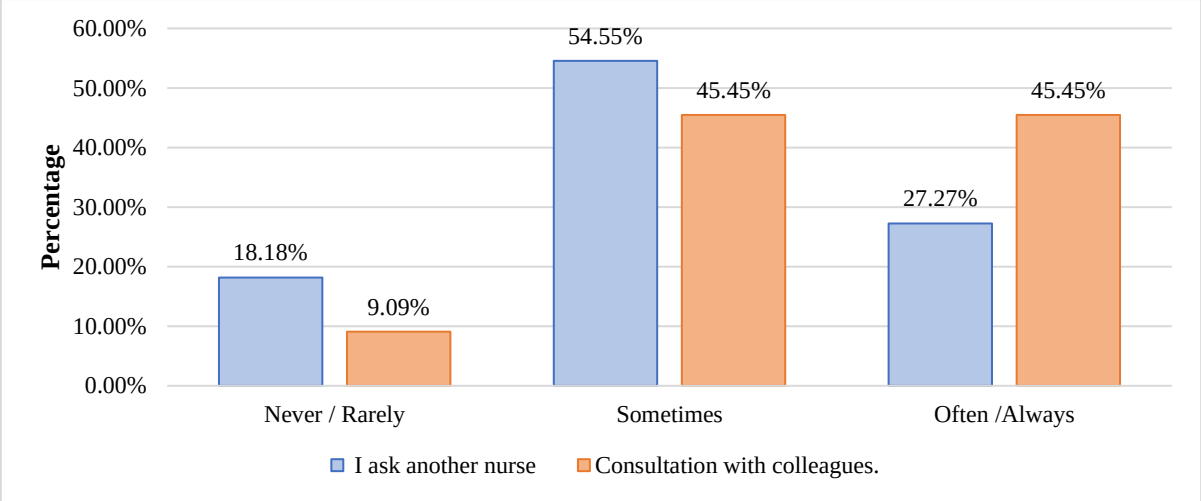


Figure 3.3.This figure compares participants responses from two questions on human interactions.

Figure 3.3 depicts that when patients present with no bacterial culture information to the clinic, the majority of the nurses only sometimes ask another nurse for advice, however, the participants indicated that learning about antibiotics from colleagues is only sometimes or often/always useful to their learning and education on antibiotics. Although it is good to work in a team, when the PHC nurses consult another nurse they must ensure that the nurse is adequately qualified by having either the R.48 qualification or authorized to prescribe antibiotics therefore, having sufficient knowledge and experience to provide the correct information.

3.4 Suggestions would be valuable to the prescribing nurses and would aid in improving antibiotic prescribing.

Educational interventions for prescribers have been widely recognised as one of the foundations of successful antibiotic stewardship programmes and have been effective in a variety of settings and thus interventions could be successfully implemented in South Africa (Farley et al., 2018). Educational interventions are known to improve antibiotic prescribing, but traditional tools may be insufficient to deliver training to meet the complex demands of the PHC prescribers working across a wide range of healthcare and resource settings (Rocha-Pereira et al., 2015). It is important for prescribers to continue their education on antibiotics as

continued learning allows professional growth, being up to date with current information and advancements and allows the prescriber to rectify previous mistakes.

This question in the survey had multiple suggestions to determine which resources would be valuable to the prescribing nurses and would aid in improving their antibiotic prescribing The nurses all agreed that the resources would be valuable to their antibiotic prescribing as all the nurses either agreed or kept a neutral stance to the statements and there was no disagreement amongst participants to any resource. Table 3.6 depicts what resources would be the most valuable to the prescribing PHC nurses, the values in the table are expressed as percentages.

Table 3.6.Nurse prescribers' opinions on educational resources that would improve antibiotic prescribing

	Percentage of nurses Disagree or Strongly Disagree	**Percentage of nurses Neutral**	**Percentage of nurses Agree or Strongly Agree**
Interactive internet-based sources	0.00	36.36	63.64
Clearer guidelines for tablet or smartphone apps	0.00	9.09	90.91
Clearer guidelines in written form	0.00	9.09	90.91
Better access to diagnostic tests such as points of care CRP (C-Reactive protein) tests.	0.00	18.18	81.82
More resources to educate the patients	0.00	0.00	100.00
More data on local antimicrobial resistance.	0.00	0.00	100.00

3.4.1 Interactive internet-based sources

Most (63.64%) of the participants agreed that interactive internet-based sources would be helpful while 36.36% of them were neutral. Electronic tools and resources that help healthcare workers prescribe medication has shown promise, however, their accuracy needs to be validated and interactive tools should focus on actionable advice that will guide antibiotic prescribers through all the different steps that need to be undertaken in order to prescribe rationally (Smith et al., 2020). For these interactive internet-based resources to function effectively, the PHC prescribing nurse would need to have access to Wi-Fi connection. A focus group in Botswana found that while many facilities such as district hospitals and clinics did have internet access, the use was limited as a result of, "Technical installation issues, connection, password access, costs, lack of time, and lack of devices" (Park et al., 2016). While

conducting the study it was seen that the above issues experienced in Botswana also apply to the PHC clinics in South Africa.

3.4.2 Resources to educate patients and more data for prescribers on local resistance patterns

All of the nurses agreed that more data on local antimicrobial resistance and more resources to educate the patient would be valuable to them. All the prescribers requested more resources to educate the patients which is similar to the results (90.40%) obtained in the study by Farley et al. (2018). Some of the interventions could include developing effective communication aids such as charts in multiple languages for both patients and prescribers to facilitate prescriber patient interactions. These resources would assist prescribers explaining issues that patients find confusing such as difference between viral and bacterial infections and other similar concepts. All of the prescribers would value data on local resistance patterns as this opens up an opportunity to introduce systems which supply up-to-date data on local resistance patterns (Farley et al., 2018). This may also indicate that the antibiogram that the majority of the participants used in patients that presented with no bacterial culture information as indicated in Table 3.5, may need improvement as all prescribers would find more data on local resistance patterns helpful.

3.4.3 Better access to diagnostic tests

Most of the nurses (81.82%) agreed that better access to diagnostic tests would be valuable. The majority of prescribers would value point of care C-Reactive protein (CRP) tests in PHC clinics. These tests are useful as they can decrease the prescribing nurses' uncertainty by adding valuable information that will help identify which patients require antibiotics. The point of care tests that should be implemented in PHC clinics should be accurate, precise, easy to use and interpret, fast and affordable but the most important is that they should be able to predict the prognosis and expected patient response to the antibiotic treatment (Llor and Bjerrum, 2014). There have been several studies which have shown that point of care tests have effectively reduced the number of antibiotics prescribed in the settings where they were implemented such as the CRP rapid test which provides results in less than three minutes has shown to significantly reduce the number of antibiotics prescribed for patients with lower respiratory tract infections without compromising the patients' health as there was no difference in clinical

outcomes between the patients that were treated with antibiotics and those that were not given antibiotics (Huang et al., 2013).

3.4.4 Clearer guidelines

Most (90.91%) of participants agreed that clearer guidelines in written form or tablets or smartphone apps would be a valuable resource to improve antibiotic prescribing. The majority of the prescribers would value clearer guidelines as well as interactive internet-based sources, which gives an opportunity to continuously update the guidelines as more evidenced based data becomes available. Prescribers in the PHC care clinics may not be aware of the of the PHC clinical guide app which is available on cell phones and contains clear step-by-step guidelines for healthcare workers, as the prescribers did indicate that they do not find tablet or smartphone apps useful and a minority of participants expressed that they do not like technology while a few of them wrote that they do not use websites or do not use technology as seen in Table 3.4. There are numerous studies that have shown clinicians are usually unaware that some resources exist (Fralick et al., 2017). Figure 3.4 compares the responses received from participants regarding guidelines.

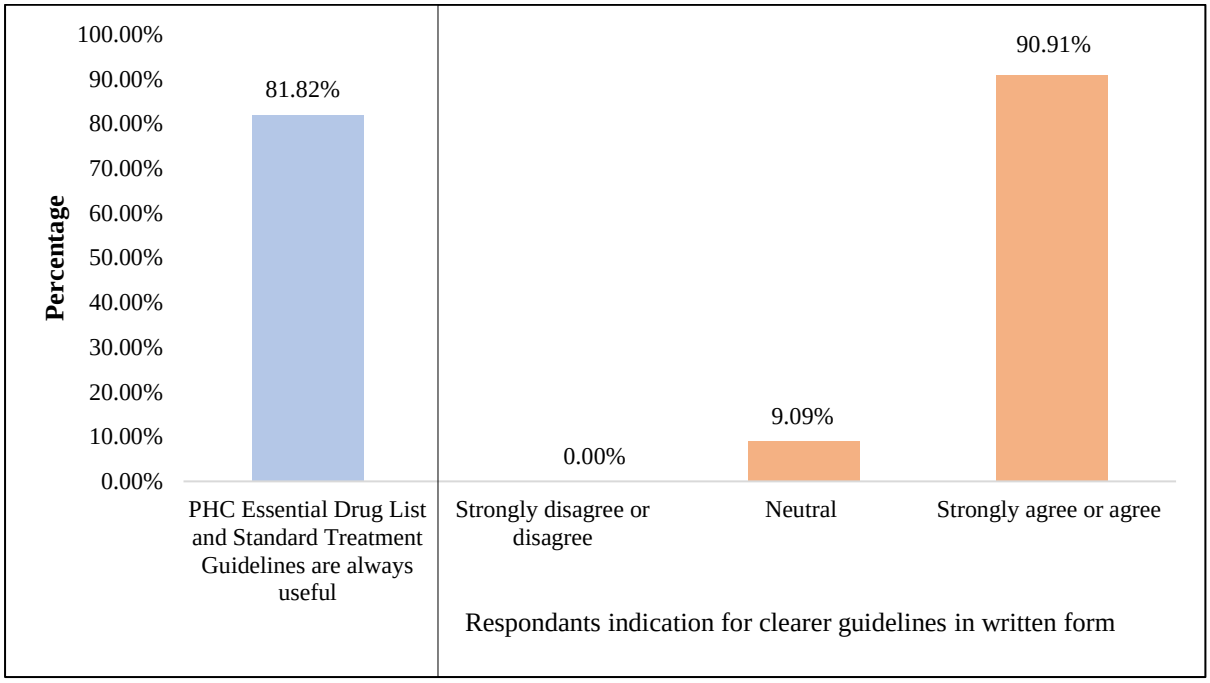


Figure 3.4.A comparison on the participant's responses on guidelines

As depicted in the figure above although the majority of participants found the PHC EDL and STG always useful to their learning on antibiotics, most of the participants would value clearer guidelines to help improve their antibiotic prescribing. The existing guidelines at the PHC clinics may not be clear enough for the prescribing nurses and may need improvement.

Chapter 4

Retrospective review of antibiotic prescriptions in PHC settings

This chapter presents the findings of the retrospective prescription analysis that was conducted across seven PHC clinics and the interpretation of the data collected. The chapter highlights and explains the antibiotic prescribing patterns of nurses at the PHC clinics and the most common antibiotics prescribed across all the PHC clinics. The chapter also provides information on the percentage of patients that were screened for TB at each clinic before an antibiotic was prescribed for the patient, as the symptoms of respiratory illnesses may coincide with that of TB and an antibiotic may be incorrectly prescribed for TB. This chapter also concludes phase 1 (quantitative data analysis) and links the findings of the surveys conducted to the prescriptions reviewed.

4.1 Antibiotic prescribing patterns of nurses in PHC clinics within the City of Johannesburg

A total of about 83 175 prescriptions were dispensed across all seven clinics over a period of three-months. A breakdown of the number of prescriptions that needed to contain an antibiotic at each clinic until the required sample size of 396 prescriptions is reached is stated below: region A: 76 prescriptions, region B: 29 prescriptions, region C: 84 prescriptions, region D: 58 prescriptions, region E: 46 prescriptions, region F: 93 prescriptions and region G: 10 prescriptions. The antibiotic prescriptions were analysed, and the results are summarized in Table 4.1.

Table 4.1.Summary statistics for antibiotic prescribing practices, by clinic

Parameter measured	Present	Region A (N = 76)	Region B (N = 29)	Region C (N = 84)	Region D (N = 58)	Region E (N = 46)	Region F (N =93)	Region G (N = 10)	Total (N = 396)	p value
Diagnosis made	No	12 (15.79%)	1 (3.45%)	2 (2.38%)	1 (1.72%)	0 (0.00%)	55 (59.14%)	8 (80.00%)	79 (19.95%)	<0.001
	Yes	64 (84.21%)	28 (96.55%)	82 (97.62%)	57 (98.28%)	46 (100.00%)	38 (40.86%)	2 (20.00%)	317 (80.05%)	
Number of antibiotics	1	64 (84.21%)	20 (68.97%)	67 (79.76%)	49 (84.48%)	25 (54.35%)	73 (78.49%)	10 (100.00%)	308 (77.78%)	0.002
	2	2 (2.63%)	4 (13.79%)	3 (3.57%)	5 (8.62%)	3 (6.52%)	4 (4.30%)	0 (0.00%)	21 (5.30%)	
	3	10 (13.16%)	5 (17.24%)	14 (16.67%)	4 (6.90%)	18 (39.13%)	16 (17.20%)	0 (0.00%)	67 (16.92%)	
Drug-drug interactions	No	75 (98.68%)	28 (96.55%)	84 (100.00%)	58 (100.00%)	46 (100.00%)	93 (100.00%)	10 (100.00%)	394 (99.49%)	0.28
	Yes	1 (1.32%)	1 (3.45%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	2 (0.51%)	
Incomplete prescription	No	37 (48.68%)	20 (68.97%)	39 (46.43%)	14 (24.14%)	37 (80.43%)	20 (21.51%)	0 (0.00%)	167 (42.17%)	<0.001
	Yes	39 (51.32%)	9 (31.03%)	45 (53.57%)	44 (75.86%)	9 (19.57%)	73 (78.49)	10 (100.00%)	229 (57.83%)	
Incomplete patient history	No	72 (94.74%)	27 (93.10%)	83 (98.81%)	56 (96.55%)	40 (86.96%)	85 (91.40%)	10 (100.00%)	373 (94.19%)	0.112
	Yes	4 (5.26%)	2 (6.90%)	1 (1.19%)	2 (3.45%)	6 (13.04%)	8 (8.60%)	0 (0.00%)	23 (5.81%)	
Incomplete treatment	No	73 (96.05%)	28 (96.55%)	82 (97.62%)	57 (98.28%)	44 (95.65%)	92 (98.92%)	10 (100.00%)	386 (97.47%)	0.862
	Yes	3 (3.95%)	1 (3.45%)	2 (2.38%)	1 (1.72%)	2 (4.35%)	1 (1.08%)	0 (0.00%)	10 (2.53%)	
Incomplete dosage/strength	No	63 (82.89%)	25 (86.21%)	83 (98.81%)	44 (75.86%)	45 (97.83%)	82 (88.17%)	9 (90.00%)	351 (88.64%)	<0.001
	Yes	13 (17.11%)	4 (13.79%)	1 (1.19%)	14 (24.14%)	1 (2.17%)	11 (11.83%)	1 (10.00%)	45 (11.36%)	
Incomplete diagnosis	No	64 (84.21%)	28 (96.55%)	82 (97.62%)	57 (98.28%)	46 (100.00%)	38 (40.86%)	2 (20.00%)	317 (80.05%)	<0.001
	Yes	12 (15.79%)	1 (3.45%)	2 (2.38%)	1 (1.72%)	0 (0.00%)	55 (59.14%)	8 (80.00%)	79 (19.95%)	
Incomplete route of administration/instructions	No	75 (98.68%)	27 (93.10%)	83 (98.81%)	55 (94.83%)	46 (100.00%)	83 (89.25%)	8 (80.00%)	377 (95.20%)	0.004
	Yes	1 (1.32%)	2 (6.90%)	1 (1.19%)	3 (5.17%)	0 (0.00%)	10 (10.75%)	2 (20.00%)	19 (4.80%)	
Incomplete duration	No	58 (76.32%)	25 (86.21%)	42 (50.00%)	17 (29.31%)	46 (100.00%)	56 (60.22%)	0 (0.00%)	244 (61.62%)	<0.001
	Yes	18 (23.68%)	4 (13.79%)	42 (50.00%)	41 (70.69%)	0 (0.00%)	37 (39.78%)	10 (100.00%)	152 (38.38%)	
Incorrect drug	No	28 (36.84%)	13 (44.83%)	32 (38.10%)	21 (36.21%)	30 (65.22%)	55 (59.14%)	2 (20.00%)	181 (45.71%)	0.001
	Yes	48 (63.16%)	16 (55.17%)	52 (61.90%)	37 (63.79%)	16 (34.78%)	38 (40.86%)	8 (80.00%)	215 (54.29%)	
Incorrect drug PHC STG	No	29 (38.16%)	14 (48.28%)	37 (44.05%)	21 (36.21%)	30 (65.22%)	55 (59.14%)	2 (20.00%)	188 (47.47%)	0.003
	Yes	47 (61.84%)	15 (51.72%)	47 (55.95%)	37 (63.79%)	16 (34.78%)	38 (40.86%)	8 (80.00%)	208 (52.53%)	
Incorrect drug SAMF	No	59 (77.63%)	24 (82.76%)	75 (89.29%)	48 (82.76%)	46 (100.00%)	86 (92.47%)	2 (20.00%)	340 (85.86%)	<0.001
	Yes	17 (22.37%)	5 (17.24%)	9 (10.71%)	10 (17.24%)	0 (0.00%)	7 (7.53%)	8 (80.00%)	56 (14.14%)	
Overdosing	No	73 (96.05%)	29 (100.00%)	79 (94.05%)	56 (96.55%)	41 (89.13%)	92 (98.92%)	10 (100.00%)	380 (95.96%)	0.119
	Yes	3 (3.95%)	0 (0.00%)	5 (5.95%)	2 (3.45%)	5 (10.87%)	1 (1.08%)	0 (0.00%)	16 (4.04%)	
Underdosing	No	74 (97.37%)	26 (89.66%)	76 (90.48%)	57 (98.28%)	35 (76.09%)	82 (88.17%)	10 (100.00%)	360 (90.91%)	0.001
	Yes	2 (2.63%)	3 (10.34%)	8 (9.52%)	1 (1.72%)	11 (23.91%)	11 (11.83%)	0 (0.00%)	36 (9.09%)	
Incorrect interval/duration	No	67 (88.16%)	24 (82.76%)	65 (77.38%)	52 (89.66%)	32 (69.57%)	67 (72.04%)	10 (100.00%)	317 (80.05%)	0.012
	Yes	9 (11.84%)	5 (17.24%)	19 (22.62%)	6 (10.34%)	14 (30.43%)	26 (27.96%)	0 (0.00%)	79 (19.95%)	

4.1.1 Prescription analysis: Diagnosis

The proportion of antibiotics prescriptions containing a diagnosis was significantly different across the clinics (p value <0.001). There was a higher proportion of prescriptions that had a diagnosis stated on the prescriptions across all clinics as compared to prescriptions that had no diagnosis stated on them. It can be seen that 19.95% (n=79) of prescriptions across all clinics had no diagnosis stated on the prescription, with the clinic in region G having 80.00% (n=8) of prescriptions with no diagnosis stated. These prescriptions were also classified as incomplete diagnosis prescriptions. In a study conducted by Gasson et al. (2018) a diagnosis was specified in 71.00% of the prescriptions analysed at the clinics, this is similar to the 80.05% of prescriptions that had a diagnosis stated in this study. In the prescriptions that had no diagnosis stated, antibiotics were prescribed for signs and symptoms such as fever, cough and headaches and the PHC prescribers listed the symptoms on the prescription. It is often better to state the diagnosis according ICD 10 codes rather than to state symptoms, as the ICD 10 codes are a common language for health care professionals (Mashalla et al., 2017). In region E, 100.00% (n=46) of the prescriptions had a diagnosis stated on them. This clinic uses the eHealth@Joburg electronic system which requires a diagnosis to be stated on the prescription. In the prescriptions where a diagnosis was not specified, it is not known whether the prescribing nurse did diagnose the patient but forgot to record the diagnosis or there was diagnostic uncertainty.

It is important to state the diagnosis on the patients records for future reference as this ensures that the patient information is provided to all relevant healthcare workers and will aid them in potential future decisions. This, in turn, will benefit the patient as less time will be spent on repeating tests and by preventing inaccurate diagnosis or the prescribing of inappropriate treatments (Mathioudakis et al., 2016).

4.1.2 Prescription analysis: Number of antibiotics prescribed

When looking at the number of antibiotics prescribed across the clinics, there was a significant difference in the number of antibiotics the patients received (p value 0.002). A higher percentage (77.78%; n=308) of prescriptions across the clinics had one antibiotic prescribed while 5.30% (n=21) of prescriptions contained two antibiotics and 16.92% (n=67) of prescriptions contained three antibiotics. The clinic in region G had 100.00% (n=10) of prescriptions that contained one antibiotic while the clinic in region E had the least number of

prescriptions 54.35% (n=25) containing one antibiotic and had the greatest percentage (39.13%; n=18) of prescriptions containing three antibiotics. Most of the prescriptions analysed had one antibiotic prescribed for patients, while the patients who received two or three antibiotics were mostly to treat sexually transmitted infections. The results are similar to the study conducted by Gasson et al. (2018) as 82.41% of patients received a prescription for one antibiotic. Antibiotic combination therapy has disadvantages and irrational multidrug antibiotic combinations can worsen the already distressing scenario of antibiotic resistance (Ahmed et al., 2014). If an antibiotic is broad-spectrum, it has extensive coverage of micro-organisms therefore, dual antibiotic coverage may be unnecessary in some patients. Some physicians may believe using dual coverage for certain micro-organisms is better, however, the majority of the literature has shown no benefit in mortality with combination therapy when compared to monotherapy in patients who presented with sepsis (Paul et al., 2004).

4.1.3 Prescription analysis: Drug-drug interactions

There was no statistical significance in proportion noted with antibiotic related drug-drug interactions across the clinics (p value 0.280). The clinics in region C, region D, region E, region F and region G, had no drug interactions, however, the clinic in region A had 1.32% (n=1) and the clinic in region B had 3.45% (n=1) of drug-drug interactions. The PHC STG states that the PHC prescriber should check the prescription to see if there are any redundant items on the prescription to avoid drug interactions and should ensure that the treatment is practical for the patient (NDoH, 2018). A study demonstrates that as the number of antibiotics prescribed increases, the prescribing errors also increase several folds, therefore if more antibiotics were prescribed for patients' errors such as drug-drug interactions would be more prevalent on the prescriptions (Iftikhar et al., 2019). Drug-drug interactions occur when one drug alters the effects of the other drug.

Although this was not statistically significant in the study, they did occur, and efforts should be made to ensure that they do not occur as these interactions may be harmful if the interaction increases the toxicity of the drug. Drug interactions are predictable and therefore should be prevented especially in patients who have altered pharmacokinetics as a result of decreased renal function and in the elderly as these drug-drug interactions may manifest as clinical effects and may be potentially life threatening to the patient (Kapp et al., 2013).

4.1.4 Prescription analysis: Incomplete prescription

The Medicine and Related Substances Act of 1965 states the following should appear on a prescription: the dosage form, the strength of the dosage form, instructions for administration and frequency of administration as well as the age and gender of the patient (MRSA, 2017). The PHC EDL and STG states that the diagnosis should also be present on the prescription (NDoH, 2018). The prescriptions analysed often had multiple components that were incomplete on a single prescription. Incomplete prescriptions were therefore measured as prescriptions that had no patient history, dosage/strength of therapy, diagnosis, route of administration or administration instructions, duration of therapy stated on the prescription as well prescriptions that had incomplete treatment. Figure 4.1 depicts the number of prescriptions that were incomplete as well as a breakdown on the number of prescriptions that were incomplete according to the various categories.

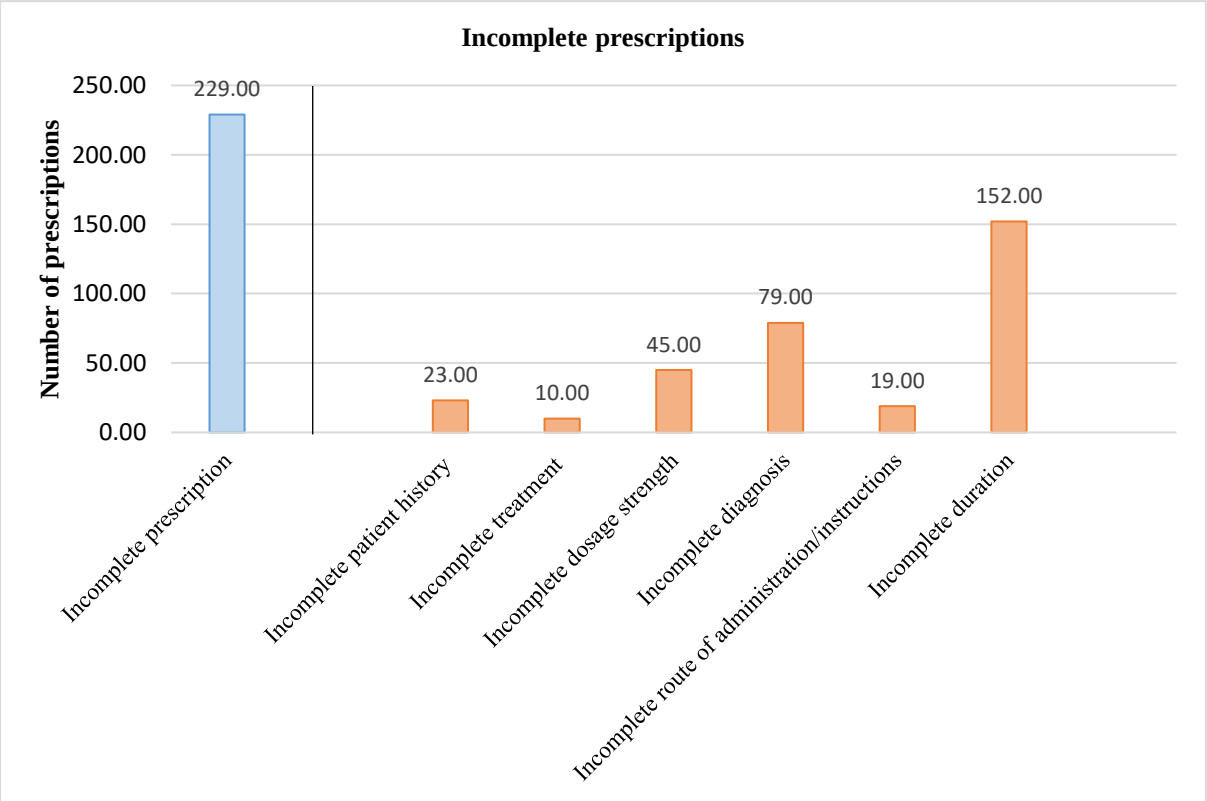


Figure 4.1.Compares the number of prescriptions that were incomplete and reasons as to why they were classified as incomplete.

The proportion of antibiotic prescriptions which were incomplete were significantly different across clinics (p value <0.001). There was a higher proportion of prescriptions (57.83%) at the PHC clinics that were incomplete compared to the proportion of prescriptions that were complete.

The clinic in region E had the greatest percentage of prescriptions that were complete 80.43% (n=37) as compared to the other clinics and only had 19.57% (n=9) prescriptions that were incomplete. This may be due to the clinic using the eHealth@Joburg system which assists in prescribing. The number of incomplete prescriptions were evaluated into the reasons why they were incomplete including incomplete treatment with only 2.53% (n=10) of prescriptions across all clinics having incomplete treatment.

4.1.4.1 Patient history

Across all the clinics, the proportion of prescriptions with an incomplete patient history was not statistically significant (p value 0.112). Most (94.19%; n=373) of the prescriptions had a complete patient history on the prescription while only 5.81% (n=23) of prescriptions had an incomplete patient history. The clinic with the greatest percentage of prescriptions that had an incomplete patient history was the clinic in region E with 13.04% (n=6) while the clinic in region G had no prescriptions that had an incomplete patient history. Incomplete patient history was not statistically significant in this study, however, in the PHC clinics the prescribing nurses take the patient history which is arguably the most important aspect in patient assessment and this process will guide the type of treatment the patient receives. It is essential that the nurses spend time taking a fully detailed patient history as not allocating enough time to this process can lead to incomplete patient information which can adversely affect patient care (Lloyd and Craig, 2007).

The nurses in region G took a complete patient history on the prescriptions reviewed. This could be due to the nurses only seeing a few patients a day allowing them to have enough time with each patient. Of the 23 prescriptions that had an incomplete patient history, 22 of those prescriptions were sexually transmitted infection prescriptions where female patients presenting with vaginal discharge syndrome were not asked if they were sexually active or not (if they were asked it was not stated on the prescription) as the treatment differs in patients who

are sexually active. Another reason why the clinic in region G may have had no incomplete patient history prescriptions could be because none of the patients were diagnosed with a sexually transmitted infection.

4.1.4.2 Treatment

The clinic in region G had no prescriptions that had incomplete treatments such as one antibiotic was omitted in the combination of antibiotics used for treatment while the clinic in region E had the greatest percentage (4.35%; n=2) of antibiotic prescriptions that had incomplete treatment. Incomplete antibiotic treatment should be avoided as a combination of antibiotics is prescribed for a variety of reasons including the one antibiotic prescribed may slow down the emergence of resistance of bacteria in another antibiotic; or the antibiotic combination may also be synergistic (Dowling et al., 1957). Omitting one medication from a combination that is proven to work may cause resistance. The proportion of antibiotic prescriptions which had an incomplete treatment was not significantly different across clinics (p value 0.862). In a prescription for a dental abscess amoxicillin was given but metronidazole was left out therefore the treatment was incomplete. The use of metronidazole in dental abscesses is due to the presence of anaerobic bacteria and therefore omitting it may result in the patient not getting better and returning to the clinic. In a study conducted in South Africa, a healthcare worker described a strategy used by frontline healthcare workers in order to minimise the negative impact that stock outs may have on patients. The healthcare workers may sometimes provide patients with partial prescriptions and advise them to return for the rest of the regimen (Hodes et al., 2017). With antibiotic therapy this may not always work as the patient may not return to complete therapy when they start feeling better.

4.1.4.3 Dosage/strength and route of administration/instructions

According to the PHC EDL the dose, dosage units, route, frequency, duration of treatment and diagnosis needs to be checked by the prescriber before dispensing the medication (NDoH, 2018). The proportion of antibiotic prescriptions which had an incomplete dosage/strength and route of administration/instructions was significantly different across clinics (p value <0.001). The majority of prescriptions contained the dosage strength while a small percentage (11.36%; n=45) of prescriptions had an incomplete dosage/strength across all the clinics. The clinic in region D had the greatest percentage (24.14%; n=14) of prescriptions that had incomplete

dosage/strength while the clinic in region G had the most percentage (90.00%; n=9) of prescriptions in which the antibiotic dosage/strength was complete. Some antibiotic prescriptions were classified as incomplete as they had no route of administration/instructions stated on them. The proportion of prescriptions that were incomplete due to no route of administration/instructions was significantly different across the clinics (p value 0.004). A higher proportion of prescriptions contained the route of administration/instructions on them as compared to prescriptions that had no route of administration/instructions. The clinic in region E had no prescriptions that were incomplete due to incomplete route of administration/instructions while the clinic in region G had the greatest percentage (20.00%; n=2) of prescriptions that were incomplete due to incomplete route of administration/instructions, similarly all the prescriptions in region G had no duration of antibiotic therapy stated on them while 100.00% of the prescriptions in region E had the duration of therapy stated on them. The clinic in region E that uses the electronic system had no omissions of duration of therapy and route of administration/instructions as the system provides drop down menus for prescribers to choose from. This suggests that the electronic system does decrease the number of omission errors.

The proportion of antibiotic prescriptions which had an incomplete duration of therapy was significantly different across clinics (p value <0.001). A greater proportion of prescriptions had duration of therapy stated on them as compared to the proportion of prescriptions that did not have the duration of therapy stated on them. A study done at the PHC clinics in Bahrain showed that the dosage strength was omitted in 9.60% of prescriptions and 18.90% of prescriptions did not have the length or duration of therapy (Aljasmi et al., 2018). In this study 11.83% of prescriptions did not have the dosage/strength on them which is similar to the results of the study conducted above in Bahrain, however, 38.38% of prescriptions did not have the duration of therapy in this study. Omission errors like missing the dosage, route of administration/instructions can lead to misinterpretation by other healthcare personnel reviewing the prescriptions (Velo and Minuz, 2009).

4.1.5 Prescription analysis: Incorrect drug

The PHC EDL and STG states, “medicines should be prescribed only when they are necessary for treatment following clear diagnosis.” Therefore, an antibiotic was classified as an incorrect

drug in patients who did not require an antibiotic and simple advice together with general supportive measures would have sufficed. An antibiotic was also classified an incorrect drug if it was used for an incorrect indication according to the PHC STG and SAMF. Just over half (54.29%) of the antibiotics prescribed at the PHC clinics were incorrect. The proportion of antibiotic prescriptions which were incorrect was significantly different across clinics (p value 0.001). There was a greater proportion of prescriptions that had an incorrect drug prescribed across the clinics as compared to the proportion of prescriptions containing the correct drug. The clinic with the highest number of incorrect drugs was the clinic in region G where 80.00% (n=8) of prescriptions had the incorrect drug while the clinic in region E had the least percentage (34.78%; n=16) of prescriptions that contained an incorrect drug. The clinic in region G had the highest percentage of incorrect drugs prescribed. The nurses that prescribed antibiotics in region G did not have any PHC training and this could be a reason as to why the clinic had the greatest percentage of incorrect drug errors. Figure 4.2 compares the results from the survey to the results from the retrospective analysis.

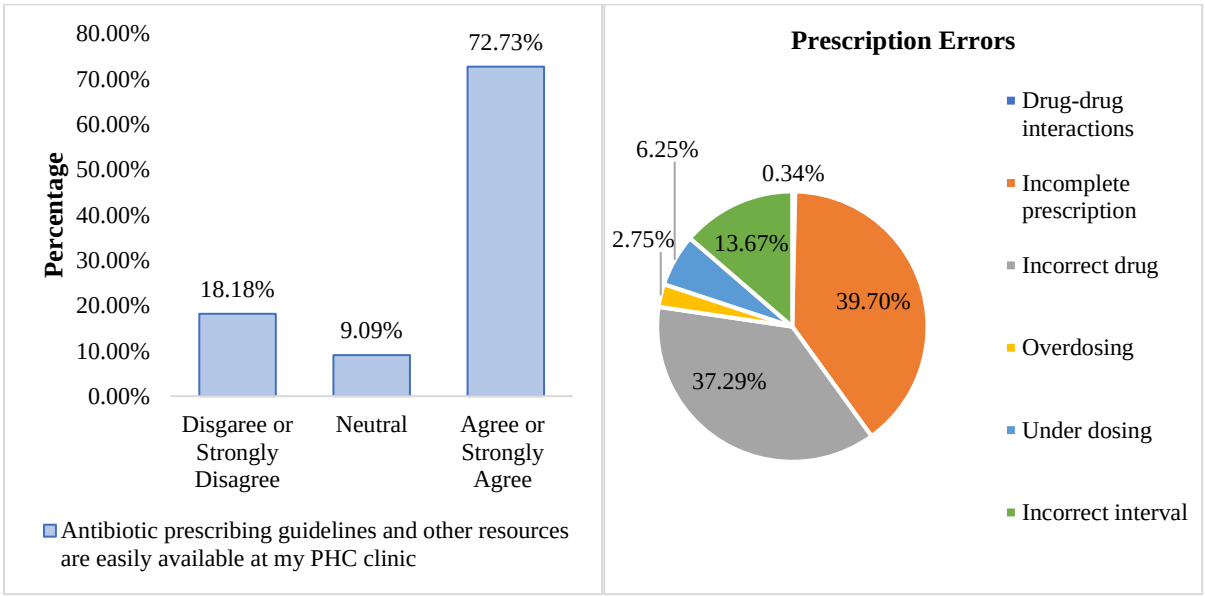


Figure 4.2.Comparison between availability of guidelines and other resources at the PHC clinics versus the prescription errors.

The majority of the prescribers indicated that guidelines and other resources are easily available at the clinics and indicated that they were confident that they prescribed antibiotics optimally, however, when looking at the prescription errors one can see that these guidelines are not

followed and can recognise the need for prescriber feedback, education and training as there are so many prescription errors that occur across all clinics.

In order to minimise the occurrence of these errors necessary steps need to be implemented. This can be done by continuously educating the PHC nurses on new developments as often as possible. Measures to improve prescribing can be successfully implemented as the PHC nurses indicated that they would like more feedback on their antibiotic selections as well as more information on the appropriate use of antibiotics in the surveys conducted. In addition to this Aronson (2009) suggests a postgraduate assessment of nurses to be taken occasionally which could be linked to a prescribing license being given to the nurse if they are competent. The small sample size of prescriptions reviewed at the clinic in region G also resulted in the high percentage of errors. Additionally, the clinic in region G had 80.00% of prescriptions that did not have a diagnosis stated on the prescription which may have led to the compounding of errors. The clinic in region E that uses the electronic prescribing system had the least percentage of incorrect antibiotics prescribed across all the clinics. Electronic prescribing may play a significant role in preventing medication history errors; alter prescribing behaviour as the system generates warning messages to the prescribers which resulted in an overall reduction in medication errors. Even though the electronic system does decrease the number of medication errors it can also facilitate errors. The drop-down choices in response to a predictive text is a common feature on many of these systems including the eHealth@Joburg and this can facilitate prescribing errors for instance selecting amiodarone instead of amoxicillin (Fitzgerald, 2009). Some of the PHC clinics that were visited did not have access to computers and therefore the electronic system cannot be implemented at all the PHC clinics.

An analysis was done to determine if the antibiotics prescribed were incorrect according to the SAMF or according to the PHC STG. The proportion of antibiotic prescriptions which were incorrect according to the SAMF was significantly different across the clinics (p value < 0.001). A greater proportion of prescriptions had an antibiotic correctly prescribed according to the SAMF as compared to the proportion of antibiotic prescriptions that were incorrectly prescribed according to the SAMF. Furthermore, the proportion of prescriptions that had an antibiotic incorrectly prescribed according to the PHC STGs was significantly different across the clinics (p value 0.003). A greater proportion 52.53% (n=208) of prescriptions had an

antibiotic incorrectly prescribed according to the PHC STG across the clinics. This suggests that the PHC STGs are not followed when prescribing antibiotics even though the prescribing nurses in the survey indicated that they consult the PHC STG in patients that present with no bacterial culture information, which is the case at these PHC clinics. The clinic in region E had 100.00% (n=46) of antibiotic prescriptions that were correct according to the SAMF. The clinic in region G had the most percentage of antibiotic prescriptions that were incorrect according to the PHC STG and the SAMF. When analysing the prescriptions, it was found that student nurses prescribed antibiotics at the clinic in region D and some of these prescriptions were not co-signed by the supervisor. This could be a contributing factor as to why this clinic had the second highest percentage of incorrect drugs on the prescriptions. Figure 4.3 depicts the participants' responses on how useful the SAMF is for their learning and education on antibiotics versus prescriptions that were incorrect according to the SAMF.

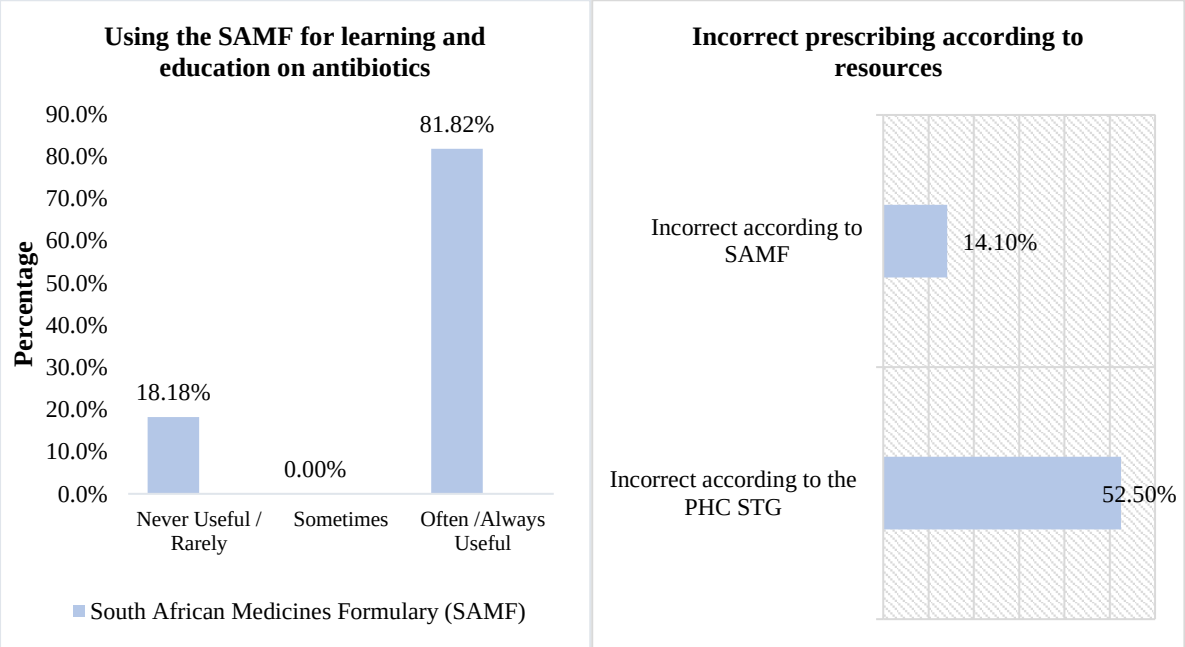


Figure 4.3.Comparison between the prescribing nurses finding resources helpful and errors according to the resources found on the antibiotic prescriptions

Most of the participants found the SAMF often or always useful to their learning and education on antibiotics, however, prescriptions were also incorrect according to the SAMF. Similarly, the PHC EDL and STG was often or always useful to most of the participants when learning on antibiotics and the guidelines were easily available to most of the participants yet more than

half of the antibiotic prescriptions were incorrect according to the PHC STG, which suggests these guidelines are not adequately used when prescribing.

The PHC STG does not indicate the use of antibiotics in respiratory tract infections such as acute bronchitis in adolescents or adults in the absence of underlying chronic obstructive pulmonary disease as acute airway infections are mostly of viral origin, this is in line with the National Institute of Clinical Excellence which does not recommend prescribing of antibiotics for bronchitis except in certain circumstances (NICE, 2008; NDoH, 2018). A worrisome finding was discovered across the PHC clinics as antibiotics were incorrectly prescribed for patients who did not need them such as for acute bronchitis. A study has shown that prescribers such as physicians are more likely to prescribes antibiotics in patients who present with purulent nasal discharge or a cough for two or three weeks in bronchitis, however, the presence of purulent nasal discharge does not distinguish if the infection is a viral or a bacterial infection and a cough is usually a result of bronchial hyperresponsiveness (Colgan and Powers, 2001). Antibiotics are usually prescribed in the hope to prevent more serious superinfections, however, a meta-analysis on antibiotic use in upper respiratory tract infections showed that antibiotics did not decrease neither the severity nor the incidence of the disease (Gadomski, 1993).

Despite these reasonings, there are some nonclinical factors that may influence the prescribers to incorrectly prescribe an antibiotic when it is not needed for patients such as the patient demands an antibiotic hence an antibiotic was prescribed, however, most of the prescribing nurses that participated in the survey indicated that they never or rarely prescribed an antibiotic in this case. Antibiotics are also prescribed incorrectly for other reasons such as; they may be an effective way of concluding a visit with a patient, diagnostic uncertainties, noncompliance of guidelines, heavy patient load as well as prescribers not having enough time to educate patients on antibiotics (Colgan and Powers, 2001; Iftikhar et al., 2019). Presumptive diagnosis is irrational and contributes to the increasing level of antibiotic resistance (Massele et al., 2001). This fact is further confirmed by Omole et al. (2018) which also states that antibiotics prescribed on assumption contribute to overuse in facilities where laboratory, microscopy, culture and sensitivity tests are lacking. In PHC clinics it is difficult to distinguish pneumonia from acute bronchitis by only performing clinical tests. The use of CRP rapid tests has been

shown to be better at predicting pneumonia than any other lower respiratory tract infections. The use of CRP rapid diagnostics has also been useful in reducing the number of antibiotics prescribed for sinusitis (Llor and Bjerrum, 2014). A study has shown that antibiotic prescriptions were the lowest when rapid testing was used and the highest when empirical treatment was used, due to the high rate of unnecessary antibiotic prescribing in adults (McIsaac et al., 2004). At the PHC clinics in South Africa, the CRP tests can only be requested by a doctor and takes 24 hours for the results to be available at the facility (NDoH, 2018). Provision should be made for the prescribing nurses at the PHC clinics to also use this test as the PHC clinics in South Africa also do not take bacterial cultures to guide antibiotic treatment and to confirm bacterial infection, while the PHC doctors only visit the clinics a few times a week. The point of care CRP tests, however, may not be a priority in the South African PHC context as the PHC clinics have limited resources such as medication and due to cost-effective considerations; disruptions to the existing level of care are the main obstacles that the South African healthcare system needs to overcome before widely disseminating the point of care CRP tests for all healthcare professionals to use (van Hecke et al., 2019).

Of the prescriptions that had an incorrect drug, most of them were incorrect as they were incorrectly prescribed according to the PHC STG which closely corresponds with the SAASP guidelines. To ensure rational antibiotic prescribing at the PHC clinics, prescribers must adhere to the STGs and must also follow the standard of prescribing medication (Chem et al., 2018). Some prescribers deviate from the guidelines as they may have gained clinical experience. A study by Boonstra et al. (2005) argues that even though PHC STGs are vital tools used in the prescribing and management in patients, these guidelines should not replace clinical judgment and experience, Schellack et al. (2017) states that at government PHC clinics prescribers are restricted to the STGs and EDL. To ensure that antibiotic prescribing is rational, prescribers must adhere to the STGs and must follow the standard process of prescribing antibiotics **(**Dyar et al., 2017). The Chief Executive Officer of the South African Health Products Regulatory Authority (SAHPRA) has issued a document which states that nurses who have been authorized to prescribe medication to adults and children should prescribe in accordance with the PHC EDL and STG and relevant facility policies (Gray et al., 2017). Most of the incorrect drug errors were due to prescribers not following the PHC STG this closely corresponds to the 54.60% of the prescriptions that were not adherent to the PHC STG guidelines at the PHC clinics in Cape Town (Gasson et al., 2018). The PHC guidelines should be internalized through

discussions about the content in the guidelines and by doing this, the staff at the PHC clinics will know and trust the content in the guidelines (Strandberg et al., 2016). In Sweden, antibiotic use is the lowest and one of the reasons for the low antibiotic use is because the guidelines are widely disseminated by mailing it to all the health centers as well as publishing the guidelines in the Swedish medical journal (Strandberg et al., 2016). This may not work in the South African PHC clinics as the surveys indicated the resources are available at the PHC clinics.

4.1.6 Prescription analysis: Dosing errors

Dosing errors were measured as overdosing, underdosing and incorrect interval or duration errors such as prescribing an antibiotic two times a day instead of three times a day or prescribing an antibiotic for five days instead of seven days. Aronson (2009) indicates that to achieve balanced prescribing, the prescriber should ask themselves the question if the correct dosage regimen has been prescribed for the correct duration before prescribing medication. Across all seven clinics, 4.04% (n=16) of prescriptions had overdosing errors. The proportion of antibiotic prescriptions with overdosing errors was not significantly different across clinics (p value 0.119). The clinic in region E (10.87%; n=5) had the highest percentage of overdosing errors while the clinic in region G had no overdosing errors. Underdosing errors accounted for 9.01% (n=36) of all errors. The proportion of prescriptions that had underdosing errors was not significantly different across clinics (p value 0.001). The clinic with the highest percentage of underdosing errors was the clinic in region E (23.91%; n=11) while the clinic in region G had no underdosing errors as well as no incorrect interval errors. The proportion of antibiotic prescriptions that contained incorrect interval errors was significantly different across clinics (p value 0.012). A greater proportion of prescriptions did not have incorrect interval or incorrect duration errors. Incorrect interval errors accounted for 19.95% (n=79) of errors on the antibiotic prescriptions with the clinic in region E having the greatest percentage (30.43%; n=14) of errors. The clinic in region E, despite the use of the electronic prescribing system had the greatest number of underdosing, overdosing and incorrect interval errors proving that the system cannot eliminate all prescribing errors. Paediatric patients are at a higher risk of experiencing medication dosing errors as compared to adults because of the need for a dosage calculation which is based on patient factors such as age, weight and body surface area. When prescribing for paediatrics many prescribers do not consider the patients weight when they calculate the dose or they simply calculate the paediatric dose by halving the adult dose (Aseeri, 2013). The clinic in region G despite all the prescriptions collected being for paediatrics, there

were no dosing or interval errors. Dosing and incorrect interval errors should be avoided as, if a subtherapeutic dose of an antibiotic is given to a patient or if the antibiotic dose is given at the incorrect interval, the patient's body will be unable to fight all the bacteria causing the bacteria to therefore develop acquired resistance against the antibiotic given, while overdosing antibiotics may result in increased adverse effects experienced by the patient. Optimizing antibiotic treatment by giving the correct dose is essential to avoid treatment failure and to minimise the emergence of resistant bacteria (Aseeri, 2013). Section 4.2 explores which antibiotics were commonly prescribed by the PHC nurses and a discussion on why the antibiotics were prescribed for patients.

4.1.7 A summary on how pharmacists can assist in decreasing antibiotic prescription errors.

There are numerous steps that can be taken to reduce the amount of antibiotic prescribing errors. Pharmacists are the custodians of medicine and should therefore ensure the safe and effective use of medications. They can encourage the correct use of antibiotics in PHC clinics by:

- Helping the PHC prescribers with the high load of patients by counselling individual patients about the correct use of antibiotics such as the dose, duration as well as route of administration when dispensing the antibiotic.
- Pharmacists are a central communication hub between other members of the multidisciplinary team, pharmacists should therefore provide the other team members with education and training programmes regarding the safe use of antibiotics.
- Be involved in preparing evidence based local prescribing guidelines for antibiotics.
- Promoting good prescribing practices and monitoring antibiotic usage (Bisht et al., 2009).
- As part of their clinical duties they can perform a clinical check on the prescriptions when dispensing medication and help by providing feedback to the prescribers on their prescribing practices such as overdosing, underdosing and incorrect drugs (Cousins et al., 2019).

4.2 The most common antibiotics prescribed

Although the prescribing of nurses is governed by the PHC STGs, the behaviours and frequency of each antibiotic prescribed are dependent on the nurse. The most common antibiotics seen across all prescriptions analysed can be seen in Table 4.2.

Table 4.2.The most common antibiotics prescribed across all seven PHC clinics

Name of antibiotic	Frequency	Percentage	Cumulative percentage
Amoxicillin	169	42.68	42.68
Ceftriaxone, azithromycin and metronidazole	65	16.41	59.09
Phenoxymethylpenicillin	48	12.12	71.21
Ciprofloxacin	24	6.06	77.27
Flucloxacillin	24	6.06	83.33
Metronidazole	15	3.79	87.12
Co-amoxyclav	14	3.54	90.66
Azithromycin	5	1.26	91.92
Azithromycin and metronidazole	5	1.26	93.18
Ceftriaxone and azithromycin	5	1.26	94.44
Flucloxacillin and chloramphenicol	4	1.01	95.45
Chloramphenicol	3	0.76	96.21
Amoxicillin and co-amoxyclav	2	0.51	96.72
Trimethoprim/sulfamethoxazole	2	0.51	97.22
Ceftriaxone	2	0.51	97.73
Flucloxacillin and ceftriaxone	2	0.51	98.23
Amoxicillin and chloramphenicol	1	0.25	98.48
Ceftriaxone and amoxicillin	1	0.25	98.74
Ceftriaxone, metronidazole and doxycycline	1	0.25	98.99
Cephalexin	1	0.25	99.24
Flucloxacillin and metronidazole	1	0.25	99.49
Cefazolin, azithromycin and metronidazole	1	0.25	99.75
Phenoxymethylpenicillin and ceftriaxone	1	0.25	100.00
Total:	**396**	**100.00**	

Amoxicillin was the most common antibiotic prescribed across all the clinics and was the antibiotic prescribed in 42.68% (n=169) of prescriptions, followed by a combination of antibiotics namely ceftriaxone, azithromycin and metronidazole which accounted for 16.41% (n=65) of prescriptions. The high use of amoxicillin may be due to the fact that amoxicillin is the drug of choice for respiratory tract infections such acute sinusitis, acute otitis media, acute exacerbations of chronic bronchitis and community acquired pneumonia for patients under 60 years of age with no comorbidity (Rossiter et al., 2016). Co-amoxiclav is popular as it is a combination of amoxicillin with clavulanic acid and has the same indications as amoxicillin, however, this combination is not as resistant to bacteria as amoxicillin. The combination of ceftriaxone, azithromycin and metronidazole is a combination of antibiotics is used to treat

sexually transmitted infections such as vaginal discharge syndrome in sexually active women, male urethritis syndrome if the sexual partner has vaginal discharge syndrome and lower abdominal pain in accordance with the PHC STG (NDoH, 2018). The sexually transmitted infection guidelines were changed in 2015, cefixime is no longer in the guidelines as it has now changed to ceftriaxone intramuscularly, while ciprofloxacin is no longer in the guidelines for penicillin allergies. The changes were made as ceftriaxone intramuscularly is highly efficacious in treating *Neisseria gonorrhoea* at all anatomical sites, improves adherence and due to the increasing resistance of gonococcal strains to cefixime and ciprofloxacin (NDoH, 2015). The nurses are not taking a detailed history in patients who present with a sexually transmitted infections, which guides therapy as well as patients receiving incorrect and incomplete treatment regimens creates resistance. Efforts should be made to preserve the current combinations used for treatment. The combination restores the effectiveness against many organisms. Ciprofloxacin, metronidazole, azithromycin and co-amoxyclav (amoxicillin and clavulonic acid) were also frequently prescribed at the PHC clinics. Macrolides such as azithromycin are well-established, safe, well-tolerated and is the antibiotic of choice for community acquired respiratory tract infections in some countries (Wierzbowski et al., 2006). The newer macrolides such as clarithromycin and azithromycin are regularly prescribed as first or second line therapy (Carbon and Poole, 1999). Macrolides are also commonly used for respiratory tract infections in patients that are allergic to penicillin which makes them the popular antibiotic of choice (NDoH, 2018). In this study, fluroquinolones like ciprofloxacin were commonly prescribed for urinary tract infections. Flucloxacillin was commonly prescribed for skin conditions such as boils or abscesses. In countries like Pakistan, metronidazole is the most prescribed antibiotic for gastrointestinal infections (Sarwar et al., 2018). In this study, common diagnosis for which metronidazole was correctly prescribed included gastrointestinal infections and bacterial vaginosis and incorrectly prescribed for lower backaches and vaginal candidiasis. Many of the antibiotics on the list correspond with the list of frequently prescribed antibiotics utilised at the PHC clinics in Cape Town (Gasson et al., 2018). The least common antibiotics prescribed across all the clinics which accounted for 0.25% (n=1) were mostly combination of antibiotics such as amoxicillin and chloramphenicol, ceftriaxone and amoxicillin, ceftriaxone, metronidazole and doxycycline, cephalexin, flucloxacillin and metronidazole, a combination of cefazolin, azithromycin and metronidazole and phenoxymethylpenicillin and ceftriaxone. The combination of cefazolin, azithromycin and metronidazole was prescribed for vaginal discharge syndrome which is not in line the PHC EDL and cefazolin is not on the PHC EDL. The other unusual combinations of antibiotics were

for patients that had multiple conditions such as urinary tract infections together with upper respiratory tract infections. The three most common antibiotics prescribed at each clinic can be seen in Table 4.3.

Table 4.3.The three most common antibiotics used in each clinic

Clinic	Most common antibiotics	Antibiotic used in clinic (%)
Region A	1. amoxicillin 2. phenoxymethylpenicillin 3. ceftriaxone, azithromycin and metronidazole Other	42.11 15.79 13.16 28.94
Region B	1. amoxicillin 2. ciprofloxacin 2. ceftriaxone, azithromycin and metronidazole 2. phenoxymethylpenicillin 3. flucloxacillin Other	24.14 13.79 13.79 13.79 10.34 24.15
Region C	1. amoxicillin 2. ceftriaxone, azithromycin and metronidazole 3. ciprofloxacin 3. metronidazole Other	52.38 15.48 8.33 8.33 15.48
Region D	1. amoxicillin 2. phenoxymethylpenicillin 3. flucloxacillin Other	48.28 17.24 8.62 25.86
Region E	1. ceftriaxone, azithromycin and metronidazole 2. amoxicillin 3. phenoxymethylpenicillin Other	39.13 28.26 10.87 21.74
Region F	1. amoxicillin 2. ceftriaxone, azithromycin and metronidazole 3. phenoxymethylpenicillin Other	40.86 17.20 11.83 30.11
Region G	1. Amoxicillin 2. trimethoprim/sulfamethoxazole 2. co-amoxyclav 2. phenoxymethylpenicillin	70.00 10.00 10.00 10.00

Amoxicillin was the most common antibiotic seen in the prescriptions at the clinics in region A (42.11%), region B (24.14%), region C (52.38%), region D (48.28), region F (40.86%) and region G (70.00%). The retrospective review period of prescriptions was during the winter months in South Africa and a study by Kontarakis et al. (2011) states that there are seasonal variations in antibiotic prescribing with the number of antibiotics prescribed increasing during the winter months for respiratory tract infections; hence amoxicillin was a common antibiotic prescribed across six of the seven clinics. The clinic in region E had a combination of antibiotics ceftriaxone, azithromycin and metronidazole that was the most prescribed at the clinic (39.19%). The ceftriaxone, azithromycin and metronidazole combination was the third most prescribed antibiotics in region A (13.16%) and in region B (13.79%) while this

combination was the second most prescribed in region C (15.48%) and in region F (17.20%). The clinics in regions A-F all have this antibiotic combination in the top three most common antibiotics prescribed at the clinics, indicating that patients presenting with sexually transmitted infections are common at the majority of the PHC clinics. Half a million young people were treated for sexually transmitted infections over a period over two years in Gauteng (Nyoka, 2017). The high rates of sexually transmitted infections at the PHC clinics could also be attributed to the high levels of migration to Johannesburg in search of better job prospects as all of the clinics visited were in developed areas (Johnson et al., 2005). In the ceftriaxone, azithromycin and metronidazole combination, the ceftriaxone needs to be administered intramuscularly which requires trained administrators as viruses such as hepatitis and HIV may be transmitted through the use of needles. If an injection is administered incorrectly it can also cause severe nerve damage in patients (Pavin et al., 2003). Other popular antibiotics that were in the top three most prescribed antibiotics at some of the clinics in each region included antibiotics like phenoxymethylpenicillin which is commonly used against tonsillitis and pharyngitis.

It was noticed on prescriptions that when patients presented with symptoms of TB, amoxicillin was prescribed in the meantime while awaiting GeneXpert results. The patient had their sputum collected for GeneXpert testing (a test used to detect tuberculosis and rifampicin resistance), however, although TB was presumed in the patient an alternate diagnosis such as bronchitis, acute viral rhinitis and cough was stated on the prescription and an antibiotic was prescribed. This is confirmed by the study conducted by Neshati et al. (2018) where the majority of TB patients were treated for alternative diagnoses such as a common cold, bronchitis or pharyngitis. This is incorrect because viral infections and the presence of a cough in patients does not necessitate antibiotic particularly amoxicillin use in the meantime while waiting for GeneXpert results. According to the National TB Management Guidelines a person suspected of having TB should have their sputum sample collected for GeneXpert testing, if the results are negative and if the patient is HIV negative an antibiotic should be prescribed for the patient, and the patient should be reassessed after one week. Considering the National TB management Guidelines there is no indication for an antibiotic to be administered to the patient while waiting for the GeneXpert results which take about 48 hours (NDoH, 2014). These practices increase antibiotic resistance in South Africa. Further research needs to be done to understand the rationale as why this practice occurs in PHC clinics.

Even though TB is a universal health challenge, South Africa has a high burden of patients afflicted by TB, thus the PHC nurses should consider TB as a presumptive diagnosis. It has been stated that the prevention of TB has been a neglected aspect of TB control (Churchyard et al., 2014). The strategies highlighted in the National TB Management Guidelines focus on prevention and includes factors like early diagnosis of TB and early initiation of treatment amongst other factors (NDoH, 2014). A study conducted in South Africa showed that 69.00% of early deaths in patients on antiretrovirals were associated with undiagnosed TB (Wong et al., 2012). Thus, it is very important that every patient that enters the PHC clinic regardless of their concern should be screened for TB and not only patients that complain of respiratory symptoms and are HIV positive (McCreesh et al., 2016).

4.3 Screening patients at PHC clinics for TB

A study conducted by Daniels et al. (2019) in various countries including South Africa found that three classes of medications were prescribed for patients who presented with a classic TB case. The medications prescribed for patients suspected to have TB included broad-spectrum antibiotics, fluoroquinolone antibiotics and steroids. These medications can be harmful for the patient and are unnecessary and may mask TB symptoms which will further delay diagnosis. As patients that present with respiratory tract infections have some symptoms that coincide with some of the symptoms of TB, it is important to differentiate between TB and other respiratory infections as TB is an infectious disease that is commonly subjected to diagnostic errors by healthcare professionals. This should be avoided as a missed or delayed TB diagnosis can affect the patient and the community adversely. A research article by Neshati et al. (2018) states that numerous recently conducted studies demonstrate that a TB diagnosis is subject to substantial errors which include diagnostic errors such as over and under diagnosing TB. Missed or delayed TB diagnosis can be disastrous as it not only affects the patient but the community may be affected through delayed treatment as there is an increased period of infectivity which leads to an increased transmission of disease, and increased medical costs if the patient develops multidrug resistant TB and mortality in some cases (Neshati et al., 2018).

Some of the PHC clinics visited in this study used a TB screening tool which is a checklist that the PHC nurses used to determine if the patients had any symptoms of TB. The four symptoms of TB on the checklist used as a screening tool are: a cough for more than two weeks or any

duration if the patient is HIV positive, unexplained weight loss of 1.50kg in a month, drenching night sweats and persistent fever for two or more weeks. The checklists were stamped on the prescriptions in some of the clinics visited, while some clinics like the clinic in region D did not have the TB screening stamp on the prescriptions. Table 4.4 demonstrates the total number of prescriptions analysed at each clinic and how many patients' prescriptions had the TB screening stamp on them as well how many sputum samples from each clinic were sent for GeneXpert testing.

Table 4.4.Table depicting number of sputum samples sent for GeneXpert testing and number of patients that were screened for TB

Clinic	Number of scripts at the clinic	Number of sputum samples taken for TB GeneXpert n (%)	Number of patients that the nurses checked for TB using a TB symptom checklist and was recorded on the prescription n (%)
Region A	76	1 (1.32%)	57 (75.00%)
Region B	29	2 (6.90%)	27 (93.10%)
Region C	84	1 (1.19%)	2 (2.38%)
Region D	58	1 (1.72%)	0 (0.00%)
Region E	46	1 (2.17%)	41 (89.13%)
Region F	93	0 (0.00%)	1 (1.08%)
Region G	10	0 (0.00%)	6 (60.00%)
Total	396	6 (1.52%)	134 (33.84%)

The clinic in region B had the highest percentage of patients screened for TB, with the TB screening tool recorded on the prescriptions (93.10%; n=27). The clinic in region C only had 2.38% (n=2) while the clinic in region F had 1.08% (n=1) of prescriptions that had a TB screening tool stamped on them which indicated that TB screening was done for those patients. Overall, across all clinics only 1.52% (n=6) of patients had sputum samples taken for GeneXpert testing while only 33.84% (n=134) of patients had records of TB screenings done on the patient prescriptions.

From the results obtained only a few patients were screened for TB and had this screening recorded on the prescription. It is not known if the PHC nurses did screen the patients for TB and requested sputum samples for GeneXpert testing but recorded it elsewhere and not on the patient prescription. Nurses should also bear in mind when writing notes to ensure that the notes are detailed enough and have the relevant information in one place so if the patient comes

back to the clinic their colleague treating the patient has the full patient history including the tests that were conducted with the relevant results. In a study conducted by Christian et al. (2018) at PHC clinics in the Western Cape and the Eastern Cape, even though TB sputum tests were conducted in 84.00% of visits, the authors still suggest that there is room for improvement therefore much more needs to be done at the PHC clinics within the City of Johannesburg in terms of TB screening, the recording of TB screening and the collection of sputum samples for GeneXpert testing.

When the nurse checks if the patient has any of the four main symptoms of TB, if the patient has even one symptom of TB the patient should have sputum samples sent for GeneXpert testing (Black, 2013). This, however, cannot be done in South Africa due to the cost of the test instead the TB symptom should be investigated appropriately. A study conducted by Neshati et al. (2018) in Iran, demonstrated that one of the most common type of errors in the diagnosis of TB made by healthcare professionals was failure to take a complete history and physical examination of the patient. A study conducted by Christian et al. (2018) in South Africa found that the PHC nurses most frequently asked patients about their history of coughing which implied that the PHC nurses relied solely on this one symptom of TB in order to determine if the patient should have their sputum sent for testing. The study also found that less than 50.00% of the patients that visited the PHC had physical examinations linked to TB screening done (Christian et al., 2018).

Patients with active, multidrug resistant TB can infect large numbers of individuals who are HIV positive which can lead to significant outbreaks of multidrug resistant TB which has high fatality rates and therefore prevention is the crucial to successful multidrug resistant TB control (NDoH, 2014). Failure to complete a full course of TB treatment encourages the development of multidrug resistant TB which is difficult and costly to treat and has poorer outcomes in patients (WHO, 2009).

Chapter 5

Qualitative semi-structured interviews

This chapter provides the results obtained from the qualitative interviews and provides a discussion on the opinions expressed in the interviews. This chapter highlights and explains the four main themes identified in the qualitative interviews which are factors and challenges that influence antibiotic prescribing, factors that contribute to antibiotic resistance in the PHC clinics, strengths in antibiotic prescribing at the PHC clinics and improvements to antibiotic prescribing. Furthermore, this chapter links the quantitative data to the qualitative data obtained.

A total of eight interviews were conducted across all seven PHC clinics and the average time for the interviews was around 37 minutes. The four main themes were identified by conducting a thematic analysis and these themes and subthemes can be seen in Table 5.1.

Table 5.1.Themes and subthemes derived from the interviews

Themes	Subthemes
5.1. Factors and challenges that influence antibiotic prescribing.	**5.1.1**. Patient related factors **5.1.2**. Prescriber related factors **5.1.3**. Facility related factors
5.2. Factors that contribute to antibiotic resistance in the PHC clinics	**5.2.1**. Patient related factors **5.2.2**. Prescriber related factors **5.2.3**. Facility related factors
5.3. Strengths in antibiotic prescribing at the PHC clinics	**5.3.1**. Correct prescribing **5.3.2**. Collaboration **5.3.2**. Advancements
5.4. Improvements to antibiotic prescribing	**5.4.1**. Education **5.4.2**. Resources at the PHC clinics

The themes determined from the qualitative assessment will be further elaborated on, with subthemes expanded.

5.1 Factors and challenges that influence antibiotic prescribing

Based on the quantitative data in obtained in objective 1 and 2, in order to determine the factors and challenges that influence the PHC nurses when prescribing an antibiotic, three subthemes emerged under this theme which are: patient related factors, prescriber related factors and facility related factors.

5.1.1 Patient related factors

5.1.1.1 Language barriers

Patient related factors that influence and pose a challenge to the nurses when prescribing antibiotics included patients faking symptoms in order to receive antibiotics, patients demanding and expecting antibiotics as well as language barriers. The patients that utilise the PHC clinics are not always South African patients and thus there may be language barriers between the prescriber and the patient. This is depicted in the quotation that follows.

> **Participant F1** stated, "In this clinic the foreigners especially the Somalians they think we do not hear their language sometimes when they tell the children eight, nine, ten years old something. I write the word then if I get the ones that are coming from school that are South African born that speak English I will ask them what is qufac In Somali? cough cough so that means the mother has told the child because the child is with me you must cough and you can see the child is forcing the cough."

In South Africa alone there are 11 official languages, and this does not include the languages spoken by the foreigners of the country which often use these PHC clinics. The healthcare professional, which in many cases is a nurse, cannot know every spoken language. At the clinic situated in region F as depicted in the above quotation, the prescriber did not understand the language spoken in the above instance by the mother to the child who forces the child to cough in order to receive an antibiotic as they perceive the nurse will prescribe an antibiotic because the child is coughing. In a multilingual society, a key barrier that hinders effective communication between the healthcare provider and the patient occurs when the healthcare providers and the patients do not share the same first language. Participant F1 seemed frustrated

with the patient, this is confirmed by Hussey (2012) as the author states that language barriers make communication time consuming for prescribers which increases frustration levels and decreases empathy. The language barrier or the patients' level of literacy poses a threat that may potentially be life-threatening to the patient as a result of misdiagnosis and mismanagement of disease (Lesch, 2007). In order to address language barriers in the healthcare sector, interpreters, who are often bilingual relatives such as children or non-medical staff, are habitually called upon to help remove the language barrier. The quote above confirms this as the PHC nurse in region F states that she often asks a child that speaks both languages to help translate key words to her to facilitate patient interactions, however, using family members, cleaners, other clinic staff or other patients as interpreters raises important ethical dilemmas as it can sometimes violate patient confidentiality (Schlemmer and Mash, 2006; Hussey, 2012).

5.1.1.2 Patients faking their symptoms

Another factor that challenges and influences prescribing is patients faking symptoms in order to receive an antibiotic. This can also be seen in the quotation by participant F1 under section 5.1.1.1 above and is also stated by participant B1.

> **Participant B1** stated, "…so, what I do if a patient complains of PV (*per vaginal*) discharge. I don't just say yes, PV discharge, for how long Carla? and an and and just give. I want to see it. Coz *(because)* I know these people who just come to you and say stories and you check, if you have eh eh uncomfortable discharge you'll have a panty liner or something because obviously your panty would be very wet and and you don't want people to see what's happening. There's nothing, the panty is dry and this story is I just went to the toilet but you journeyed from wherever to the clinic. So, in that journey they should at least something even if it's not wet, I'll see a stain and you find that there's absolutely nothing. They just want it because they believe they're going to clean themselves."

A study was conducted during the winter months in South Africa, where researchers sent undercover patients who were not actually sick to private general practitioners and public clinics stating that they have symptoms such as a cough and a cold that is getting better.

Typically the “patients” were trained to state symptoms that would indicate acute bronchitis which would not necessitate the use of antibiotics, however, three-quarters of patients that were sent to doctors and clinics were prescribed antibiotics for no reason as the patients were just pretending to be ill (van Dyk, 2019). In the above quotation the nurse confirms that patients’ fake symptoms in order to receive antibiotics, therefore, a thorough physical examination and careful assessment of patient’s symptoms during the consultation should be considered before prescribing antibiotics.

During the interviews a trend was noticed where prescribers mentioned female patients came into the PHC clinics wanting metronidazole as they believed it helped clean their womb. This is why female patients frequently came into the clinics complaining of vaginal discharge in order to receive metronidazole. The prescribers, however, did not know if this myth was true or not.

Participant C2 stated, “…most of them most of the people who come here patients that come here to (inaudible) Flagyl *(metronidazole)* they say it cleans the womb or before they go on period after they went on period, they demand Flagyl to clean the womb.”

Prescribers at the PHC clinics should be aware of the myths surrounding antibiotic use so they can adequately educate patients and clarify any misunderstandings that the patient may have, which may change the patients mind to receiving an antibiotic. Metronidazole is an antibiotic and therefore, will only be effective in eradicating bacteria and cannot be used for other uses such as cleaning the womb. The myth may have emerged from patients receiving metronidazole in order to treat sexually transmitted infections according to the PHC STG (NDoH, 2018). A participant also mentioned that when they did perform a physical examination in patients and saw no indication for prescribing an antibiotic, the patient demands an antibiotic as stated in the quote.

Participant F1 mentioned the patient related factors which include, "I tell her if your child is at school and the child vomited last night now you not sending him to school you coming to the clinic but he hasn't vomited this morning and he is, seven, eight years old if he vomits with every vomit give him a glass of water but if it is three, four, five times then you come. No! no! no! they want an antibiotic for the first vomit…the child is very sick, my children are dangerous they don't tell you my children are very sick they tell you my children are dangerous that means they very sick, my child's nose is raining, my child's mouth is smiling when its smelling smiling... I look into the throat I say mummy his throat is normal, auscultate the chest, the chest is clear then you don't give an antibiotic then she starts fighting, screaming, shouting."

The participant again reinforces language barriers between the patient and the healthcare provider which can result in misunderstandings. Common words to describe patient symptoms such as bad breath and a runny nose are miscommunicated, however, with time prescribers will understand keywords in other languages. Although, the majority of the prescribers in the survey disagreed or strongly disagreed that they feel pressure from patients to prescribe antibiotics, and only few prescribers indicated that they often or always prescribe antibiotics when the patient demands and expects an antibiotic. The patient fighting, screaming and shouting demanding antibiotics may be a reason why they feel pressure to prescribe an antibiotic and are forced to prescribe an antibiotic in order to avoid a commotion at the clinic, as the retrospective review of prescriptions indicated that majority of the antibiotic prescribing was incorrect. In a study conducted by Lum et al. (2018) in Australia, the general practitioners interviewed indicated that patient expectations to receive antibiotics is one of the significant challenges to prescribing. In the study a doctor spoke of "caving in" to patient expectations to prescribe antibiotics as they were exhausted in trying to persuade the patient otherwise and therefore just took the path met with the least resistance from the patient (Lum et al., 2018). In South Africa, a study conducted at PHC clinics also demonstated high rates of unnecessary antibiotic prescribing at these PHC clinics which were often associated with patient demands for an antibiotic, however, the study indicated that although patient demands for an antibiotic was an important factor it was not as significant as prescribers made it out to be (The Centre for Health Policy, 2017). A study found that doctors that just started their career were less successful managing patient expectation for an antibiotic while the more experienced doctors

are more skilful in communicating with patients and could therefore diffuse emotional and professionally awkward situations (Lum et al., 2018). The above participant had over 20 years of experience yet was unable to communicate effectively with the patient. Managing patient demands for an antibiotic is complex, as it is important for the prescriber to maintain the patients trust therefore, well-honed strategies and advanced communication skills which may include shared decision making is needed as communication skills training have been found to significantly reduce antibiotic prescribing without adversely affecting patient outcomes. Patients visiting the PHC clinics need more information on when to visit the PHC clinic and what conditions necessitate the use of antibiotics as patients cannot be visiting the PHC clinic and demand an antibiotic for a cough.

It is important for prescribers to determine the patients agenda for the consultation, this should preferably be done at the beginning of the consultation and prescribers should not assume that the patient expects an antibiotic (Lum et al., 2018).

Participant D1 indicated, “They Google their symptoms, come here and demand eh eh antibiotic and when you refuse and explain to them that this condition does not warrant, and they say Google says.”

Patients are taking more control of their health by using the internet to seek more information related to illnesses and treatment (Dickerson et al., 2004). This is also depicted in the quotation above. Just as some prescribers indicated that they use Google in the surveys for their learning on antibiotics, patients also search the internet as a source of information regarding health. This is also confirmed in a study conducted at CHC clinics and private general practice surgeries where a provider stated “People today go googling things. At times they’ll be telling you, “Sister, don’t you think I must get an antibiotic?” We will explain that this is viral. You don’t need an antibiotic. You just need rest, fluids, take your Panado. Your cough mixture” (Manderson, 2020). When patients search the internet, they may also fake symptoms to the nurse based on the conditions they researched that require antibiotic treatment therefore prescribers should be extra cautious when prescribing antibiotics in patients.

Participant D1 stated, “yeah and politicians interfere a lot neh cause a patient will come in demand an antibiotic and you say no your condition does not eh warrant me to give an antibiotic and they go out to the whoever in the community and that person comes back to say, why don't you give an antibiotic to this person?”

When prescribers do not prescribe antibiotics the patients usually go to a community leader who is influential, who comes to the clinic and asks the nurse why they did not prescribe an antibiotic, to which the nurse would just prescribe an antibiotic. This indicates that prescribers do feel pressure to prescribe an antibiotic even though most of them disagreed to the statement in the survey and even though most of the prescribers in the survey indicated that they were confident that they use antibiotics optimally, they do give in to patients demands. This makes patients lose trust in the prescriber.

5.1.2 Prescriber related factors

5.1.2.1 Patient history and symptoms

The prescribers ask the patients for a history and symptoms that they present with, which influenced their decision to prescribe an antibiotic for the patient. Specific symptoms like fever also influenced their decision to prescribe an antibiotic for the patient.

Participant C2 also stated, “We confirm (stutters) we confirm by few we take eh the history subjective that and objective that so we can do a diagnose…normally let’s say its upper respiratory tract infection we’ll ask for the duration, any fever accompanied? or any TB contact if the patient let’s say it’s a respiratory patient whether the patient is asthmatic? yeah this is the most specific questions.”

Participant E1 based their decision on these patient factors, “…if the patient has TB symptoms or contacts, uhm if there’s any mental health conditions, if the patient is smoking, drinking alcohol because those are also influencing the medication.”

Participant B1 stated, “And now they've developed a fever or an obvious infection that need an antibiotic. I will do that, gladly give it.”

When determining if a patient requires an antibiotic, prescribers in South Africa as elsewhere typically consider clinical signs and symptoms that the patient presents with. This is confirmed in a study conducted by Manderson (2020) as the prescribing nurses and doctors in public clinics described that their decision making for treatment was based on patient symptoms and it was found in the study that specific variations in patients symptoms were considered to signal bacterial infection for prescribers. In the study by Manderson (2020) specific symptoms such as a bright red tympanic membrane in the ear, follicles and enlarged tonsils in the throat was an indication for when an antibiotic should be prescribed. This also occurred in this study as stated by participant F1.

Participant F1 stated "… it's a streptococcal we know we know upper respiratory tract we know respiratory tract infection is caused by streptococcus so when you look into the throat you will know if that's a (stutters) a tonsillitis upper respiratory tract infection but once it has follicles than your treatment changes …It's because of the diagnosis what you see if I look into your throat and its pink, its normal you don't need an antibiotic. Now because we don't have vitamin C, I give them a packet of vitamin B because they sat here for so long and they want something but if there's like excoriated red you can see it's a red throat the person the patient is pyrexial then I will order the a a an antibiotic.

This was also noticed during the retrospective review of prescriptions as antibiotics were prescribed for specific patient symptoms such as a fever. A study conducted in India also demonstrated that patients often came to the clinics for symptoms such as a cough, vomiting, fever and colds which do not require antibiotics for treatment (Nair et al., 2019). The PHC STG states that a fever itself cannot be a diagnosis and an indication for an antibiotic to be prescribed except in certain circumstances and the cause of the fever should be investigated as any undiagnosed fever should not be treated with an antibiotic (NDoH, 2018). Specific symptoms that are correct and are indicators for an infection such as those listed in the PHC STG can assist prescribers when making a diagnosis and should be used as indicators for diagnosis.

5.1.2.2 Patient expectations of prescribers

A challenge that influences prescribing is the patient's expectations of the prescribers. This is expressed in the quotation where prescribers cannot check resources online because patients expect them to know everything.

> **Participant B1** said, "…but here you need to go to your cell phone in the middle of consultation and not all the patients understand. They just think you have busy on WhatsApp. Even if you say mummy, I'm just checking something. Just feel like you know what you're supposed to be knowing everything that's wrong with them and all that."

In the survey, the majority of the nurses indicated that antibiotic prescribing guidelines and other resources were easily available at the clinic, but they may be online versions. The desk copies of the PHC STGs that were available at the PHC clinics to the nurses were an older version, hence some prescribers needing to access the newer online versions. Patients misunderstand the prescriber when the prescriber is checking information on their phone and feel like the prescriber is wasting time during the consultation by chatting instead of assisting them. This may be why tablet or smartphone apps were never or rarely useful for the nurses for that participated in the survey. The prescribers do not check the PHC STGs or the PHC clinical guide app when prescribing leading to prescriptions being incorrect according to the PHC STGs especially in clinics that do not have computers such as the clinic in region B so the latest guidelines can only be accessed by the prescribers by using their cellphones. Attempts should be made to ensure each PHC clinic consulting room has a computer so that the prescribers may check resources without the patient knowing as there are many antibiotic related errors that occurred at the PHC clinics.

Additionally, when resources are unavailable, the prescribing nurses should not be afraid to consult another colleague. A study conducted stated that student or newly qualified nurses found it difficult to ask for help as it may give the impression that they are not sufficiently capable or felt ashamed to ask colleagues for help (Ketelaar et al., 2015).

5.1.2.3 Clinic hopping

A challenge that prescribers have with patients is "clinic hopping" where they visit multiple clinics when they do not feel better immediately instead of returning to the same clinic and some patients complain that they do not have transport or money for transport to visit a CHC clinic.

Participant E1 indicated, "One of the things that I've also find out, are that patients go from clinic to clinic (laughs) and if this problem for example if I treat him and uhm his not getting better he go to another clinic he go and so the patient is every time as a new client by a different facility, instead of coming back so that we can uhm treat the problem. Uhm that is my (laughs) opinion."

A study by van Hecke et al. (2019) states that the prescribers which were primary care clinicians in South Africa stated that they perceive patients tend to "clinic hop" in order to obtain the antibiotics they want. At the South African PHC clinics, the study further states that patients are rarely given follow up appointments to follow up on acute cases (van Hecke et al., 2019). Patients want an instant cure, so they try the prescribed medicine for a day or two and if this does not work, they go to some other doctor instead of following up and returning to see the same prescriber (Kotwani et al., 2010). This was also done at the PHC clinics visited, instead of patients visiting the same clinic over and over again if they do not feel better, the patients go to a clinic where they know they will receive an antibiotic as they perceive an antibiotic will result in a faster recovery rate. This increases frustration in prescribers who use antibiotics rationally as this sends a mixed message to patients. At worst, this behaviour encourages patients to perversely seek out prescribers or clinics where they know an antibiotic will be prescribed (Lum et al., 2018). From the seven PHC clinics visited, only one PHC clinic had an electronic prescribing system. The electronic prescribing system is aimed to be implemented at all clinics and hospitals so that the health of patients can be tracked overtime irrespective of which healthcare facility or provider they use (Hlabangane, 2015). This would assist the PHC nurses by checking if the patient already consulted another health professional.

5.1.2.4 Limited access to CHC clinics

The PHC nurses are often limited in the choices and are forced to make difficult decisions as some patients are poor and cannot afford to come back to the clinic or visit a CHC clinic.

> **Participant D1** stated, "Patient refuses to go to CHC because the common problem when you refer to CHC because we only have doctor once a week here. The common problem is I don't have money for transport to get to a CHC and it becomes difficult for me."

On one hand patients visit multiple clinics to get an antibiotic while on the other hand patients that visit the PHC clinics cannot always afford to visit the PHC clinic again or make their way to a CHC clinic that they may be referred to as they cannot afford to pay for transport. A study conducted by Anstey Watkins et al. (2019) studied the perceptions of antibiotic access and use in the South African rural communities and it was found that the cost of public transport such as using a local taxi from the village to the PHC clinics was a concern for the participants. Women and children were frightened to walk to the clinics as they were afraid of being attacked or being raped on the way. This type of social disorganization is not uncommon in South Africa. In general, patients are most likely to receive an antibiotic prescription if they lived in a poor community or if they travelled a long distance to access the PHC clinic as there were obvious or assumed difficulties for them to return (Manderson, 2020). Most patients relied on free antibiotic treatment from the PHC clinics, however, patients did buy over-the-counter medication such as painkillers, cough syrups and anthelminthics while a minority of patients consulted a doctor and paid for their antibiotics at the pharmacy and therefore valued the medication they paid for and perceived it to be of a higher quality as compared to the free medication received from the PHC clinics (Anstey Watkins et al., 2019). The prescribers also prescribe medication as they feel that patients have usually tried symptomatic treatments before visiting the clinic and because the patient spent money to come to the clinic and waited for a consultation they have to prescribe something for the patient (Manderson, 2020). This was also mentioned by participant F1 under section 5.1.2.1 patient history and symptoms where the prescriber felt that they had to give the patient something such as a packet of vitamins even if the patient was not sick as the patient wanted something from the prescriber as they waited for a long period of time at the clinic.

5.1.2.5 Uncertainty in prescribing

A factor that influences prescribing is the patient already taking multiple medications; the prescriber would use their discretion and prescribe something for a shorter duration to increase patient compliance to the antibiotic course. This is consistent with the results in the survey as all the prescribers in the survey indicated that patients not finishing their course drives resistance. Most of the prescriptions reviewed during the retrospective prescription analysis had no drug-drug interactions, which may suggest that the patient's medication history is reviewed as the nurse knows the patient is taking multiple medication as indicated in the quotation.

Participant C1 indicated, "Yeah, sometimes I it does, sometimes you find a patient is taking a lot of treatment like different kinds of treatment and then that person already has a burden of pills. So, when we look at that person condition like today, maybe his got an infection and then you go for eh a shorter way so that this person can also tolerate the antibiotics, especially you can also finishes the antibiotic the antibiotic that you are giving them because now the person is having a lot of pills to take and now you adding another..."

Participant C2 further stated, "Normally if the patient present with different kinds of conditions is eh antibiotic, we use a broad-spectrum antibiotic for such patients."

Participant G1 stated their challenges as, "Uhm it's very difficult when you have treated the person, and then they come back with the very same eh problem."

Participant B1 further stated, "Like we don't have the newest uhm EDL, we still have 2014 by the time we get this one that is currently in the…they would have published another one… It is sometimes challenging; you'll find that there's a patient with multiple infections and then you don't know which one to prioritize."

The prescribers have limited resources at the PHC clinics and do not have access to the latest version of the PHC STGs at the clinics which can influence the way they prescribe. This could be a reason as to why the antibiotic prescriptions were incorrect according to the PHC STG even though all the prescribers indicated that they consulted the PHC STG in patients with no bacterial culture information as is the case in patients that visit the PHC clinics. The same

applies to the other resources such as the SAMF. The 2014 PHC STG is an outdated version of the STG and should be replaced with the current version available as the PHC STGs are only updated every couple of years. The operational managers at the clinics should follow up and ensure that the latest versions are available in an attempt to minimise prescribing errors. A prescriber also found prescribing for repeated infections challenging. When asked in the survey if the nurse prescribers found antibiotic prescribing challenging, the majority of them disagreed or strongly disagreed to the statement, yet in the interviews they stated that patients who presented with multiple infections and patients who have recurring infections are found to be challenging cases when prescribing antibiotics. Factors such as prescriber uncertainty on the cause of infection and treatment outcome contribute to the increasingly dangerous use of antibiotics (Manderson, 2020). When dealing with diagnostic uncertainty, prescribers often prescribe antibiotics to cover themselves or to prevent secondary bacterial infections as the PHC clinics do not have laboratory facilities available to confirm diagnosis and they rely on their clinical judgement (Kotwani et al., 2010; Nair et al., 2019). In cases where prescribers are unsure of antibiotic treatment for patients, the patients should either be seen by the doctor at the PHC clinic or referred to a different level of care such as a CHC by following the referral pathway.

5.1.2.6 Experience and prescribing

Another prescriber related factor that influences prescribing is the experience and confidence gained, which decreases the amount of errors that the prescriber makes as compared to when they just started prescribing.

Participant C2 also expressed, "Eh like prescribing sometimes you be prescribing maybe underdosing or present the wrong antibiotic so now with more consultations the more I see eh patients the more now, so I gain more confidence and experience…no sometimes we do deviate from the guidelines but not for the (laughs) emotions maybe if the conditions the patient has got two conditions maybe upper respiratory tract infections and otitis media it's not in the guidelines but that's where we deviate."

As the prescribing nurses gain more experience in the setting that they are working in by encountering different cases, observing doctors and colleagues they alter prescribing behavior

and learn from their mistakes. This could be why there were so many antibiotic errors at the clinics as the nurses may be new to the PHC environment as observed in region D where student nurses prescribed antibiotics. Nurses are often scared to overdose patients due to the adverse effects and therefore underdose patients to be on the "safe" side, the prescriptions therefore had more underdosing errors as compared to overdosing errors. At the PHC level, there is often a severe shortage of doctors, as a result, the nurses prescribed antibiotics based on their past experience observing doctors, as well as searching the internet for signs and symptoms the patient presents with (Nair et al., 2019).

5.1.3 Facility related factors

There are a few factors in the facility that challenge and influence antibiotic prescribing at the PHC clinics, some of the facility related factors that influence prescribing include technology and a shortage of resources.

5.1.3.1 Technology

With regards to technology, participant E1 stated in the quotation.

Participant E1 stated, "Uhm we use the system of the facility or the company that does work for COJ *(City of Johannesburg)*, but if the uhm system is offline than we going using our own network, our own phones and and data sometimes."

Participant (P) D1 stated, "Always there's a problem with connecting connectivity if I may put it that way.
Researcher (R): Ok
P: Yeah. Because the one that we trying so far is using our phones to obtain results via lab track.
P: It is, it is a limitation because now I want GeneXpert results or pap smear results and I call the lab, forever engaged their lines so the alternative is to go on lab track and sometimes I don't have data."

The PHC clinics differed in terms of infrastructure, as some clinics had computers and Wi-Fi while others did not. At the PHC clinics that did have Wi-Fi, the participants stated that it did not always work, and they often had to use their own data. In a study conducted by Anstey Watkins et al. (2019) in South Africa, four nurses mentioned that they had to make calls at least once a month for clinical emergencies and did this because they were concerned about the patients wellbeing, however, they were not pleased that they had to use their own airtime in order to make the calls. The PHC nurses had to use their own data if they were unsure of treatment for which they were not reimbursed. This could be a reason why guidelines are not checked since the latest versions were not available in a hardcopy on the desk but can be accessed online. The PHC clinics that do have computers should have the nurses download the latest versions of the guidelines available. The majority of the nurses that participated in the survey indicated that interactive internet-based resources would improve their antibiotic prescribing. A good and reliable Wi-Fi connection would be needed at the PHC clinics for this and the eHealth@Joburg system to be implemented to decrease antibiotic prescribing errors particularly incomplete prescription errors as seen in the retrospective review of prescriptions. When launching the eHealth@Joburg electronic prescribing it was said that the system would be connected by the wide-area network and in the event of power outages, the system would be connected to generators, a solar energy system, an uninterrupted power supply system and electrical reticulation, however, even though the clinic in region E has the electronic prescribing system the participant reported to having to use their own data when there is a power failure (Fourie, 2018).

5.1.3.2 Shortages of staff, medication and resources

Medication errors are caused by professional, managerial factors, work-related and lastly personal factors (Dumo, 2012).

Participant B1 stated, “Sometimes like in the region you find that we are short staffed and then we get somebody from another facility who comes here.”

Participant D1 stated, “It's depends. It depends on on the number of patients. Yeah. Some you forget, here they are too many and you have to see all of them.”

Shortages of staff, stock levels, not being able to take bacterial cultures, not having enough time with each patient are factors that influenced the prescriber's decision for an antibiotic, and these are also challenges at the facility that prescribers face when prescribing antibiotics. Patients that visit PHC clinics are expected to wait about three to four hours before they meet a health professional. A patient expressed frustration with the quality of care at the PHC clinics and attributed it to poor triaging, long queues prior to consultation, slow retrieval of patient files, limited time spent in consultations, lack of medication available at the clinic (seen by the patient as due to the failure of clinic staff to stock take), and poor management of staff time, including times for breaks. In order to reduce the time spent at the clinic, patients particularly women visited clinics where they knew they would have a satisfactory visit even if it meant the clinic was not the nearest clinic from their home (Manderson, 2020). In another study conducted in the Western Cape, providers complained that although the clinic complied with the number of staff in accordance with the approved post lists, the number of staff at the clinic was still not sufficient for the number of patients visiting the clinic. Service delivery at the clinic was further compromised by staff absenteeism, leave and compulsory training (Scheffler et al., 2015). A study was conducted by Dean et al. (2002) which analysed prescribing errors in a hospital and working conditions such as insufficient staff and heavy workload were identified as factors that contributed to medication errors. The prescribing nurses often have a long queue of patients that they have to attend to and therefore spend limited time with each patient during the consultation which may lead to them rushing, thus leading to the high number of prescribing and omissions errors in prescriptions.

Participant B1 stated regarding stock shortages, "Although I cannot think from the top of my head eh except for Bicillin (*benzylpenicillin*) we always had issues with Bicillin, eh I can't remember from the top of my head which other antibiotics had problems with sometimes you find that it's not depot's problem, it's us who eh is under stocked and you find that for that season, there is lot of those cases that need those eh kind of antibiotic. So yes, we do sometimes have Bicillin definitely."

As seen in the quotation above, sometimes the staff at the PHC clinic make a mistake when procuring stock for the clinic. Mismanagement in drug procurement procedures often result in a delayed supply of medication leading to stock-outs often followed by oversupply of medication. In some cases, the medication that is supplied is near-expiry and this leads to the over prescription of antibiotics as prescribers may try to finish off the stock before expiry (Kotwani et al., 2010). It is the responsibility of the PHC operational managers to monitor stock levels and replenish medication in order to maintain minimum and maximum stock levels (Muthathi et al., 2020).

The point of care tests would be useful in the PHC clinics particularly in low to middle income countries such as in the South African healthcare context. The point of care tests may be useful as broad-spectrum antibiotics are overused alongside the high risk of undertreating serious bacterial infections such as TB, inadequate lab facilities present and shortages of highly skilled staff at the PHC clinics. Clinicians who were either nurses or doctors at the PHC clinics in South Africa reported that were only a few antibiotic classes available to choose from at their clinics, antibiotics were often out of stock and because of budget constraints they were limited special investigations for patients (van Hecke et al., 2019).

Participant G1 indicated, "Right now, we have uhm the uhm I'm not so sure about the edition, but it's older. We don't have the latest edition, because ehh those editions should be supplied by the employer."

The above prescriber felt that it is the government's duty to supply all the clinics with the latest versions of the PHC STGs and it not her responsibility to ensure that she has the latest version of the PHC STG. A reason why prescribers deviate from the guidelines includes them substituting antibiotics with alternatives that are available at the clinics as stated in the quotation.

Participant C2 stated, "…No it depends on the type of antibiotic actually some of the antibiotics (stutters) there just no problem if we don't have, we can substitute."

Drug shortages are associated with increased medication errors as prescribers may be unfamiliar with alternative medications (Phuong et al., 2019). This may not occur at the PHC clinics in South Africa as the medication is known by their generic names as stated in the PHC EDL and STG instead of their brand names, however, an antibiotic maybe used as an alternative because of its vast coverage against a variety of micro-organisms.

Participant F1 stated about cultures "…TB with them their sputum's every sputum of a patient that is symptomatic of TB they do send a culture."

Participant F1 stated, "… at the end of the month I have to say how many did I screen under five and over five and then I will show you the stamp and I will show you every patient what is being done."

In the interviews, participant F1 mentioned that they ask patients if they experienced any symptoms of TB and if the patients had any positive symptoms, a sample of their sputum was taken and sent for testing, however, the quantitative results show that this practice does not occur at the clinic in region F as only a small percentage of patients had the TB checklist on the prescription. Participant F1 showed both the stamp and another book where the information on patients screened for TB was kept to the researcher which depicted that the TB checklist was not on the patient prescription but in another book. In region D, the nurses checked the patients for symptoms of TB themselves and this was not done in the vitals room by another nurse but rather in the consulting room by the prescribing nurse, however, none of the prescriptions had the TB checklist stamped on them.

5.2 Factors that contribute to antibiotic resistance in the PHC clinics

5.2.1 Patient related factors

Patient related factors that contribute to antibiotic resistance included buying antibiotics over-the-counter, patient education, sharing medication and patient compliance.

Participant A1 stated, “They must stop abusing antibiotics like um most of the patients buy antibiotics from the chemist which is wrong, the antibiotics you need to see a doctor and prescribe.”

Although antibiotics are only available with a prescription in many countries such as South Africa, they are often given to patients without a prescription across the world. The overall global prevalence of dispensing antibiotics over-the-counter (without a prescription) in community pharmacies is 62.00% (Auta et al., 2019). This practice is incorrect as is contributes to antibiotic resistance patterns. Studies should be undertaken in South Africa to investigate why this occurs.

Participant B1 stated,” Some of the patient who comes in demand antibiotics is because of lack of knowledge. They just believe that everything with an antibiotic I’ll be ok… this one will be consulting on their behalf and coming especially with chronic medication because they have once been diagnosed with hypertension or antiretrovirals. So, this other patient will come to this facility for this other person to take medication and they will receive at the other facility for themselves. So that's what is currently happening.”

A survey conducted revealed that nearly half of parents tend to save leftover antibiotics prescribed for their children while nearly three-quarters of those parents gave the excess antibiotics to someone else without consulting a doctor (Dall, 2018). This indicates that the parents do not ensure that the patient which is their child completes the antibiotic course. Patients admitted to not finishing their prescribed antibiotics and indicated that they either disposed their leftover antibiotics in the outdoor toilets, kept them for the next episode of illness or shared the medication with neighbours and family members (Anstey Watkins et al., 2019). Disposing of antibiotics in the toilet is harmful for the environment and can be accessed by people who should not have access to the antibiotics including small children.

Participant C1 expressed, “Then I think even the the frequency of the antibiotic sometimes is can lead to that because now if I have to take it for now say like eh flucloxacillin have to take it eh Q QID *(every six hours)* and then that one four times it’s not really easy to take those pills.”

Nurses perceive and are of the opinion that prescribing an antibiotic four times a day affects patient compliance, however, in a study conducted in Norway there was overall good compliance in treatment even with regimens of four doses per day and there was no significant difference in patient compliance with a three doses a day regimen versus a four doses a day regimen (Eide et al., 2012). This may, however, be different in South African patients. Patients need to complete the course of antibiotics as prescribed in order to prevent resistance therefore in a study conducted, the doctors prescribed antibiotics for three days so that the patient can return for the follow up appointment (Nair et al., 2019). In South Africa, this may not work as some patients cannot afford to visit the clinic on multiple occasions as they may need to take off work for an additional day and patients may not return if they feel better which in turn creates resistance in patients and therefore the PHC STGs should be followed for duration of antibiotic therapy.

5.2.2 Prescriber related factors

5.2.2.1 Incorrect antibiotic prescribing practices

The nurses stated a few habits that were incorrect and can contribute to resistance. These errors are depicted in the quotations.

Participant A1 stated, “I’ll give the antibiotic neh, for that cough which is, I’ll prescribe antibiotic ahh Amoxil 1g *(gram*) TDS (*every 8 hours)* neh for five days.”

Participant F1 stated,” ...you will pick up a lot of this will come from experience where you don’t have to resort to your protocol. In fact, I don’t know when last I used a protocol must be over ten years ago I haven’t used it.”

Participant C1 said “...I think some other personnel they do under prescribed they dosage specifically the dosage they I don't know whether they are scared to prescribe or what but they kind of underdose those patients.”

Participant G1 said, “I feel guilty that I could have given this instead of this knowing very well that what I gave was not gonna *(going to)* to help at all…I gave this and she was like no you were supposed to give this and this and this and that. I was like you know what eh

This statement is consistent with the results of the survey as the majority of the nurses indicated that inappropriate use of antibiotics is professionally unethical which is why the nurse experiences guilt. The statement made by participant G1 depicts dissonance between the knowledge of the prescriber and their prescribing practices. The prescriber knew that the antibiotic would not help the patient, yet the antibiotic was prescribed and was aware that in doing so a breach of best prescribing practice occurred. Self-acknowledgement of this behaviour resulted in the prescriber feeling a range of emotions such as disappointment in themselves, a sense of guilt as depicted in the quotation above and can also lead to feelings of being manipulated as well as exhaustion. Participant G1 did identify the error made by her and made a resolution to never repeat the mistake in the future, thus a lesson was learnt and a change in practice has occurred, making such events less likely to occur in the future (Eldar, 2002).

Prescriber related factors and practices that contribute to resistance includes incorrect prescribing. Incorrect prescribing practices were noticed at almost all the clinics in the retrospective analysis as antibiotics were being given for specific symptoms such as a cough which does not necessitate antibiotic use but rather the cough should be investigated and if the cough is due to pneumonia an antibiotic should be given. Other prescribing errors included prescribers not referring to the guidelines because of experience, as well as underdosing antibiotics. The prescriber that mentioned other personnel at the clinic underdose patients was from region C and the antibiotic prescriptions analysed in region C did have a small percentage of underdosing errors. The prescribers may find it difficult to correct other prescribers on their prescribing errors as some nurses may take offence to it and they feel it is not their responsibility to correct the errors of their colleagues as stated in the quotation.

Participant D1 (P) stated, "Some people take offence when you show them their mistakes so.

Researcher (R): So, it just depends on the person?

P: It depends on the person exactly.

R: Ok and ethically what do you think about that? Should you tell the person or not?

P: I think my supervisor has to not me, our boss."

A study conducted in Spain depicted the attitude of external responsibility in primary care physicians, this can also be seen in this study as well as in the survey most of the nurses agreed that other nurses overprescribed antibiotics and this is mentioned again by participant C1 where the participant mentioned other personnel underdose antibiotics, this is why feedback on prescribing is important at these clinics so prescribers may become aware of their shortcomings and take responsibility of their behaviour instead of passing the blame on colleagues and other healthcare professionals (Vazquez-Lago et al., 2012). Guidelines are updated when new scientific research becomes available including the development of new technologies in treatment, diagnostic alternatives, or changes in values and preferences and therefore should be consulted to familiarize oneself with the changes regardless of clinical experience (Vernooij et al., 2014).

5.2.3 Facility related factors

Facility related factors that contribute to resistance include facilities that readily prescribe antibiotics as well as facilities not educating patients on antibiotic use as stated in the quotations.

> **Participant B1** stated, “They'll even quote that such and such a clinic have been or this province we’ll go there every year. They'll just give us.”
>
> **Participant D1** stated, “We've we got a health promoter he gives talks, but I've never heard him giving talks about antibiotics.”

In the interview a prescriber stated that patients mentioned other clinics where they readily got antibiotics from. The reasons why a facility prescribes antibiotics to patients even when it is not needed should be investigated. The participant did not mention the name of the clinic due to professional conduct, however, the prescribers at the clinic that readily prescribe antibiotics to patients should not compromise their professional integrity and prescribe antibiotics without reason in patients.

Participant D1 stated the health promoters give talks at the clinics but the talks may be on prevention and managing conditions such as hypertension, diabetes, HIV and TB and has never heard the health promoter talking to the patients about antibiotics. In the study by Anstey Watkins et al. (2019), community members had limited understanding on antibiotics and associated them with viral infections and the term antibiotic resistance was unfamiliar to all the respondents. The people that had some understanding of antibiotics was due to their direct or indirect experience due to pulmonary TB or using cotrimoxazole for HIV or Acquired Immune Deficiency Syndrome (AIDS) infection. The treatment of TB, and the use of cotrimoxazole in the prevention and treatment of opportunistic and HIV-related infections, involves long-term antibiotic use. Thus, they have both become very much a part of the community’s lives therefore peoples’ frame of reference around antibiotics usually came from their experience of the TB epidemic which was prevalent in their locality (Anstey Watkins et al., 2019).

5.3 Strengths in antibiotic prescribing at the PHC clinics

There are prescribers that prescribe antibiotics correctly, ethically and in accordance with the guidelines, referring patients when they are unable to assist them, screening patients for TB and providing alternatives.

5.3.1 Correct prescribing

There are nurses that are prescribing antibiotics correctly and in line with the guidelines across all clinics as seen in the retrospective review as well as nurses in the surveys who indicated that they did not give in to patients demands and only prescribed antibiotics when necessary. Correct prescribing habits are stated in the quotations.

Participant G1 stated, “I I believe that it’s my duty or it’s my rule as a nurse that I must read what had happened before, before starting with this consultation.”

A thorough patient history, completion of a prescription such as writing the diagnosis, dosage of medication given, the interval the medication was given for is important. This information should be taken and be recorded in detail in the patients records as nurses look at this before starting the consultation which is correct practice.

Participant D1 expressed, “(sighs) I'm not sure because if it's beyond me I always refer (inaudible) I don't take chances. I always refer if it's beyond me.”

It is important for prescribers to identify their limitations and if they are unable to provide a service, are unsure and if anything falls outside their scope of practice to act in the patients’ best interest and refer the patient in order to avoid errors in prescribing.

Participant E1 said, “We prescribe in line with the EDL we have quite a lot of uh prescribe books (shows me the books), our adult PHC uhm this is primary clinical health care but we use the EDL to to prescribe we use the IMCI (Integrated Management of Childhood Illness) uhm prescribed book for children under five we have a lot guidelines and protocols in place…”

Although the nurse in region E indicated that many protocols and guidelines are in place at the clinic, the clinic did have a few prescriptions that were incorrect according to the PHC STGs which suggests that even though all protocols and guidelines may be available at the clinics they may not be used by the prescribers.

5.3.2 Collaboration

The nurses at the PHC clinics collaborate with other clinics by borrowing stock and work in a team with each other and the doctors that visit the facility. This is illustrated in the quotations.

Participant F1 said, “You know where I supposed to be ordering something eh but the aim of it is the patient never leaves a clinic without an antibiotic if we do not have A we definitely have B if we do not have A and B but we do have C. The patient will not leave without an antibiotic.”

Participant C1 said, “And find out if they have some and then you just go and collect it for the patient.”

Participant D1 stated, “I do get information in fact most often than not when I have a problem I used to call the doctor she didn't mind yeah our female doctor I used to call her on the phone and present the case to say I have one, two, three, four and then she'll say no I’m coming on Thursday book the patient I’ll see her on Thursday yeah.”

When there is no stock of a particular medication at the PHC clinic, networks of an alternate communication in order to overcome the problem were established at clinics by adopting a borrowing system. This system is not one without flaws as borrowing of medication resulted

in discrepancies in reporting stock shortages and only medication that was "unborrowable" was reported, which disrupted the stock forecasting patterns at each facility and medication that was borrowed was not returned (Hodes et al., 2017). The healthcare staff at the clinics in the study by Hodes et al. (2017) would contact staff members from other clinics often via WhatsApp when they experienced low levels of stock of a particular medicine and they often had to use their own resources such as data, airtime and personal cell phones. Alternative medication was given to patients and an effort was made to ensure that patients did not leave the facility without the required medication. The nurses at the PHC clinics work around the limited resources at the clinics. Another strength at the PHC clinics was that prescribers collaborate with doctors. The doctors that visit the facilities provide support for the nurses, reduce the workload and can be an important source of knowledge for the nurses. Health care is defined as a multidisciplinary profession in which healthcare professionals such as doctors, nurses and health professionals from different specialties must work, communicate and share resources (Manser, 2009). Working in a team has many benefits including reducing the number of medical errors that occur and improved health outcomes for the patient (Babiker et al., 2014).

Participant B1 said, "I had the same eh problem yesterday already… so I was just checking eh all the patients if they were put on treatment and all that only to find that this patient went home without proper medication for syphilis. The nurse didn't even see the results. So, when I have realized that, I checked who saw the patient I called the the professional nurse in and then showed them everything, and then eh discuss the patient what happened and all that they obviously didn't see the results. Because we didn't have a hard copy it was recorded by hand, they phoned the the lab to retrieve their results. So, we finally called patient to say please come back to the clinic, there's treatments that we didn't give you. Fortunately, the patient was here today I saw the patient and then eh Bicillin was initiated today."

If feedback is given and patient files are reviewed periodically, antibiotic as well as other prescribing errors may be picked up, corrected and be prevented in the future. Participant B1 that participated in this interview was the operational manager at the clinic in region B and prescribes at the clinic when there are short staffed at the clinic to ease the workload for the other nurses. She works in collaboration with the nurses at the clinic to help improve antibiotic prescribing by providing the nurses with feedback on their prescribing practices. This was done

by auditing and reviewing patient files periodically and therefore, some of the antibiotic errors made at the PHC clinic were corrected through this process. The participant in region D stated that their supervisor did not review files but rather an external company comes and audits the files at the PHC clinic. By auditing the files, the error was corrected, the patient was called back to the clinic to receive the correct treatment resulting in the nurse becoming aware of the error. A study was conducted to determine the impact prescription review and prescriber feedback system had on prescribing practices at the PHC clinics in Malaysia and the results determined that routine feedback effectively reduced prescribing errors (Lim et al., 2018). The prescriptions in region B did have incorrect drug, incomplete prescription, drug-drug interaction, underdosing and incorrect interval errors. The feedback and audit should perhaps be given and done much more frequently. As the prescribing nurse that participated in the interview is also an operational manager at the facility in region B there may also be bias in some answers given by her during the interview. In the survey most of the nurses wanted more feedback on their antibiotic selections which indicates the need for feedback to be given as the existing audit and feedback system although it may still pick up errors at the clinic much more feedback can be given to prescribers regarding their prescribing patterns such the most common antibiotics prescribed and whether they adhere to guidelines.

5.3.3 Advancements

There have been advancements made at the PHC clinics. Some clinics such as the clinic in region E now have computers, Wi-Fi and an electronic prescribing system which assists in medication prescribing. This is seen in the quotation.

Participant E1 stated, “We have a system the eHealth system so the eHealth system gives us exactly what type of medication how many medication we prescribe for each patient and it gives you the exact medication names and dosage and uhm how many days do you prescribe… at uhm my training facility where I’ve come from the university we’ve done in depth uhm studies uhm cultures is important uhm and then like the University Western Cape they are specializing in pharmacology and dentist and nursing so we being exposed to all those to be able to like today and I’m to be able to make decern decisions with with everything that I’m doing and then continuous training to our facilities where I’m currently is where my manager is sending us regular for trainings

The PHC clinic, particularly the one in region E has made advancements in technology by implementing the eHealth@Joburg system and sending the prescribing nurses for regular training. Prescribers at the PHC clinics should be sent on training that is pertinent to them such as training on methods and strategies to manage patient expectations for an antibiotic and advanced communication in order to convey the prescribing decision clearly, confidently and persuasively to patients in order to reduce inappropriate antibiotic prescribing (Lum et al., 2018).

5.4 Improvements to antibiotic prescribing

The prescribers were asked for recommendations and improvements to be made at the PHC clinics. Recommendations included education for both the prescriber and the patient and having more resources available at the PHC clinics such as the taking of bacterial cultures for antibiotic susceptibility testing.

5.4.1 Education

One way in which incorrect antibiotic prescriptions can be reduced at the PHC clinics is by properly educating the patients who frequent them. Patients must be educated on the harms of incorrect antibiotic use and by knowing this information they will ensure that they are only prescribed antibiotics when needed.

Participant F1 stated, “Education, if they can pump, pump their money into education it’s going to make our lives very easy. The thing is because our patients are uninformed we do not have somebody who is going to stand on a daily basis like, if you go now you gonna (*going to*) get all the patients that are here this morning by 11 they are gone, so you need somebody at that time you need somebody at 2pm you don’t get it at all not even once in the morning. I try I try when I have time, but I cannot do it on a daily basis…”

The above quotation depicts that patients do not get education from a health promoter at the clinic in region F. A report by Daviaud and Subedar (2012) states that in terms of staffing norms at PHC clinics, the requirements for health promoters are that they should spend an average of 18 hours a week per clinic but in clinics such as in region F, health education by a health promoter is not even done once in the morning. The study by Manderson (2020) states that the advice that is given by the prescribers to patients is pragmatic antibiotic related advice such as: completing the course as prescribed; not sharing the prescribed medicine or using someone else’s course of antibiotics, keep the syrups in the fridge or in a cool place once reconstituted and out of reach from children. The primary purpose of such advice by prescribers was to ensure patient adherence to antibiotic use through what prescribers characterised as “fear” or “obligation”. In the public sector, the prescribers spend about five minutes with a patient and therefore the prescribers emphasised that they had no time to properly educate patients and just gave minimum information to patients and information such as antibiotic resistance and self-care was not discussed (Manderson, 2020). Other suggestions on educating patients included mass education campaigns by using advertisements in newspapers, television and through pamphlets in multiple languages so that patients can understand the importance of using antibiotics correctly and the disadvantages of incorrect use (Kotwani et al., 2010). When the PHC nurses dispense antibiotics, the patient receives the antibiotic in a packet with the name of the antibiotic as well as written and pictorial instructions for use. This does not mean that patient understands that the prescribed drug is classified as an “antibiotic.” and therefore the prescriber should let the patient know the medication is an antibiotic (Anstey Watkins et al., 2019). The health promoters should be at all PHC clinics and should touch on a variety of issues in the waiting areas including correct antibiotic use.

In the surveys all the participants indicated more resources to educate patients would improve their antibiotic prescribing. This is consistent with the quotation above. The patients being more informed would result in a decrease in redundant antibiotics prescriptions at the PHC clinics as patients would not demand antibiotics unnecessarily.

5.4.2 Resources at the PHC clinics

Resources are limited at the PHC clinics; however, existing resources should be maximised through effective management and planning.

> **Participant C2** said, "I think we need to have clear guidelines in the facility and also to have some in service trainings specifically pertaining to antibiotics."

The participant above stated that the guidelines do not indicate what must be done if a patient presents with two infections concurrently, and sometimes a patient may not fit into the algorithm as presented in the guideline, therefore clearer and interactive-internet guidelines would be valuable in such situations as well as training specifically related to antibiotic prescribing would be valuable to them. This was also mentioned in the surveys where most prescribers said they would value clearer guidelines in written form and on tablet and smart phone apps to improve antibiotic prescribing.

Participant G1 expressed, "We don't get feedback from the doctors. Unless if there's something you know, it's like when they are calling you to reprimand you… But you know the positive feedback, like you know sister I received this child this and this and that, this is what happened. We don't get such rep... uhm feedback. Normally that feedback, we get that from the patient when they come back for their return date. And then they'll be like, sister you know I went to south as you referred me and this is what happened, and this is what. But we rarely get any feedback from the professionals… It would help! it would help! Because sometimes you will give uh this kind of an antibiotic only to find out that this uh infection is actually not responding to this antibiotic. So, taking cultures would be very! very! eh useful in that case so that you don't go there you know. It's like you are blindfolded you know! So at least when you are taking cultures you know that ok this patient I've taken cultures and then the results are saying… and then this is what I must use and you not wasting in that in that case you using antibiotics unnecessarily when on a patient that is not even gonna (*going to*) respond."

The nurse above also expressed that when the PHC guidelines are made, the nurses that are working at the PHC clinics should be consulted for their input and special provisions should be included in the guidelines as sometimes a patient may not fit into the algorithm presented in the guidelines. The nurses are the ones at the clinics who encounter different cases and would be able to provide valuable input to guide the authors of the PHC EDL and STGs.

When feedback is given to prescribers both positive and negative feedback should be given. A study conducted by Harvard Business Review found that 57.00% of people preferred positive and constructive feedback for recognition as this constructive feedback provides an opportunity to learn, grow, helps people feel confident which in turns helps them to do a better job and feel appreciated which makes them more motivated and engaged. It shows them that they are supported, their efforts are recognised, and this can lead to better working relationships (Zenger and Folkman, 2014)

Participant B1 stated, “Uhm it will be eh an easy thing to have uhm a computer in front of me as I'm diagnosing the patient, and this computer is linked to other facilities. So that I know that Hamna, was not in another facility yesterday receiving the same treatment. Because then it will assist us to know that you know, this level of antibiotics has already been applied. Now I need to step up. So, I think if we can have that it will be very important...the PHC training as I said, and continuous assessment of our professional nurses is they are doing the right thing and in-service training… I think PHC training is a requirement for each and every nurse who is in the primary health facility.”

The operational manager in region B indicated that PHC training is important for all the professional nurses; however, the nurse in region B who was surveyed did not have the R.48 qualification. This shows that even though the operational manager thinks it is important it is not implemented at the clinic. Much more needs to be done by managers to ensure that the nurses have the required post-basic qualification for the PHC clinics as Daviaud and Subedar, (2012) in their PHC staffing model assumed that all PHC clinics must have a PHC nurse. The surveys indicated that only a minority of nurses had the required post-basic qualification which could have led to the high numbers of prescriptions that were incorrect according to the retrospective prescription review.

The electronic prescribing system that was supposed to be implemented in 2018, is still not implemented at the PHC clinics, this system was supposed to link all the facilities together to assist the nurses at the PHC clinics (Fourie, 2018).

Participant E1 stated, “In my experience since I’m here and started on eHealth there’s limited uhm limited uhm information or guidance because for e.g. (*example)* myself I will know that this is the type of medication I use but when I go into the prescription section of the technology it asks you for diagnosis when you put in the diagnosis it doesn’t give you the medication or the diagnosis is not there so this is something that we work on.”

Even though the electronic prescribing system did decrease the number of errors in region E and it is linked to other facilities that have the electronic prescribing system so that the nurses can check if patients are frequenting multiple facilities for the same antibiotic treatment. There are still improvements that can be made to the system before it is implemented at the other PHC clinics. Suggestions need to be taken from the prescribing nurses that work daily on the system as well as clinicians to add in alternative treatment options/indications on the system that can still be correct for a prescribed medication as the nurse in the quotation stated the options on the system are limited.

Participant D1 said, "…we only have doctor once a week here."

The patients at the PHC clinics are not receiving optimal care by the nurses as there is a high workload at these clinics and the doctor only frequented the clinic in region D once a week. Staffing guidelines of the PHC clinics need to be revisited and should aim to include a doctor more than once a week to assist nurses with complicated cases, if the nurses had the required qualifications at the clinic they would be much more equipped to handle complex cases as the PHC post-basic qualification provides nurses with additional skills required to work at the PHC clinics.

Chapter 6: General discussion and conclusion

The primary objective of the study was to determine antibiotic prescribing practices across the seven PHC clinics chosen within the City of Johannesburg. It further aimed to determine factors at the PHC clinics that contribute to the way antibiotics are prescribed as well as the attitudes and perceptions of the prescribers towards antibiotics and if the prescribing practices of the nurses at the PHC clinics contribute to antibiotic resistance in patients.

This chapter draws recommendations to improve antibiotic prescribing at the PHC clinics that can be used by policy makers, discusses the strengths and limitations of the study, areas for future studies and finally concludes the study.

6.1. Strengths of the study

This study, to our knowledge is the first mixed method study in South Africa to determine the attitude, perceptions and practices of the nurses at the PHC clinics with regards to antibiotics and can be used to guide and provide information for future antibiotic studies. This study demonstrated amongst other things poor antibiotic adherence to the PHC guidelines, antibiotic prescription errors as well as a qualitative component to provide an in-depth understanding of the quantitative data. The methodology of this study was standardised and robust, with an objective comparison of the retrospective prescriptions reviewed to current national guidelines for PHC clinics.

6.2. Limitations of the study

The study is limited to public local government PHC clinics within the City of Johannesburg Metropolitan Municipalities and does not include private and provincial PHC clinics in the different municipalities in Gauteng. The sample size was small and therefore there was a low response rate for objectives 1 and 3. A larger sample size would result in precise results. The small sample size is a limitation to the study as logistic regression and p values could not be calculated for objective 1. Due to the small sample size only two nurses were used to validate the tools for objectives 1 and 3. There may be selection bias in the sampling methods used for objectives 1 and 3 of the study as a result of the small sample size. Another limitation is that

the study only evaluated prescribing data and clinical judgements and expertise were not considered in this study. Prescriptions with no diagnosis stated on them were also included in the study, even though these prescriptions were reviewed by a subject expert they may still be subject to interpretation errors. The study also does not include antibiotics used prophylactically or for the use of TB and only looked at acute antibiotic prescriptions it therefore only gives us insight to one component of antibiotic use. In South Africa, prescribing nurses are often under resourced and may only have certain types of antibiotics available at the PHC clinic and are therefore forced to prescribe certain antibiotics thus also limiting the study. There was a lack of research on the attitudes, perceptions and practices of public PHC nurses in Gauteng to be used for comparison and drawing meaningful conclusions.

6.3. Recommendations and suggestions for PHC clinics to improve antibiotic prescribing

The following recommendations were made by combining the participants responses in the survey and the qualitative interviews, by the researcher reviewing the retrospective antibiotic prescriptions and by suggestions made in literature. Additionally, recommendations were also made based on what was observed at the clinics by the researcher.

6.3.1. There is a need for education for both the prescribers and the patients

For patients this can be achieved by dissemination of accurate, updated and correct educational material which includes resources such as brochures and pamphlets in a variety of languages handed out at the clinics as well as the health promoters at each clinic conducting talks throughout the day on various health related topics such as antibiotic compliance, use, resistance and symptoms that would not necessitate the use of antibiotics to reiterate the correct use of antibiotics. The information can also be aired on television and radio so that the majority of patients have access to basic information on antibiotics.

For prescribers this can be achieved by using the various educational resources that are available and continuously updating their knowledge by reading and reviewing the latest publications, journals, attending training courses and consultation with colleagues. The prescribers may also learn about their prescribing practices if their prescribing practices are

audited and feedback is given to them. Prescribers being educated, would result in the judicious use of antibiotics.

6.3.2. There is a need for effective communication between the prescribers and the patient

As South Africa is so diverse, there are a number of different languages spoken and therefore the prescriber and the patient may not share the same first language which hinders effective communication. Dissemination of information in various languages that is available in the consulting room may assist prescribers. The use of pictures on medication packets can also be used to increase patient compliance as pictures can be easily understood. The prescribers should also attend various trainings that would aid in communication with patients to effectively convey the message to the patient in a way that the patient will understand. Effective communication between the prescriber and the patient creates trust, whereby the patient trusts that the prescriber has their best interests in mind while treating them and this is crucial to curb unnecessary antibiotic use and will improve antibiotic prescribing practices at the PHC clinics.

6.3.3. More resources need to available at the PHC clinics

The PHC clinics have limited resources available which hinder patient care. Staffing needs to be improved by employing more healthcare professionals to ease the burden of the nurses so that the nurses can spend an appropriate amount of time with each patient, this would also decrease omission and other prescribing errors. The clinics needs to have enough medication available as well as the latest editions of reference material for prescribers to use in order to prescribe optimally. The prescribers at the clinic also need access to computers and Wi-Fi so that the eHealth@Joburg prescribing system can be installed at all the clinics to track the patient's health history. Facilities such as microscopy, culture, sensitivity and point of care testing are also lacking at the PHC clinics, however, implementation of these facilities at the PHC clinics in South Africa is not financially feasible.

6.3.4. Clearer guidelines and policies to improve prescribing

Existing guidelines are not interactive and are not inclusive of the many different scenarios of the patients that visit the PHC clinics. The algorithms may therefore need to be amended as

nurses felt that some patients did not fit into the algorithms which left them confused on what to do.

6.4. Areas for future study

This study only focused on the prescribing nurses at the PHC clinics, future studies should consider all the healthcare professionals at the PHC clinics. Studies should be done on the attitudes and perceptions of the healthcare professionals towards pharmacists assisting the nurses at the PHC clinics. In order to combat antibiotic resistance future antibiotic studies should include patients in order to determine their attitudes, perceptions and practices regarding antibiotics as these also influence resistance. Future studies should include both provincial and local PHC and CHC clinics in both rural and urban areas across South Africa to evaluate the differences in these settings and if there are any differences in antibiotic prescribing, perceptions, use and resources at these settings. Studies should also consider the use of antibiotics prophylactically and for TB as well as prescribing according to clinical expertise. Future antibiotic studies should also be conducted for a longer period of time preferably over a year to determine seasonal variations in antibiotic prescribing in both acute and chronic patients and could look at trends in antibiotic prescribing in patients of various age groups. Future studies can also look at all antimicrobial prescribing patterns such as antifungals and antivirals instead of just antibiotics. Antibiotic related studies conducted in the future can also aim to identify deficiencies in the PHC STG guidelines and how these guidelines can be more interactive and inclusive of the different patient scenarios that are presented at the PHC clinics.

6.5. Conclusion of the study

This study set out to determine the attitudes, perceptions and practices of the PHC nurses towards antibiotic resistance. This was investigated by employing a survey, a retrospective analysis of prescriptions and by conducting semi-structured qualitative interviews.

The results of the study confirmed some of the existing findings that have already been established by previous research and draws some new insights. The study found that there are gaps in the knowledge of the prescribers and many antibiotic related errors occur at the PHC clinics including overdosing, underdosing, incorrect prescribing and incomplete prescription

errors. The SAASP and the PHC STG guidelines are evidence-based and play an important factor in reducing the number of antibiotic errors that occur in PHC clinics, however, these guidelines are not adhered to by the prescribers. Prescribers have basic knowledge on antibiotic resistance such as the overuse of antibiotics causes resistance; however, this knowledge is not enough to curb antibiotic resistance at PHC clinics. There were differences in the errors made at the clinics based on facility related factors such as the technology available for prescribers at the clinics. The PHC clinics do have strengths as the prescribers try to educate patients and work with the limited resources by using alternative antibiotics when there are medication stockouts. The prescribers are limited at the PHC clinics as they cannot order CRP testing for patients at the PHC facilities, not having enough time for each patient, not having the latest PHC STG versions. There are gaps in the knowledge of both patients and prescribers which can be substantially reduced as suggested by Gasson et al. (2018), by increasing the prescribers access to the latest guidelines, smartphone applications and empowering pharmacists to act as gatekeepers at the facilities to ensure that appropriate and correct prescribing of antibiotics takes place thus reducing antibiotic resistance.

References

Abbo, L., Smith, L., Pereyra, M., Wyckoff, M., Hooton, T.M., 2012. Nurse practitioners attitudes, perceptions, and knowledge about antimicrobial stewardship. *The Journal for Nurse Practitioners*, 8, 370-376

Abdul Majid M.A., Othman M., Mohamad S.M., Lim S.A.H., Yusof A., 2017. Piloting for interviews in qualitative research: Operationalization and lessons learnt. *International Journal of Academic Research in Business and Social Sciences*, 7, 1073-1080

Abera, B., Kibret, M., Mulu, W., 2014. Knowledge and beliefs on antimicrobial resistance among physicians and nurses in hospitals in Amhara Region, Ethiopia. *BioMed Central Pharmacology and Toxicology*, 15, 26-32

Adorka, M., Dikokole, M., Mitonga, K.H., Allen, K., 2013. Healthcare providers' attitudes and perceptions in infection diagnosis and antibiotic prescribing in public health institutions in Lesotho: A Cross-sectional Survey. *African Health Sciences*, 13(2), 344-350

Agency for Healthcare Research and Quality, 2014. Concise antibiogram toolkit; Getting started-sources of data. Viewed on 11 September 2020. Available on: https://www.ahrq.gov/sites/default/files/wysiwyg/nhguide/5_TK2_T2-Concise_Antibiogram_Toolkit_Getting_Started.pdf

Ahmed, A., Azim, A., Gurjar, M., Baronia, A.K., 2014. Current concepts in combination antibiotic therapy for critically ill patients. *Indian Journal of Critical Care Medicine*, 18(5), 310-314

Ainsa, J., Levy, S.B., 2002. The antibiotic paradox. How the misuse of antibiotics destroys their curative powers. *International Microbiology*, 5(3), 155-156

Al-Eidan, F.A., Mcelnay, J.C., Scott, M.G., Mcconnell, J.B., 2002. Management of Helicobacter pylori eradication-the influence of structured counselling and follow-up. *British Journal of Clinical Pharmacology*, 53, 163-171

Aljasmi, F., Almalood, F., Al Ansari, A., 2018. Prevalence of medication errors in primary health care at Bahrain Defence Force Hospital- Prescription-based study. *Drug, Healthcare and Patient Safety*, 10, 1-7

Anstey Watkins, J., Wagner, F., Xavier Gómez-Olivé, F., Wertheim, H., Sankoh, O., Kinsman, J., 2019. Rural South African community perceptions of antibiotic access and use: Qualitative evidence from a health and demographic surveillance system site. *The American Journal of Tropical Medicine and Hygiene*, 100(6), 1378-1390

Aronson, J.K., 2009. Medication errors: What they are, how they happen, and how to avoid them. *Quality Journal of Medicine: An International Journal of Medicine*, 102(8), 513-521

Aseeri M.A., 2013. The impact of a pediatric antibiotic standard dosing table on dosing errors. *The Journal of Pediatric Pharmacology and Therapeutics*, 18(3), 220-226

Auta, A., Hadi, M.A., Oga, E., Adewuyi, E.O., Abdu-Aguye, S.N., Adeloye, D., Strickland-Hodge, B., Morgan, D.J., 2019. Global access to antibiotics without prescription in community pharmacies: A systematic review and meta-analysis. *The Journal of Infection*, 78(1), 8-18

Avorn, J., Barrett, J.F., Davey, P.G., McEwen, S.A., O'Brien, T.F., Levy, S.B., 2001. Antibiotic resistance: Synthesis of recommendations by expert policy. *World Health Organisation*, 10, 1-155

Ayukekbong, J.A., Ntemgwa, M., Atabe, A.N., 2017. The threat of antimicrobial resistance in developing countries: Causes and control strategies. *Antimicrobial Resistance and Infection Control*, 6(47), 1-8

Baadani, A.M., Baig, K., Alfahad, W.A., Aldalbahi, S., Omrani, A, S., 2015. Physicians' knowledge, perceptions, and attitudes toward antimicrobial prescribing in Riyadh, Saudi Arabia. *Saudi Medical Journal*, 36 (5), 613-619

Babalola, C.P., Awoleye, S.A., Akinyemi, J.O., Kotila, O.A., 2011. Evaluation of prescription pattern in Osun State (Southwest) Nigeria. *Journal of Public Health and Epidemiology*, 3(3), 94-98

Babiker, A., El Husseini, M., Al Nemri, A., Al Frayh, A., Al Juryyan, N., Faki, M.O., Assiri, A., Al Saadi, M., Shaikh, F., Al Zamil, F., 2014. Health care professional development: Working as a team to improve patient care. *Sudanese Journal of Paediatrics*, *1*4(2), 9-16

Bamford, C., Bonorchis, K., Ryan, A., Simpson, J., Elliott, E., Hoffmann, R.,Naicker, P., Ismail, N., Mbelle, N., Nchabeleng, M., Nana, T., Sriruttan, C., Seetharam, S., Wadula, J., 2011. Antimicrobial susceptibility patterns of selected bacteraemic isolates from South African public sector hospitals, 2010. *Southern African Journal of Epidemiology and Infection*, 26(4), 243-250

Bartlett, J.G., 2011. A call to arms: The imperative for antimicrobial stewardship. *Clinical Infectious Diseases*, 53, 4-7

Bisht, R., Katiyar, A., Singh, R., Mittal, P., 2009. Antibiotic resistance- A global issue of concern. *Asian Journal of Pharmaceutical and Clinical Research*, 2(20), 34-39

Blaauw, D, Lagarde, M., 2019. Two-thirds of SA patients prescribed unnecessary antibiotics by their GP. Viewed on 30 May 2020. Available on: https://www.medicalbrief.co.za/archives/two-thirds-sa-patients-prescribed-unnecessary-antibiotics-gp/.

Black, A., 2013. A new algorithm for the diagnosis of all forms of tuberculosis is required for South Africa. *South African Medical Journal*, 103(6), 355-356

Bloom, B.R., Murray, C.J.L., 1992. Tuberculosis: Commentary on a re-emergent killer. *Science*, 257, 1055-1064

Boonstra, E., Lindbaek, M., Khulumani, P., Ngome, E., Fugelli, P., 2005. Adherence to treatment guidelines in primary health care facilities in Botswana. *Tropical Medicine and International Health*, 7(2), 178-186

Bresick, G., Christians, F., Makwero, M., Besigye, I., Malope, S., Dullie, L., 2019. Primary health care performance: A scoping review of the current state of measurement in Africa. *British Medical Journal Global Health*, 4(8), e001496

Brink, A.J., Messina, A.P., Feldman, C., Richards, G.A., Becker, P.J., Goff, D.A., Bauer, K.A., Nathwani, D., van den Bergh, D., Netcare Antimicrobial Stewardship Study Alliance, 2016. Antimicrobial stewardship across 47 South African hospitals: An implementation study. *The Lancet Infectious Diseases*, 16(9), 1017-1025

Brunetti, L., Hermes-DeSantis, E., 2010. The internet as a drug information resource. *United States Pharmacist*, 35(1), Epub

Businesstech, 2018. These 4 Graphs show how many South Africans don't have medical aid – and the surprising rise of traditional healers. Viewed on 16 February 2019. Available on: https://Businesstech.Co.Za/News/Government/253159/These-4-Graphs-Show-How-Many-South-Africans-Dont-Have-Medical-Aid-And-The-Surprising-Rise-Of-Traditional-Healers/

Carbon, C., Poole, M.D., 1999. The role of newer macrolides in the treatment of community-acquired respiratory tract infection. A review of experimental and clinical data. *Journal of Chemotherapy*, 11(2), 107-118

Centres for Disease Control and Prevention, 2012. Carbapenem-Resistant Enterobacteriaceae containing New Delhi Metallo-Beta-Lactamase in two patients- Rhode Island. *Morbidity and Mortality Weekly*, 61, 446-448

Centres for Disease Control and Prevention, 2013. Antibiotic resistance threats in the US. Viewed On 17 January 2019. Available on: https://www.Cdc.Gov/Drugresistance/Threat-Report-2013/Pdf/Ar-Threats-2013-508.Pdf

Chem, E.D., Anong, D.N., Akoachere, J.F.K.T., 2018. Prescribing patterns and associated factors of antibiotic prescription in primary health care facilities of Kumbo East and Kumbo West Health Districts, North West Cameroon. *Public Library of Science One*, 13(3), 1-18

Chetty, S., Reddy, M., Ramsamy, Y., Naidoo, A., Essack, S., 2019. Antimicrobial stewardship in South Africa: A scoping review of the published literature. *Journal of Antimicrobial Chemotherapy-Antimicrobial Resistance*, 1(3), 1-16

Christian, C.S., Gerdtham, U.G., Hompashe, D., Smith, A., Burger, R., 2018. Measuring quality gaps in TB screening in South Africa using standardised patient analysis. *International Journal of Environmental Research and Public Health*, 15(4), 729-738

Churchyard, G., Mametja, L., Mvusi, L., Ndjeka, N., Hesseling, A., Reid, A., Babatunde, S., Pillay, Y., 2014. Tuberculosis control in South Africa: Successes, challenges and recommendations. *South African Medical Journal*, 104(3), 244-248

Colgan, R., Powers, J.H., 2001. Appropriate antimicrobial prescribing: Approaches that limit antibiotic resistance. *American Family Physician*, 64, 999-1004

Costelloe, C., Metcalfe, C., Lovering, A., Mant, D., Hay, A.D., 2010. Effect of antibiotic prescribing in primary care on antimicrobial resistance in individual patients: Systematic review and meta-analysis. *British Medical Journal*, 340: c2096, 1-11

Cousins, D., Crompton, A., Gell, J., Hooley, J., 2019. The top ten prescribing errors in practice and how to avoid them. *The Pharmaceutical Journal*. Viewed on 10 April 2020. Available on: https://www.pharmaceutical-journal.com/cpd-and-learning/learning-article/the-top-ten-prescribing-errors-in-practice-and-how-to-avoid-them/20206123.article?firstPass=false

Cox, J.A., Vlieghe, E., Mendelson, M., Wertheim, H., Ndegwa, L., Villegas, M.V., Gould, I., Levy Hara, G., 2017. Antibiotic stewardship in low-and middle-income countries: The same but different? *Clinical Microbiology and Infection*, 23(11), 812-818

Creswell, J.W., Plano Clark, V.L., 2011. Designing and conducting mixed methods research. 2nd ed. Thousand Oaks (CA): Sage

Dall, C., 2018. Survey finds parents commonly save, share leftover antibiotics. Viewed on 20 October 2020. Available on: https://www.cidrap.umn.edu/news-perspective/2018/11/survey-finds-parents-commonly-save-share-leftover-antibiotics

Daniel, W.W., 1999. Biostatistics: A Foundation for analysis in the health sciences. 7th ed. New York: John Wiley and Sons

Daniels, B., Kwan, A., Pai, M., Das, J., 2019. Lessons on the quality of tuberculosis diagnosis from standardized patients in China, India, Kenya, and South Africa. *Journal of Clinical Tuberculosis and Other Mycobacterial Diseases*, 16, 100109

Daviaud, E., Subedar, H., 2012. Staffing norms for primary health care in the context of PHC re-engineering. Cape Town: Medical Research Council

Davies, J., Davies, D., 2010. Origins and evolution of antibiotic resistance. *Microbiology and Molecular Biology Reviews*, 74, 417-433

Dean B, Schachter M, Vincent C, Barber N., 2002. Causes of prescribing errors in hospital inpatients: A prospective study. *Lancet*, 359, 1373-1378

Dickerson, S., Reinhart, A.M., Feeley, T.H., Bidani, R., Rich, E., Garg, V. K., Hershey, C. O., 2004. Patient internet use for health information at three urban primary care clinics. *Journal of the American Medical Informatics Association*, 11(6), 499-504

Dolk, F.C.K., Pouwels, K.B., Smith, D.R.M., Robotham, J.V., Smieszek, T., 2018. Antibiotics in primary care in England: Which antibiotics are prescribed and for which conditions? *Journal of Antimicrobial Chemotherapy*, 73(2), ii2–ii10

Dowling, H.F., Finland, M., Hamburger, M., Jawetz, E., Knight,V., Lepper, M. H,, Meiklejohn, G., Rantz, L.A., Rhoads, P.S., 1957. The clinical use of antibiotics in combination. *American Medical Association Archives of Internal Medicine*, 99(4), 536-538

Dryden, M., Johnson, A.P., Ashiru-Oredope, D., Sharland, M., 2011. Using antibiotics responsibly: Right drug, right time, right dose, right duration. *Journal of Antimicrobial Chemotherapy*, 66, 2441-2443

Dumo, A.M., 2012. Factors affecting medication errors among staff nurses: Basis in the formulation of medication information guide. *International Journal of Health Education*, 88-149

Dyar, O.J., Huttner, B., Schouten, J., Pulcini, C., 2017. What is antimicrobial stewardship? *Clinical Microbiology and Infection*, 23, 793-798

Eide, T.B., Hippe, V.C., Brekke, M., 2012. The feasibility of antibiotic dosing four times per day: A prospective observational study in primary health care. *Scandinavian Journal of Primary Health Care*, 30(1), 16-20

Ekwanzala, M.D., Dewar, J.B., Kamika, I., Momba, M., 2018. Systematic review in South Africa reveals antibiotic resistance genes shared between clinical and environmental settings. *Infection and Drug Resistance*, 11, 1907-1920

Eldar, R., 2002. Understanding and preventing adverse events. *Croatian Medical Journal*, 43(1), 86-88

Engelbrecht, S.G., 2010. Adherence to the medicine code list in primary health care military clinics in Gauteng'. Master of Science in Medicine (Pharmacy). University of Limpopo.

Essack, S., Schellack, N., Pople, T., van der Merwe, L., Suleman, F., Meyer, J., Gous, A., Benjamin, D., 2011. Part III. GARP: Antibiotic supply chain and management in human health. *South African Medical Journal*, 101(8), 562-566

Expatica, 2020. A guide to healthcare in South Africa. Viewed on 27 May 2020. Available on: https://www.expatica.com/za/healthcare/healthcare-basics/healthcare-in-south-africa-105896/

Farley, E., Stewart, A., Davies, M.A., Govind, M., Bergh, D.V.D., Boyles, T.H., 2018. Antibiotic use and resistance: knowledge, attitudes and perceptions among primary care prescribers in South Africa. *South African Medical Journal*, 108, 763-761

Fitzgerald, R.J., 2009. Medication errors: The importance of an accurate drug history. *British Journal of Clinical Pharmacology*, 67(6), 671-675

Fletcher-Lartey, S., Yee, M., Gaarslev, C., Khan, R., 2016. Why do general practitioners prescribe antibiotics for upper respiratory tract infections to meet patient expectations: A mixed methods study, *British Medical Journal Open*, 6(10), e012244

Fourie, C., 2018. Joburg eHealth system reaches half a million patients. Viewed on 20 October 2020. Available on: https://midrandreporter.co.za/200177/tweets-city-joburg-celebrates-500-000th-ehealth-registrant/

Fralick, M., Haj, R., Hirpara, D., Wong, K., Muller, M., Matukas, L., Bartlett, J., Leung, E., Taggart, L., 2017. Can a smartphone app improve medical trainees' knowledge of antibiotics? *International Journal of Medical Education*, 8, 416-420

Fshealth, 2005. Guideline policy for authorization of Occupational Health Nurses to obtain permit for provision of primary health care services to the health care workers of the Free State Health Hospitals/Institutions. Viewed on 19 March 2020. Available on: http://www.fshealth.gov.za/portal/pls/portal/PORTAL.wwsbr_imt_services.GenericView?p_docname=3139936.DOC&p_type=DOC&p_viewservice=VAH&p_searchstring=

Fshealth, 2007. Identification of the appropriate speciality areas relevant to the Occupational Specific Dispensation (OSD) for nurses. Viewed on 19 March 2020. Available on:

http://www.fshealth.gov.za/portal/pls/portal/PORTAL.wwsbr_imt_services.GenericView?p_docname=3137672.DOC&p_type=DOC&p_viewservice=VAH&p_searchstring=

Gadomski, A.M., 1993. Potential interventions for preventing pneumonia among young children: Lack of effect of antibiotic treatment for upper respiratory infections. *Paediatric Infectious Disease Journal*, 12, 115-120

Gasson, J., Blockman, M., Willems, B., 2018. Antibiotic prescribing practice and adherence to guidelines in primary care in The Cape Town Metro District, South Africa. *South African Medical Journal*, 108, 304-310

Gelband, H, Duse, A.G., 2011. Global antibiotic resistance partnership (GARP): Executive summary. *South African Medical Journal*, 101(8), 549-596

Geyer, N., 1998. Nurse prescribers in primary health care. *Curationis*, 28-33

Gopalakrishnan, S., Udayshankar, P.M., Rama R., 2014. Standard treatment guidelines in primary healthcare practice. *Journal of Family Medicine and Primary Care*, 3(4), 424-429

Gray, A., 2014. Prescribing in South Africa: What's next? Viewed on 19 March 2020. Available on: https://sahivsoc.org/Files/Thurs_Andy_Gray%20Prescribing%20in%20south%20africa.pdf

Gray, A., Vawda, Y., Padarath, A., Barron, P., 2017. South African health review. Health Systems Trust. Viewed on 16 February 2019. Available on: https://www.Cabsa.Co.Za/South-African-Health-Review-2017-20th-Edition-2882017.

Grove, S.K., Burns, N., Gray, J. R., 2013. The Practice of nursing research: Appraisal, synthesis and generation of evidence. 7th ed. London: Elsevier Saunders

Gurwitz, J.H., Field, T.S., Avorn, J., Mccormick, D., Jain, S., Eckler, M., Bensor, M., Edmondson, A.C., Bates, D.W., 2000. Incidence and preventability of adverse drug events in nursing homes. *American Journal of Medicine*, 109, 87-94

Hallas, J., 1996. Drug related hospital admissions in subspecialties of internal medicine. *Danish Medical Bulletin*, 43, 141-155

Hardy-Holbrook, R., Aristidi, S., Chandnani, V., Dewindt, D., Dinh, K., 2013. Antibiotic resistance and prescribing in Australia: Current attitudes and practice of GPs. *Healthcare Infection*, 18(4), 147-151

Hartmann, D.P., 1977. Considerations in the choice of interobserver reliability measures. *Journal of Applied Behavior Analysis*, 10, 103-116

Hlabangane, S., 2015. Joburg Clinics Go 'Paperless' with eHealth. Viewed on 20 October 2020. Available on: https://ehealthnews.co.za/joburg-clinics-paperless-ehealth/

Hodes, R., Price, I., Bungane, N., Toska, E., Cluver, L., 2017. How front-line healthcare workers respond to stock-outs of essential medicines in the Eastern Cape Province of South Africa. *South African Medical Journal*, 107(9), 738-740

Huang, Y., Chen, R., Wu, T., Wei, X., Guo, A., 2013. Association between point-of-care CRP testing and antibiotic prescribing in respiratory tract infections: A systematic review and meta-analysis of primary care studies. *The British Journal of General Practice*, 63(616), e787-e794

Hussey, N., 2012. The language barrier: The overlooked challenge to equitable health care. *South African Health Review*, 1, 189-195

Iftikhar, S., Sarwar, M. R., Saqib, A., Sarfraz, M., Shoaib, Q. U., 2019. Antibiotic prescribing practices and errors among hospitalized pediatric patients suffering from acute respiratory tract infections: A multicenter, cross-sectional study in Pakistan. *Medicina (Kaunas, Lithuania*), 55(2), 44-55

Jairath, N., Hogerney, M., Parsons, C., 2000. The role of the pilot study: A case illustration from cardiac nursing research. *Applied Nursing Research,*13, 92-96

Johnson, L.F., Coetzee, D.J., Dorrington, R.E., 2005. Sentinel surveillance of sexually transmitted infections in South Africa: A review. *Sexually Transmitted Infections*, 81(4), 287-293

Jutel, A., Menkes, D.B, 2008. Soft targets: Nurses and the pharmaceutical industry. *PLoS Medicine*, 5(2): e5

Kapp, P.A., Klop, A.C., Jenkins, L.S., 2013. Drug interactions in primary health care in the George, South Africa: A cross-sectional study. *South African Family Practice*, 55(1), 78-84

Karthikeyan, M., Balasubramanian, T., Khaleel, M.I., Sahl, M., Rashifa, P.A., 2015. A systematic review on medication errors. *International Journal of Drug Development and Research*, 7, 9-11

Katende-Kyenda, N.L., Lubbe, M.S., Serfontein, J.H.P., Truter, I., 2007. Antimicrobial prescribing patterns in a group of private primary health care clinics in South Africa. *Health SA Gesondheid*, 12(1), 21-29

Keeton, C., 2010. Bridging the gap in South Africa. *Bulletin of the World Health Organization,* 88(11), 803-804

Ketelaar, S.M., Nieuwenhuijsen, K., Frings-Dresen, M.H., Sluiter, J.K., 2015. Exploring novice nurses' needs regarding their work-related health: A qualitative study. *International Archives of Occupational and Environmental Health*, 88(7), 953-962

Kontarakis, N., Tsiligianni, J.G., Papadokostakis, P., Giannopoulou, E., Tsironis, L., Moustakis, V., 2011. Antibiotic prescriptions in primary health care in a rural population in Crete, Greece. *BioMed Central Research Notes*, 4, 38-43

Korstjens, I., Moser., A., 2018. Series: Practical guidance to qualitative research. Part 4: Trustworthiness and publishing. *European Journal of General Practice*, 24(1), 120-124

Kotwani, A., Wattal, C., Katewa, S., Joshi, P.C., Holloway, K., 2010. Factors influencing primary care physicians to prescribe antibiotics in Delhi India. *Family Practice*, 27(6), 684-690

Kourkouta, L., Kotsiftopoulos, C.H., Papageorgiou, M., Iliadis, C.H., Monios, A., 2017. The rational use of antibiotics medicine. *Journal of Healthcare Communications*, 2(3), 27-30

Kumar, S., Little, P., Britten, N., 2003. Why do general practitioners prescribe antibiotics for sore throat? Grounded theory interview study. *British Medical Journal*, 326(7381), 138-143

Lagnaoui, R., Moore, N., Fach, J., Longy-Boursier, M., Bégaud, B., 2000. Adverse drug reactions in a department of systemic diseases-oriented internal medicine: Prevalence, incidence, direct costs and avoidability. *European Journal of Clinical Pharmacology*, 56, 181-186

Lesch, H., 2007. Plain language for interpreting in consulting rooms. *Curationis*, 30(4), 73-78

Levy, S.B., 1994. Balancing the resistance equation. *Trends in Microbiology*, 2, 341-342

Levy, S.B., Marshall, B., 2004. Antibacterial resistance worldwide: Causes, challenges and responses. *Nature Medicine*, 10, 122-129

Liaskou, M., Duggan, C., Joynes, R., Rosado, H., 2018. Pharmacys role in antimicrobial resistance and stewardship. *The Pharmaceutical Journal*, 10(6), 1-19

Lim, W.Y., Hss, A.S., Ng, L.M., Rani, S., Jasudass, J., Sararaks, S., Vengadasalam, P., Hashim, L., Praim Singh, R.K., 2018. The impact of a prescription review and prescriber feedback system on prescribing practices in primary care clinics: A cluster randomised trial. *BioMedCentral Family Practice*, 19(1), 120-132

Llor, C., Bjerrum, L., 2014. Antimicrobial resistance: Risk associated with antibiotic overuse and initiatives to reduce the problem. *Therapeutic Advances in Drug Safety*, 5(6), 229-241

Lloyd, H., Craig, S., 2007. A guide to taking a patient's history. *Nursing Standard*, 2(13), 42-48

Lum, E., Page, K., Whitty, J., Doust, J., Graves, N., 2018. Antibiotic prescribing in primary healthcare: Dominant factors and trade-offs in decision-making. *Infection, Disease and Health, 23*, 74-86

Lushniak, B.D., 2014. Antibiotic resistance: A public health crisis. *Public Health Reports*, 129(4), 314-316

Maguire, M., Delahunt, B., 2017. Doing a thematic analysis: A practical, step-by-step guide for learning and teaching scholars. *American Institute of Chemical Engineers Journal*, 3, 3352-3354

Mahlati P, Dlamini J., 2015. Minimum data sets for human resources for health and the surgical workforce in South Africa's health system. A rapid analysis of stock and migration: Africa institute for health and leadership development. Viewed on 30 My 2020. Available on: http://www.who.int/workforcealliance/031616south_africa_case_studiesweb.pdf?ua=

Maillacheruvu, P., McDuff, E., 2014. South Africa's return to primary care: The struggles and strides of the primary health care system. *The Journal of Global Health*. Viewed on: 27 March 2020. Available on: https://www.ghjournal.org/south-africas-return-to-primary-care-the-struggles-and-strides-of-the-primary-health-care-system/

Manderson, L., 2020. Prescribing, care and resistance: Antibiotic use in urban South Africa. *Humanities and Social Sciences Communications*,7, 77-86

Manning, M.L., Pfeiffer, J., Larson, E.L., 2016. Combating antibiotic resistance: The role of nursing in antibiotic stewardship. *American Journal of Infection Control*, 44, 1454-1457

Manser, T., 2009. Teamwork and patient safety in dynamic domains of healthcare: A review of the literature. *Acta Anaesthesiologica Scandinavica*, 53(2), 143-151

Masango-Makgobela, A., Govender, I., Ndimande, J., 2013. Reasons patients leave their nearest healthcare service to attend Karen Park Clinic, Pretoria North. *African Journal of Primary Health Care and Family Medicine*, 5(1), 1-5

Mashalla, Y., Setlhare, V., Massele, A., Sepako, E., Tiroyakgosi, C., Kgatlwane, J., Chuma, M., Godman, B., 2017. Assessment of prescribing practices at the primary health Care facilities in Botswana with an emphasis on antibiotics; Findings and implications. *International Journal of Clinical Practice*, 71(12), 1-14

Massele, A.Y., Nsimba, S.E.D., Rimoy, G., 2001. Prescribing habits in church-owned primary health care facilities in Dar es Salaam and other Tanzanian Coast Regions. *East African Medical Journal*, 78(10), 510-514

Mathioudakis, A., Rousalova, I., Gagnat, A.A., Saad, N., Hardavella, G., 2016. How to keep good clinical records. *Breathe (Sheffield, England)*, 12(4), 369-373

McCaughan, D., Thompson, C.A., Cullum, N.A., Sheldon, T.A., Raynor, P., 2005. Nurse practitioner and practice nurses' use of research information in clinical decision making: Qualitative findings from a national study. *Family Practice*, 22, 490-497

McCreesh, N., Faghmous, I., Looker, C., Dodd, P.J., Plumb, I.D., Shanaube, K., Muyoyeta, M., Godfrey-Faussett, P., Ayles, H., White, R.G., 2016. Coverage of clinic-based TB screening in South Africa may be low in key risk groups. *Public Health Action*, 6(1), 19-21

McCullough, A.R., Rathbone, J., Parekh, S., Hoffmann, T.C., Del Mar, C.B., 2015. Not in my backyard: A systematic review of clinicians' knowledge and beliefs about antibiotic resistance. *The Journal of Antimicrobial Chemotherapy*, 70(9), 2465-2473

McIsaac, W., Kellner, J., Aufricht, P., Vanjaka, A. Low, D., 2004. Empirical validation of guidelines for the management of pharyngitis in children and adults. *The Journal of the American Medical Association*, 291, 1587-1595

McKellar, M.R., Fendrick, A.M., 2014. Innovation of novel antibiotics: A economic perspective. *Central Infectious Diseases*, 59(3), 104-107

Medicines and Related Substances Act 101, 1965. Viewed on 13 October 2020. Available on: https://www.hpcsa.co.za/Uploads/Legal/legislation/medicines_and_related_sub_act_101_of_1965.pdf

Medicines and Related Substances Act, 1965, 2017. Draft general medicine regulations. Viewed on 16 October 2020. Available on: http://www.samed.org.za/Filemanager/userfiles/Draft%20General%20Medicine%20Regulations%2027%20January%202017.pdf

Middaugh, D.J., 2006. Managers must be present to win*! Medical Surgical Nursing*, 15(b), 382-383

Mji, G., Braathen, S., Vergunst, R., Scheffler, E., Kritzinger, J., Mannan, H., Schneider, M., Swartz, L., Visagie, S., 2017. Exploring the interaction of activity limitations with context, systems, community and personal factors in accessing public health care services: A presentation of South African case studies. *African Journal of Primary Health Care and Family Medicine*, 9(1), 1-9

Muthathi, I.S., Levin, J., Rispel, L. C., 2020. Decision space and participation of primary healthcare facility managers in the ideal clinic realisation and maintenance programme in two South African provinces. *Health Policy and Planning*, 35(3), 302-312

Nair, M., Tripathi, S., Mazumdar, S., Mahajan, R., Harshana, A., Pereira, A., Jimenez, C., Halder, D., Burza, S., 2019. "Without antibiotics, I cannot treat": A qualitative study of antibiotic use in Paschim Bardhaman district of West Bengal, India. *PLoS One*, 14(6), e0219002

National Department of Health, 2014. National tuberculosis management guidelines. Viewed on 4 September 2020. Available on: http://www.tbonline.info/media/uploads/documents/ntcp_adult_tb-guidelines-27.5.2014.pdf

National Department of Health, 2015. Antimicrobial resistance national strategy framework 2014-2024. Viewed on 2 June 2020. Available on: https://www.health-e.org.za/wp-content/uploads/2015/09/Antimicrobial-Resistance-National-Strategy-Framework-2014-2024.pdf

National Department of Health, 2015. Sexually transmitted infections, one day update, STI guideline changes. Viewed on 18 October 2020. Available on: https://sahivsoc.org/Files/STI%20Guideline%20Changes%20v2%20(1)%20Feb%202015.pdf

National Department of Health, 2016. Antimicrobial resistance background document. Viewed on 26 May 2020. Available on: http://www.health.gov.za/index.php/component/phocadownload/category/199-antimicrobial-resistance

National Department of Health, 2018. Primary healthcare, laboratory handbook, a step-by-step guide. Viewed on 18 October 2020. Available on: https://www.idealhealthfacility.org.za/docs/Tools/PHC%20Laboratory%20Handbook%2022%20May%202018%20Lo%20Res.pdf

National Department of Health, 2018. Standard Treatment Guidelines and Essential Medicines List for South Africa, Primary Healthcare Level, 2018 edition. Viewed on 20 February 2019. Available on: http://www.kznhealth.gov.za/pharmacy/PHC-STG-2018v1.pdf

National Institute for Health and Clinical Excellence., 2008. Respiratory tract infections-Antibiotic prescribing: Prescribing of antibiotics for self-limiting respiratory tract infections in adults and children in primary care, London: NICE

Ndihokubwayo, J.B., Yahaya, A.A., Desta, A.T., Ki-Zerbo, G., Odei, E.A., Keita, B., Pana, A.P., Nkhoma, W., 2013. Antimicrobial resistance in the African region: Issues, challenges and actions proposed. *African Health Monitor*, 16, 27-30

Neshati, H., Sheybani, F., Naderi, H., Sarvghad, M., Soltani, A.K., Efterkharpoor, E., Nooghabi, M.J., 2018. Diagnostic errors in tuberculous patients: A multicenter study from a developing country. *Journal of Environmental and Public Health*, 11, 1-11

Norushe, T.F., van Rooyen, D., Strumpher, J., 2004. In-service education and training as experienced by registered nurses. *Curationis*, 27(4), 63-70

Nunu, W., Munyewende, P., 2017. Patient satisfaction with nurse-delivery primary health care services in Free State and Gauteng Provinces, South Africa: A comparative study. *African Journal of Primary Health Care and Family Medicine*, 9(1), 1-8

Nursing, 2012. Resources for reliable drug information. Viewed on 01 April 2020. Available on: https://journals.lww.com/nursing/Fulltext/2012/10000/Resources_for_reliable_drug_information.23.aspx

Nyoka, N., 2017. Half a million young people treated for STIs over two years in Gauteng. Viewed on 11 September 2020. Available on: https://www.news24.com/news24/southafrica/news/half-a-million-young-people-treated-for-stis-over-two-years-in-gauteng-20170906

O'Neill, J., 2016. Review on antimicrobial resistance. tackling drug-resistant infections globally: Final report and recommendations. Viewed on 27 May 2020. Available on: https://amr-review.org/sites/default/files/160518_Final%20paper_with%20cover.pdf.

Omole, V.N., Joshua, I.A., Muhammad-Idris, Z.K., Usman, N.O., Ahmad, I.A., 2018. Use of injections and antibiotics and profile of health workers in rural primary health care facilities in North-western Nigeria. *International Journal of Medicine and Health Development*, 23(1), 183-188

Park, E., Masupe, T., Joseph, J., Ho-Foster, A., Chavez, A., Jammalamadugu, S., Marek, A., Arumala, R., Ketshogileng, D., Littman-Quinn, R., Kovarik, C., 2016. Information needs of Botswana health care workers and perceptions of wikipedia. *International Journal of Medical Informatics*, 95, 8-16

Parsonage, B., Hagglund, P.K., Keogh, L., Wheelhouse, N., Brown, R.E., Dancer, S. J., 2017. Control of antimicrobial resistance requires an ethical approach. *Frontiers in Microbiology*, 8, 2124-2137

Paul, M., Benuri-Silbiger, I., Soares-Weiser, K., Leibovici, L., 2004. Beta lactam monotherapy versus beta lactam-aminoglycoside combination therapy for sepsis in immunocompetent patients: Systematic review and meta-analysis of randomised trials. *British Medical Journal*, 328(7441), 668-681

Pavin, M., Nurgozhin, T., Hafner, G., Yusufy, F., Laing, R., 2003. Prescribing practices of rural primary health care physicians in Uzbekistan. *Tropical Medicine and International Health*, 8(2), 182-190

Phuong, J.M., Penm, J., Chaar, B., Oldfield, L.D., Moles, R., 2019. The impacts of medication shortages on patient outcomes: A scoping review. *PloS One*, 14(5), e0215837

Rábano-Blanco, A., Domínguez-Martís, E.M., Mosteiro-Miguéns, D.G., Freire-Garabal, M., Novío, S., 2019. Nursing students' knowledge and awareness of antibiotic use, resistance and stewardship: A descriptive cross-sectional study. *Antibiotics (Basel),* 8(4), 203-220

Robson, C., 2002. Real world research: A resource for social scientists and practitioner researchers. 2nd ed. London (UK): Blackwell Publishing

Rocha-Pereira, N., Lafferty, N., Nathwani, D., 2015. Educating healthcare professionals in antimicrobial stewardship: Can online-learning solutions help? *Journal of Antimicrobial Chemotherapy,* 70(12), 3175–3177

Rossiter, D., Blockman, M., Barnes, K.I., 2016. South African Medicines Formulary. 12th ed. Pretoria (Erasmuskloof): Health and Medical Publishing Group

Rossolini, G.M, Arena, F., Pecile, P., Pollini, S., 2014. Update on the antibiotic resistance crisis. *Current Opinion in Pharmacology*, 18, 56-60

Sarwar, M.R., Saqib, A., Iftikhar, S., Sadiq, T., 2018. Antimicrobial use by WHO methodology at primary health care centers: A cross-sectional study in Punjab, Pakistan. *BioMed Central Infectious Diseases,* 18, 492-500

Scheffler E, Visagie S, Schneider M., 2015. The impact of health service variables on healthcare access in a low resourced urban setting in the Western Cape, South Africa. *African Journal of Primary Health Care and Family Medicine,* 7(1), 1-11

Schellack, N., Benjamin, D., Brink, A., Duse, A., Faure, K., Goff, D., Mendelson, M., Meyer, J., Miot, J., Perovic, O., Pople, T., Suleman, F., van Vuuren, M., Essack, S., 2017. A situational analysis of current antimicrobial governance, regulation, and utilization in South Africa. *International Journal of Infectious Diseases,* 64, 100-106

Schlemmer, A., Mash, B., 2006. The affects of a language barrier in a South African district hospital. *South African Medical Journal,* 96, 1084-1087

Shweta, B., Bajpai, R., Chaturvedi, H.K., 2015. Evaluation of inter-rater agreement and inter-rater reliability for observational data: An overview of concepts and methods. *Journal of the Indian Academy of Applied Psychology,* 41, 20-27

Singh, S., 2016. Antimicrobial resistance and antibiotic stewardship: Knowledge, attitudes and perceptions amongst final-year undergraduate health professional students in a South African university. Masters in Pharmacy Practice (Clinical Pharmacy). University of KwaZulu-Natal

Skodvin, B., Aase, K., Charani, E., Holmes, A., Smith, I., 2015. An antimicrobial stewardship program initiative: A qualitative study on prescribing practices among hospital doctors. *Antimicrobial Resistance and Infection Control*, 4, 1-8

Smith, C., van Velthoven, M.H., Truong, N.D., Nam, N.H., Anh, V.P., Al-Ahdal, T.M.A., Hassan, O. G., Kouz, B., Huy, N.T., Brewster, M., 2020. Prescribing in low-income and lower middle-income countries: A systematic review. *British Medical Journal Global Health*, 5, e002094

Sooruth, U.M., Sibiya, M.N., Sokhela, D.G., 2015. The use of Standard Treatment Guidelines and Essential Medicines List by professional nurses at primary healthcare clinics in the

uMgungundlovu district in South Africa. *International Journal of Africa Nursing Sciences*, 3, 50-55

Sorensen, T.L., Monnet, D., 2000. Control of antibiotic use in the community: The Danish experience. *Infection Control and Hospital Epidemiology*, 21, 387-389

South African Nursing Council., 2005. Nursing education and training standards. Pretoria: Government Printer

Stemler, S.E., 2004. A comparison of consensus, consistency, and measurement approaches to estimating interrater reliability. *Practical Assessment, Research and Evaluation*, 9, (4), 1-11

Strandberg, E.L., Brorsson, A., André, M., Gröndal, H., Mölstad, S., Hedin, K., 2016. Interacting factors associated with low antibiotic prescribing for respiratory tract infections in primary health care-A mixed methods study in Sweden. *BioMed Central Family Practice*, 17, 78-87

Tacconelli, E., Carrara, E., Savoldi, A., Harbarth, S., Mendelson, M., Monnet, D.L., Pulcini, C., Kahlmeter, G., Kluytmans, J., Carmeli, Y., Ouellette, M., Outterson, K., Patel, J., Cavaleri, M., Cox, E.M., Houchens, C.R., Grayson, M.L., Hansen, P., Singh, N., Theuretzbacher, U., Magrini, N., WHO Pathogens Priority List Working Group., 2018. Discovery, research, and development of new antibiotics: The WHO priority list of antibiotic-resistant bacteria and tuberculosis. *Lancet Infectious Diseases*, 18(3), 318-327

Tang, H., Ng, J.H., 2006. Googling for a diagnosis-Use of Google as a diagnostic aid: Internet based study. *British Medical Journal*, 333, 1143-1145

Teska, P., Gauthier, J., 2017. *Antibiotic resistance and the importance of hand hygiene*. Viewed on 02 April 2020. Available on: https://www.infectioncontroltoday.com/hand-hygiene/antibiotic-resistance-and-importance-hand-hygiene

The Centre for Health Policy, 2017. CHP policy briefs and research reports. ABR: Overview of the project policy brief. Viewed on 20 October 2020. Available on: http://www.chp.ac.za/Policy-Briefs

The University of Texas Southwestern Medical Center, 2016. Antibiotics: When you need them and when you don't. Viewed on 13 October 2020. Available on: https://utswmed.org/medblog/antibiotics-resistance-proper-use/

Truter., 2015. Antimicrobial prescribing in South Africa using a large pharmacy database: A drug utilisation study Ilse Truter. *Southern African Journal of Infectious Diseases*, 30(2), 52-56

United States Food and Drug Administration, 2016. Battle of the bugs: Fighting antibiotic resistance. Viewed on 30 March 2019. Available on: https://www.fda.gov/drugs/drug-information-consumers/battle-bugs-fighting-antibiotic-resistance

Uys, L.R., Klopper, H.C., 2013. What is the ideal ratio of categories of nurses for the South African public health system? *South African Journal of Science*, 109(5/6), 1-4

Van Dyk, J., 2019. Undercover researchers went into doctors' rooms. You won't believe what they found. Viewed on 19 October 2020. Available on:https://bhekisisa.org/article/2019-03-20-south-africa-antimicrobial-resistance-doctors-over-prescribing-research/

van Hecke, O., Butler, C., Mendelson, M., Tonkin-Crine, S., 2019. Introducing new point-of-care tests for common infections in publicly funded clinics in South Africa: A qualitative study with primary care clinicians. *British Medical Journal open*, 9(11), e029260

van Teijlingen, E.R., Hundley, V., 2001. The importance of pilot studies. Social Research Update, 35. Viewed on 26 June 2020. Available on: http://sru.soc.surrey.ac.uk/SRU35.html

Vazquez-Lago, J.M., Lopez-Vazquez, P., López-Durán, A., Taracido-Trunk, M., Figueiras, A., 2012. Attitudes of primary care physicians to the prescribing of antibiotics and antimicrobial resistance: A qualitative study from Spain. *Family Practice*, 29(3), 352360

Velo, G.P., Minuz, P., 2009. Medication errors: Prescribing faults and prescription errors. *British Journal of Clinical Pharmacology*, 67(6), 624-628

Ventola, C.L., 2015. The antibiotic resistance crisis part 1: Causes and threats. *Pharmacy and Therapeutics*, 40(4), 277-283

Vernooij, R.W., Sanabria, A.J., Solà, I., Alonso-Coello, P., Martínez García, L., 2014. Guidance for updating clinical practice guidelines: A systematic review of methodological handbooks. *Implementation Science*, 9, 3-11

Viktil, K.K., Blix, H.S., 2008. The impact of clinical pharmacists on drug-related problems and clinical outcomes. *Basic and Clinical Pharmacology and Toxicology*, 102(3), 275-280

von Pressentin, K.B., Swanepoel, H., Opie., J.J.S., Jenkins L.S., 2019. Antimicrobial stewardship in rural districts of South Africa: Growing a positive culture. *South African Family Practice*, 61(6), 276-281

Wasserman, S., Potgieter, S., Shoul, E., Constant, D., Stewart, A., Mendelson, M., Boyles, T. H., 2017. South African medical students' perceptions and knowledge about antibiotic resistance and appropriate prescribing: Are we providing adequate training to future prescribers? *South African Medical Journal*, 107(5), 405-410

Webb, E.M., Rheeder, P., Wolvaardt, J.E., 2019. The ability of primary healthcare clinics to provide quality diabetes care: An audit. *African Journal of Primary Health Care and Family Medicine*, 11(1), e1-e6

Wickens, H.J., Farrell, S., Ashiru-Oredope, D.A.I., Jacklin, A., Holmes, A., Cooke, J., Sharland, M., Ashiru-Oredope, D., Mcnulty, C., Dryden, M., Fry, C., Hand, K., Holmes, A., Howard, P., Johnson, A., Elson, R., Mansell, P.J., Faulding, S., Wagle, S., Smart, S., Wellsteed, S., 2013. The increasing role of pharmacists in antimicrobial stewardship in English hospitals. *Journal of Antimicrobial Chemotherapy*, 68, 2675-2681

Wierzbowski, A.K., Hoban, D.J., Hisanaga, T., DeCorby, M., Zhanel, G.G., 2006. The use of macrolides in treatment of upper respiratory tract infections. *Current Allergy Asthma Reports*, 6(2), 171-181

Wilkie, A., 2015. Improve your research technique-reflexive thinking, 5 practical tips. Viewed on 15 July 2020. Available on: https://www.cxpartners.co.uk/our-thinking/improve-your-research-technique-reflexive-thinking-5-practical tips/#:~:text=Reflexivity%20is%20the%20process%20of,us%20are%20detached%2C%20objective%20observers.

Wong, E.B., Omar, T., Setlhako, G.J., Osih, R., Feldman, C., Murdoch, D. M., Martinson, N.A., Bangsberg, D.R., & Venter, W.D.F., 2012. Causes of death on antiretroviral therapy: A post-mortem study from South Africa. *Plos One*, 7(10), e47542

World Health Organisation, 2009. Addressing the key bottlenecks hampering the prevention an scale-up of M/XDR TB control and patient care. Viewed on 7 September 2020. Available on: https://www.who.int/tb/challenges/mdr/bottlenecks/bottlenecks_full_version.pdf?ua=1

World Health Organisation, 2014. Knowledge, attitudes, and practices (KAP) surveys during cholera vaccination campaigns: Guidance for Oral Cholera Vaccine Stockpile Campaigns, working group on monitoring and evaluation. Viewed on 21 November 2020. Available on: https://www.who.int/cholera/vaccines/kap_protocol.pdf

World Health Organisation, 2018. Astana Declaration on primary health care: From Alma-Ata towards universal health coverage and the sustainable development goals. Viewed on 27 May 2020. Available on: https://www.who.int/primary-health/conference-phc/DRAFT_Declaration_on_Primary_Health_Care_28_June_2018.pdf

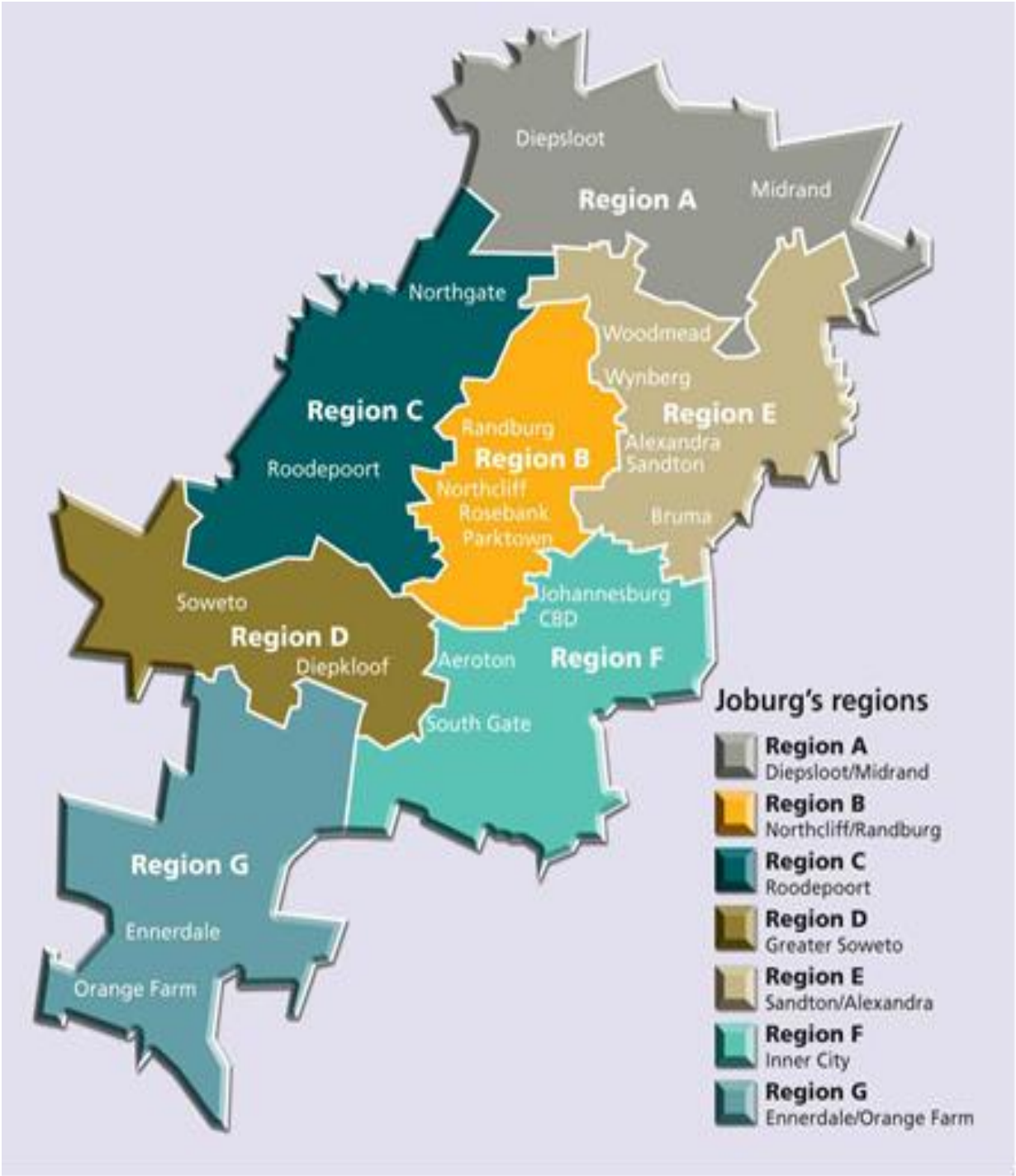
World Health Organisation, 2019. Primary health care. Viewed on 30 May 2020. Available on: https://www.who.int/news-room/fact-sheets/detail/primary-health-care

Zaman, S., Hussain, M., Nye, R., Mehta, V., Kazi, T.M., Hossain, N., 2017. A review on antibiotic resistance: Alarm bells are ringing. *Cureus*, 9(6), 1-9

Zenger, J., Folkman, J., 2014. Why we need to give more positive feedback. Viewed on 23 October 2020. Available on: https://www.t-three.com/soak/insights/why-we-need-to-give-more-positive-feedback#:~:text=Positive%20feedback%20helps%20motivation%2C%20boosts,simple%20part%20of%20your%20practice

Appendices

Appendix A: Map depicting the regions within the City of Johannesburg



Appendix B: Permission to use tool

Re: Permission to use research tool for South African setting

AM **Abbo, Lilian M. <LAbbo@med.miami.edu>**
20/02/2019 21:58

To: Stephanie De Rapper Cc: Hamna Hasan

Abbo_NP KAP Survey...
193.08 KB

Stephanie,

Thank you for your email
Attached is the survey tool we used (the paper was published a few years ago)
Kindly keep me updated on your progress!
Good luck to your student

Lilian Abbo, M.D. FIDSA
Chief Infection Control & Antimicrobial Stewardship
Jackson Health System
Associate Professor of Infectious Diseases
Department of Medicine & Miami Transplant Institute
University of Miami Miller School of Medicine
JHS Office: 305-585-7571
UM ID Office: 305- 243-4598
www.ugotabug.med.miami.edu

From: Elise Farley <elisefarley@gmail.com>
Sent: 03 May 2019 08:57 AM
To: Stephanie De Rapper <Stephanie.DeRapper@wits.ac.za>
Subject: Re: Permission Request: Antibiotic use and resistance: Knowledge, attitudes and perceptions among primary care prescribers in South Africa

Dear Stephanie,

Yes that is fine and we are glad the tool will be useful.

If you do end up publishing anything can you reference our manuscript as the source of the tool.

Thanks, Elise

Appendix C: Survey on the attitude, perceptions and practices of nurses in Primary Health Care (PHC) clinics within the City of Johannesburg District in the management of antibiotic resistance.

Dear Sir /Madam

Can you please take 10 minutes of your time and answer a few questions that will assist me in completing my research project at the University of the Witwatersrand. The research projects looks at the attitudes, perceptions and practices of nurses in Primary Health Care (PHC) clinics within the City of Johannesburg district in the management of antibiotic resistance. The study should be completed in December 2020. Your involvement would be greatly appreciated

Your participation in the survey is completely voluntary, and all your opinions will be kept anonymous. You have the right not to participate in the survey. Completing the survey will be regarded as informed consent to participate in this study.

For more information in this study please contact:

Hamna Hasan
0610644059
Hamnahasan_10@live.com

Stephanie de Rapper
0823104898
Stephanie.derapper@wits.ac.za

This survey is adapted and is a combination of 2 surveys, Survey 1 was found in the article, "*Nurse Practitioners' Attitudes, Perceptions, and Knowledge About Antimicrobial Stewardship"* by Abbo et al., 2012. Survey 2 was found in the article," *Antibiotic Use and Resistance: Knowledge, Attitudes and Perceptions Amongst Primary Care Prescribers in South Africa."* by Farley et al., 2018.

Signature:_____

NURSES' ATTITUDES, PERCEPTIONS AND PRACTICES ABOUT ANTIBIOTIC STEWARDSHIP SURVEY TOOL

PHC site: _____

Please answer the following questions in the spaces provided, circle or tick the most appropriate options.

Thank you for your time.

Questions about you:

1. **Please tell us your gender**
   - ☐ Female
   - ☐ Male

2. **Are you a doctor or a nurse?**
   - ☐ Nurse
   - ☐ Doctor
   - ☐ Nurse clinician

3. **If you are a nurse/nurse clinician, do you have an R.48 license, please specify other licenses that you have?**
   - ☐ Yes
   - ☐ No
   - ☐ Other

If other, please specify the name of the license_____

4. **What duties do you perform in the PHC clinic?**
    - ☐ Prescribing
    - ☐ Dispensing
    - ☐ Counselling
    - ☐ All the above

5. **How many years ago did you graduate from your area of speciality?**
    - ☐ 1
    - ☐ 2
    - ☐ 3
    - ☐ 4
    - ☐ 5
    - ☐ 6
    - ☐ ≥7
    - ☐ N/A

Questions with regards to your perceptions and attitudes:

6. Tell us your perceptions on a scale from strongly disagree to strongly agree for each of the following statements:

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Antibiotics are overused in South Africa	☐	☐	☐	☐	☐
Antibiotics are overused in my clinic	☐	☐	☐	☐	☐
Antibiotic resistance is a significant problem in South Africa	☐	☐	☐	☐	☐
Antibiotic resistance is not a significant problem at my clinic	☐	☐	☐	☐	☐
New antibiotics will be developed in the future that will keep up with the problem of "resistance"	☐	☐	☐	☐	☐
Inappropriate use of antibiotics causes antibiotic resistance	☐	☐	☐	☐	☐
Strong knowledge of antibiotics is important to my healthcare career	☐	☐	☐	☐	☐
I am confident that I use antibiotics optimally	☐	☐	☐	☐	☐
I overprescribe antibiotics	☐	☐	☐	☐	☐
Other nurses overprescribe antibiotics	☐	☐	☐	☐	☐
I would like more feedback on my antibiotic selections	☐	☐	☐	☐	☐
I would like more information on the appropriate use of antibiotics.	☐	☐	☐	☐	☐
I am less likely to use restricted antibiotics if Infectious Disease approval is required	☐	☐	☐	☐	☐
Patients not finishing their course of antibiotics drives resistance.	☐	☐	☐	☐	☐
Lack of hand disinfection causes the spread of antibiotic resistance.	☐	☐	☐	☐	☐
I feel pressure from patients to prescribe antibiotics.	☐	☐	☐	☐	☐
Interactions with pharmaceutical representatives do not influence my antibiotic selections.	☐	☐	☐	☐	☐
Inappropriate use of antibiotics is professionally unethical	☐	☐	☐	☐	☐
Inappropriate use of antibiotics can harm patients	☐	☐	☐	☐	☐
The taking of cultures is important in antibiotic decision making.	☐	☐	☐	☐	☐
I find prescribing antibiotics difficult	☐	☐	☐	☐	☐
I give in to patients demands to prescribe antibiotics.	☐	☐	☐	☐	☐
Antibiotic prescribing guidelines and other resources are easily available at my PHC clinic	☐	☐	☐	☐	☐

7. How do you select antibiotics in a patient with no culture information?
Please select one for each statement on a scale from never to always.

	Never	Rarely	Sometimes	Often	Always
I start with broad-spectrum and tailor upon culture results	☐	☐	☐	☐	☐
I base my decisions on the PHC clinic antibiogram	☐	☐	☐	☐	☐
I ask another nurse	☐	☐	☐	☐	☐
I consult the PHC Standard Treatment Guidelines	☐	☐	☐	☐	☐
I use the same 1 or 2 antibiotics	☐	☐	☐	☐	☐

8. If you prescribe antibiotics that are not absolutely necessary, what are some of the reasons?
Please select one for each statement on a scale from never to always.

	Never	Rarely	Sometimes	Often	Always
Antibiotics don't need to be necessary. I just need to think that they may help the patient.	☐	☐	☐	☐	☐
Antibiotics don't harm the patients if they aren't needed	☐	☐	☐	☐	☐
Patients demands and expectation for antibiotics	☐	☐	☐	☐	☐
The patient is ill or immunocompromised	☐	☐	☐	☐	☐
Reassurance when using antibiotics even if it might be the wrong one.	☐	☐	☐	☐	☐
Treat colonisation to prevent infection	☐	☐	☐	☐	☐
Not Applicable – I only prescribe antibiotics when necessary	☐	☐	☐	☐	☐
If other: please specify					

9. How useful are the following sources of information with respect to your learning and education about antibiotics?
Please select one for each statement on a scale from never useful to always useful.

	Never Useful	**Rarely**	**Sometimes**	**Often**	**Always Useful**
Antimicrobial stewardship programmes and guidelines.	☐	☐	☐	☐	☐
Antibiotic website	☐	☐	☐	☐	☐
Consultation with colleagues.	☐	☐	☐	☐	☐
South African Medicines Formulary (SAMF)	☐	☐	☐	☐	☐
MIMS	☐	☐	☐	☐	☐
Tablet or smartphone apps	☐	☐	☐	☐	☐
Pharmaceutical representatives	☐	☐	☐	☐	☐
Textbooks	☐	☐	☐	☐	☐
Medical journal	☐	☐	☐	☐	☐
PHC Essential Drug List and Standard Treatment Guidelines	☐	☐	☐	☐	☐
Internet website	☐	☐	☐	☐	☐
Please specify internet website:					

10. How much would you value the following resources to improve your antibiotic prescribing on a scale from strongly disagree to strongly agree for each of the following statements:

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Interactive internet-based sources	☐	☐	☐	☐	☐
Clearer guidelines for tablet or smartphone apps	☐	☐	☐	☐	☐
Clearer guidelines in written form	☐	☐	☐	☐	☐
Better access to diagnostic tests such as points of care CRP tests.	☐	☐	☐	☐	☐
More resources to educate the patients	☐	☐	☐	☐	☐
More data on local antimicrobial resistance.	☐	☐	☐	☐	☐

11. Please answer on a scale from always to never
Where: Always is ≥90%; Often is > 70%; sometimes is 50%; rarely is <30% and never <10%

	Never	Rarely	Sometimes	Often	Always
If a patient expects an antibiotic but you **don't** think it's absolutely necessary, how often do you prescribe them	☐	☐	☐	☐	☐

Appendix D: Study information document

STUDY INFORMATION DOCUMENT

Study title: The attitudes, perceptions and practices of nurses in Primary Health Care (PHC) clinics within the City of Johannesburg district in the management of antibiotic resistance.

Dear Sir/Madam

Introduction:

I Hamna Hasan, am doing a research project on the attitudes, perceptions and practices of nurses in Primary Health Care (PHC) and clinics within the City of Johannesburg district in the management of antibiotic resistance. Research is a process used in seeking new knowledge. In this study we want to learn the attitudes, perceptions and practices of nurses towards antibiotics resistance as well as determine their antibiotic prescribing practices.

There is an increase in the number of micro-organisms becoming resistant to antimicrobials worldwide. The problem is that no new antibiotics are being developed. We therefore need to work in an antimicrobial stewardship team that is multidisciplinary to optimize the use of antibiotics. In countries like the United States, Australia, France and many more around the world a clinical pharmacist is part of the multidisciplinary antimicrobial stewardship team. In South Africa although majority of the population use PHC clinics, they often have limited resources, are underequipped and do not have multidisciplinary teams to combat antibiotic resistance. There are a limited number of studies done about nurses and antibiotic stewardship in South Africa. The existing policies that are in place in the hospitals are not working as antibiotic resistance is increasing.

Invitation to Participate: Participation in this study is entirely voluntary. I would like to invite you to participate in this research study.

What is involved in the study?

Survey

The researcher will survey the nurses at seven randomly selected PHC clinics which are in different regions within the City of Johannesburg (CoJ) district. These surveys will determine the attitudes, perceptions and practices of nurses in the management of antibiotic resistance as well as determine the prescribing practices in each PHC clinic.

The survey will be prepared using REDCap and the researcher will question each nurse and record the answers. The survey consists of short multiple-choice questions and the survey will only take 10 mins of your time to complete.

All completed surveys will be analysed using the tools on REDCap and Statistica.

Risks

There are no risks in participating in this study.

Benefits

You will be granted the opportunity to gain more knowledge about what other nurses' opinions are on antibiotic resistance.

Participation is voluntary

Your participation in this survey is completely voluntary, and all your opinions will be kept anonymous. You have the right not to participate in this survey. Completing the survey will be regarded as informed consent to participate in this study.

Confidentiality

Confidentiality will be maintained in this study. The survey does not require any personal identifying information to be divulged.

Who has reviewed the study and given Ethical approval for this study?

This study has been sent to the Wits University Human Research Ethics Committee for approval.

Approximate time that the study will be completed in

December 2020

For more information or questions regarding the study, or if you would like to report any problems, please contact:

Researcher: Hamna Hasan

0610644059

Hamnahasan_10@live.com

Supervisor: Stephanie De Rapper

0823104898

Stephanie.derapper@wits.ac.za

If you have any concern over the way the study is being conducted, please contact the Chairperson of this Committee who is Professor Clement Penny, who may be contacted on telephone number 011 717 2301, or by e-mail on Clement.Penny@wits.ac.za. The telephone numbers for the Committee secretariat are 011 717 2700/1234 and the e-mail addresses are Zanele.Ndlovu@wits.ac.za and Rhulani.Mukansi@wits.ac.za

Thank you for reading this Study Information Sheet.

Appendix E: Participant informed consent form

PARTICIPANT INFORMED CONSENT FORM

Research Project entitled: The attitudes, perceptions and practices of nurses in Primary Health Care (PHC) clinics within the City of Johannesburg district in the management of antibiotic resistance.

I hereby confirm that I have accurately read and understood the information sheet provided by the researcher, and I understand that the following will be done:

1. I will participate in the study towards the research project.
2. I will remain anonymous.
3. I will be required to answer a survey about my attitudes, perceptions and practices of nurses in Primary Health Care (PHC) clinics within the City of Johannesburg district in the management of antibiotic resistance.
4. I will give my opinion when answering the questions in the survey.
5. I confirm that I have given consent freely and willingly and that I may withdraw at any time during the study.
6. I confirm that I was given the opportunity to ask questions, and all the questions have been answered to my satisfaction by the researcher.

• I hereby agree that I understand the requirements of this project and am willing to participate and provide feedback for research purposes.

Sign: _____ Date: _____

Appendix F: Retrospective prescription review data collection tool

RETROSPECTIVE PRESCRIPTION REVIEW DATA COLLECTION TOOL

Prescription/Patient confidentiality code: _____

Age of patient: _____

Study site: _____

Table 1: Overview of prescription: Errors per prescription

	Drug-drug interactions	Incomplete prescription	Incorrect drug	Overdosing	Under dosing	Incorrect interval
Number of incidences						
Percentage incidence						

Table 2: Overview of prescription: Antibiotic prescribing per visit

		Comments
Date of visit		
Diagnosis made by Nurse		
Symptoms that aided in diagnosis		
Number of antibiotics prescribed		
Name of antibiotic/s prescribed		
Were any samples taken to be cultured?		
Were antibiotic susceptibility tests done?		
Findings of these tests?		
Other		

Appendix G: Permission to use interview tool

From: "Skodvin, Brita" <brita.skodvin@helse-bergen.no>
Date: 03 May 2019 at 4:29:11 PM SAST
To: Stephanie De Rapper <Stephanie.DeRapper@wits.ac.za>
Cc: Hamna Hasan <1109367@students.wits.ac.za>, Zelna Booth <zelna.booth@wits.ac.za>, Rubina Shaikh <Rubina.Shaikh@wits.ac.za>
Subject: :SV: Permission Request: An antimicrobial stewardship program initiative: a qualitative study on prescribing practices among hospital doctors

Dear Stephanie De Rapper,
Thank you for your request. Me and my institution would feel honoured if you would apply the study guide we used in the study, "An antimicrobial stewardship program initiative: a qualitative study on prescribing practices among hospital doctors".
I wish you the best of luck with the work and hope that you will make the results from your study available, as it would have been very interesting to read for us.

Kind regards,

Brita Skodvin
Consultant
Norwegian Advisory Unit for Antibiotic Use in Hospitals
+4791558715
www.antibiotika.no

Appendix H: Interview Guide

The aim of this project of this study is to establish the attitudes, perceptions and practices of nurses in PHC clinics in the management of antibiotic resistance. We want to further refine the results from the survey and qualitatively determine the reasoning and circumstances behind the quantitative results.

This interview tool is found in an article by Skodvin et al., 2015 titled, "*An Antimicrobial Stewardship Program Initiative: A Qualitative Study on Prescribing Practices Amongst Hospital Doctors."*

General

- Have you had time to read the information letter?
- Do you have any questions to what I have just said?
- Could you please sign the consent form?

Thank you so much for participating in the interview

Demographics

- Can you tell me about your background? What I mean by this is your age, speciality, working position, responsibilities, which clinics (s) did you work at and which university did you attend?

Culture

Do you remember last time in the clinic the patient came in with "an infection"?

- Could you please describe how did you go about treating the patient? What did you do?
- How did you apply diagnostic tools?

Let`s say the patient suffered from an infectious disease originating from a bacterial infection such as *Strep* throat;

- How did you go about choosing antimicrobial (antibiotic) treatment with regards to prescribing of antimicrobials (antibiotics)?
- Could you please tell me, when do you find antimicrobial (antibiotic) prescribing difficult?
- What do you do when this happens?
- What role do other nurses, play for your prescribing of antimicrobials (antibiotics)?

Patient characteristics

- Do you think that the patient and the patient´s condition influences your prescribing, and if so, in what way?

Emotions

- Could you please describe a situation where there was a discrepancy between the antimicrobial (antibiotic) you should have prescribed and the one you actually prescribed?
- Could you explain how that happened?

Education/knowledge

- How is the training in antimicrobial (antibiotic) prescribing at your clinic?
- What emphasis is there on antimicrobials (antibiotics) in your educational program?
- What or who have taught you what you know about antimicrobials (antibiotics)?
- How has increasing clinical experience altered your prescribing?
- What do you think of antimicrobial (antibiotic) guidelines?

Technology

- What role do electronic tools play when you are prescribing antimicrobials (antibiotics)? For instance, do you use the web and apps?
- Are there any electronic solutions you miss when prescribing antimicrobials (antibiotics)?

Structure

Is there anything about the way your clinic is organized that could facilitate the prescribing of antimicrobials? With organization, I mean schedules, time, staff, medical records, charts and so on.

- Were there any stock limitations (during the retrospective study period) that could have contributed to the patterns of antibiotics that were prescribed?
- How is your access to information and help when you need it? Is it easily available?

Politics

- What are your thoughts on antimicrobial (antibiotic) resistance?

Finally; having all the resources in world, if you were to give us some advice

- What measures do you think would be most useful in order to improve antimicrobial (antibiotic) prescribing?
- Is there anything else you would like to add before we finish?

Thank you for completing this interview

Appendix I: Interview study information document

STUDY INFORMATION DOCUMENT

Study title: The attitudes, perceptions and practices of nurses in Primary Health Care (PHC) clinics within the City of Johannesburg district in the management of antibiotic resistance.

Dear Sir/Madam

Introduction:

I Hamna Hasan, am doing a research project on the attitudes, perceptions and practices of nurses in Primary Health Care (PHC) and clinics within the City of Johannesburg district in the management of antibiotic resistance. Research is a process used in seeking new knowledge. In this study we want to learn the attitudes, perceptions and practices of nurses towards antibiotics resistance as well as determine their antibiotic prescribing practices.

There is an increase in the number of micro-organisms becoming resistant to antimicrobials worldwide. The problem is that no new antibiotics are being developed. We therefore need to work in an antimicrobial stewardship team that is multidisciplinary to optimize the use of antibiotics. In countries like the United States, Australia, France and many more around the world a clinical pharmacist is part of the multidisciplinary antimicrobial stewardship team. In South Africa, although majority of the population use PHC clinics, they often have limited resources, are underequipped and do not have multidisciplinary teams to combat antibiotic resistance. There are a limited number of studies done about nurses and antibiotic stewardship in South Africa. The existing policies that are in place in the hospitals are not working as antibiotic resistance is increasing.

Invitation to Participate: Participation in this study is entirely voluntary. I would like to invite you to participate in this research study.

What is involved in the study?

Interview

The researcher will interview the nurses at each of the seven randomly selected PHC clinics which are in different regions within the City of Johannesburg (CoJ) district. These interviews will provide more insight and delve deeper regarding antimicrobial behaviors and attitudes in the clinics as well determine the circumstances why some antimicrobials are prescribed. The interviews will expand on the attitudes, perceptions and practices of nurses in the management of antibiotic resistance as well as determine the rationale behind the prescribing practices, antibiotic use, attitudes and perceptions in each PHC clinic based on results of the surveys.

The interview will be prepared using REDCap and a qualified interviewer or the researcher being trained by a qualified interviewer will interview the nurses and record the answers on a recording device so that the answers may be analysed qualitatively.

The interview consists of questions and will only take 30 mins of your time to complete.

All completed interviews will be analysed using MAXQDA.

Risks

There are no risks in participating in this study.

Benefits

You will be granted the opportunity to gain more knowledge about what other nurses' opinions are on antibiotic resistance.

Participation is voluntary

Your participation in this survey is completely voluntary, and all your opinions will be kept anonymous. You have the right not to participate in this interview. Completing the interview will be regarded as informed consent to participate in this study.

Confidentiality

Confidentiality will be maintained in this study. The interview does not require any personal identifying information to be divulged.

Who has reviewed the study and given Ethical approval for this study?

This study has been sent to the Wits University Human Research Ethics Committee for approval.

Approximate time that the study will be completed in

December 2020

For more information or questions regarding the study, or if you would like to report any problems, please contact:

Researcher: Hamna Hasan
0610644059
Hamnahasan_10@live.com

Supervisor: Stephanie De Rapper
0823104898
Stephanie.derapper@wits.ac.za

If you have any concern over the way the study is being conducted, please contact the Chairperson of this Committee who is Professor Clement Penny, who may be contacted on telephone number 011 717 2301, or by e-mail on Clement.Penny@wits.ac.za. The telephone numbers for the Committee secretariat are 011 717 2700/1234 and the e-mail addresses are Zanele.Ndlovu@wits.ac.za and Rhulani.Mukansi@wits.ac.za

Thank you for reading this Study Information Sheet.

Appendix J: Participant informed consent form for the nurses participating in the interview

PARTICIPANT INFORMED CONSENT FORM

Research Project entitled: The attitudes, perceptions and practices of nurses in Primary Health Care (PHC) clinics within the City of Johannesburg district in the management of antibiotic resistance.

I hereby confirm that I have accurately read and understood the information sheet provided by the researcher, and I understand that the following will be done:

1. I will participate in the study towards the research project.
2. I will remain anonymous.
3. I will be required to answer an interview about my attitudes, perceptions and prescribing practices amongst other questions regarding antibiotic resistance and antibiotic stewardship.
4. I will give my opinion when answering the questions in the interview.
5. I confirm that I have given consent freely and willingly and that I may withdraw at any time during the study.
6. I confirm that I was given the opportunity to ask questions, and all the questions have been answered to my satisfaction by the researcher.

• I hereby agree that I understand the requirements of this project and am willing to participate and provide feedback for research purposes.

Sign: _____ Date: _____

Appendix K: Participant informed consent form for recording the interview

PARTICIPANT INFORMED CONSENT FORM- PERMISSION TO RECORD INTERVIEW

Research Project entitled: The attitudes, perceptions and practices of nurses in Primary Health Care (PHC) clinics within the City of Johannesburg district in the management of antibiotic resistance.

I hereby confirm that I have accurately read and understood the information sheet provided by the researcher, and I understand that the following will be done:

1. I will participate in the study towards the research project.
2. I understand that my responses will be kept strictly confidential. I understand that my name will not be linked with the research materials and will not be identified or identifiable in the report or reports that result from the research.
3. I agree for this interview to be recorded. I understand that the audio recording made of this interview will be used only for analysis and that extracts from the interview, from which I would not be personally identified, may be used in any conference presentation, report or journal article developed as a result of the research and that the researcher may use anonymous quotes in the research report. I understand that no other use will be made of the recording without my written permission, and that no one outside the research team will be allowed access to the original recording.
4. I agree that my anonymised data will be kept for future research purposes such as publications related to this study after the completion of the study.
5. I confirm that I have given consent freely and willingly and that I may withdraw at any time during the study.
6. I confirm that I was given the opportunity to ask questions, and all the questions have been answered to my satisfaction by the researcher.

• I hereby agree that I understand the requirements of this project and am willing to participate and provide feedback for research purposes.

Sign: _____ Date: _____

Appendix L: Approval letter from the National Department of Health

GAUTENG PROVINCE

Joburg
A world class African city

JOHANNESBURG HEALTH DISTRICT

Faculty Of Health Sciences
Research Ethics Committee,
University of The Witwatersrand
Johannesburg, South Africa
hamnahasan_10@live.com

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Hillbrow CHC: Administration Building
Cr Smith Str. & Klein Street
Private Bag X21, Johannesburg
South Africa, 2017

DRC Ref: 2019-03-001

Dear: Hamna Hasan

Title: ***The attitudes, perceptions and practices of nurses in Primary Health Care (PHC) clinics within the City of Johannesburg District in the management of antibiotic resistance***

Your application for Research Approval refers

The District Research Committee has reviewed your application. This letter serves in principle as approval to access the Districts Health facilities (mentioned below) for the above project subject to following conditions:

- The facility to be visited: **See attached list**
- This facility will be visited from **11/04/2019 to 11/04/2020**
- The research can only commence after you submit an ethics clearance certificate from a recognized institution.
- You will report to the Facility Manager before initiating the study.

Region	Regional Health Manager	Contact No.	Cell phone
ABCEF	Ms Matlala	011 440 1259	082 307 0267
D (LA)	Busi Phiri	011 986 - 0164	082 467 9386
G	Ms. T Cebekhulu	011 213 9708	071 678 7561

The following conditions must be observed:

- Participants' rights and confidentiality will be maintained all the time.
- No resources (Financial, material and human resources) from the above facilities will be used for the study. Neither the District nor the facility will incur any additional cost for this study.
- The study will comply with **Publicly Financed Research and Development Act, 2008 (Act 51 of 2008) and its related Regulations.**

- You will submit a copy (electronic and hard copy) of your final report. In addition, you will submit a six-monthly progress report to the District Research Committee.
- Your supervisor and University of The Witwatersrand will ensure that these reports are being submitted timeously to the District Research Committee.
- The District must be acknowledged in all the reports/publications generated from the research and a copy of these reports/publications must be submitted to the District Research Committee.

We reserve our right to withdraw our approval, if you breach any of the conditions mentioned above.

Please feel free to contact us, if you have any further queries. On behalf of the District Research Committee, we would like to thank you for choosing our District to conduct such an important study.

Regards,

Dr E.N. Ohaju
Chairperson: District Research Committee
Johannesburg Health District
Date 11/04/2019

Mrs M. L. Morewane
Chief Director
Johannesburg Health District
Date: 11/04/2019

Dr R. Bismilla
Executive Director
Johannesburg Health District
Date: 2/5/19

Appendix M: Ethics clearance certificate

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG	HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

Office of the Deputy Vice-Chancellor (Research & Post Graduate Affairs)

TO: Ms H Hasan
School of Therapeutic Sciences
Department of Pharmacy and Pharmacology
Medical School
University

E-mail: hamnahasan_10@live.com

CC: Supervisor: Miles S de Rapper, R Shaikh and Z Booth
<Stephanie.deRapper@wits.ac.za>
and <HREC-Medical_ResearchOffice@wits.ac.za>

FROM: Iain Burns
Human Research Ethics Committee (Medical)
Tel: 011 717 1252

E-mail: Iain.Burns@wits.ac.za

DATE: 2019/07/07

REF: *R14/49*

PROTOCOL NO: **M190410** *(This is your ethics application study reference number. Please quote this reference number in all correspondence relating to this study)*

PROJECT TITLE: *The attitudes, perceptions and practices of nurses in primary health care clinics (PHC) within the City of Johannesburg District in management of antibiotic resistance*

Please find attached the Clearance Certificate for the above project. I hope it goes well and that an article in a recognized publication comes out of it. This will reflect well on your professional standing and contribute to the Government funding of the University.

MSWorks2003/lain/2007/Research.wps

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

R14/49 Ms H Hasan

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M190410

NAME: (Principal Investigator)	Ms H Hasan
DEPARTMENT:	School of Therapeutic Sciences Department of Pharmacy and Pharmacology Medical School University
PROJECT TITLE:	The attitudes, perceptions and practices of nurses in primary health care clinics (PHC) within the City of Johannesburg District in management of antibiotic resistance
DATE CONSIDERED:	2019/04/26
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Miles S de Rapper, R Shaikh and Z Booth
APPROVED BY:	Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	2019/07/07

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on the 3rd Floor Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.

I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to submit details to the Committee. **I agree to submit a yearly progress report**. When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in **April** and will therefore reports and re-certification will be due early in the month of **April** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature Date

PLEASE QUOTE THE CLEARANCE CERTIFICATE NUMBER IN ALL ENQUIRIES

Appendix N: Ethics amendment approval

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG	HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

2019/08/26

Ms H Hasan
School of Therapeutic Sciences
Department of Pharmacy and Pharmacology
Medical School
University

Sent by e-mail to: hannahasan_10@live.com

Dear Ms Hasan

Re: **Protocol Ref No: M190410**
Protocol Title: *The attitudes, perceptions and practices of nurses in primary health care clinics (PHC) within the City of Johannesburg District in management of antibiotic resistance*
Principal Investigator: Ms H Hasan

Thank you for your letter of 2019/08/06.

I confirm that the proposed amendment has been noted and approved. For the record, you are now including prescribing nurses who do not yet have a R48 license.

Thank you for keeping us informed.

Yours Sincerely

J. Burns

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Mr I Burns
For the Human Research Ethics Committee (Medical)

Work2020\lsir3007\Acknowledge.docx

Appendix O: Sample size

DATA RECEIVED FROM DISTRICT:
NUMBER OF PRACTICING PHC NURSES AND AVERGAE NUMBER OF ATTENDED PATIENTS
PER SITE SELECTED

The following data was used in order to obtain the sample size for objectives 1 and 3

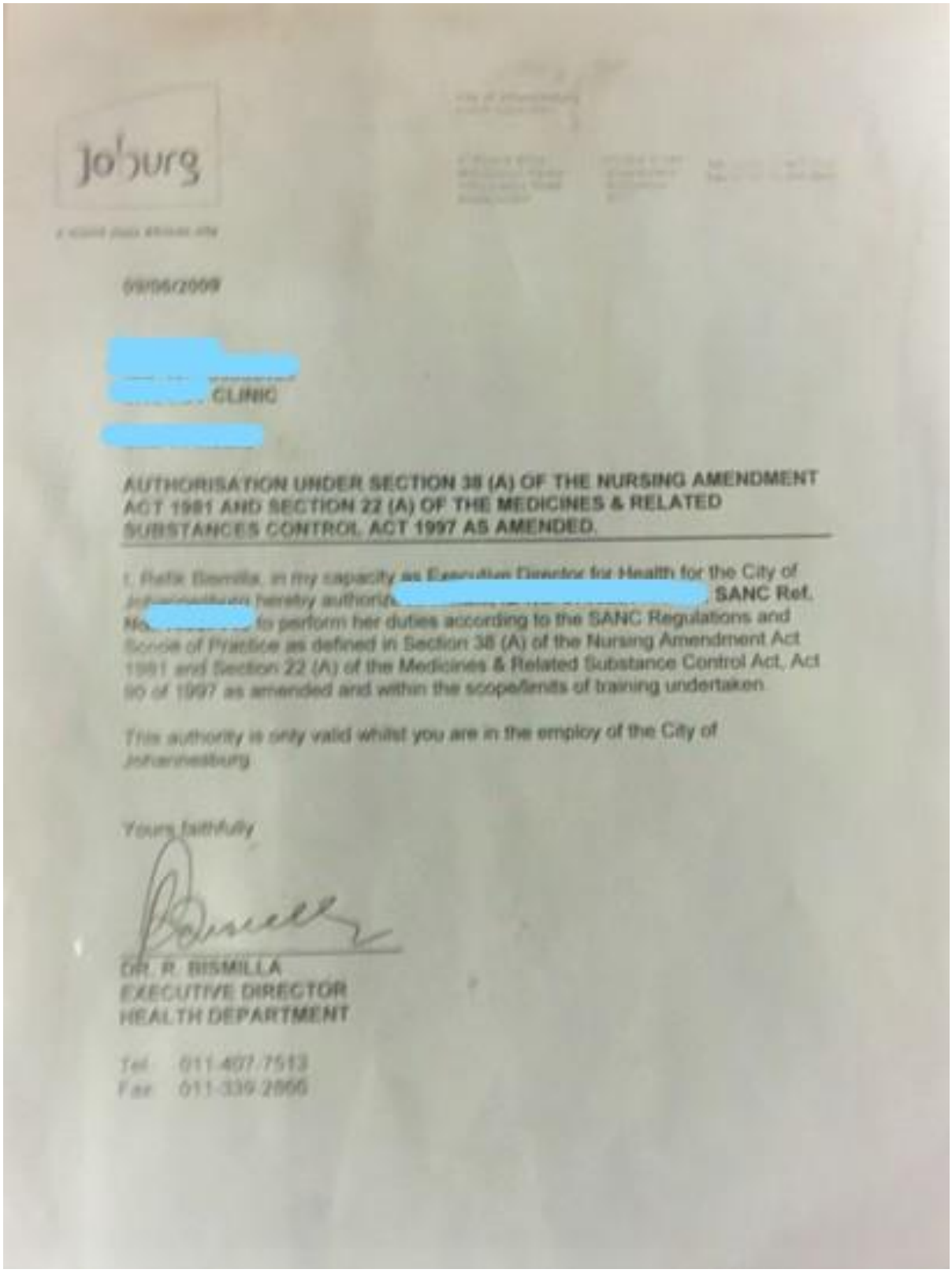
Table 1: The number of practicing nurses per site selected

Region	Number of PHC nurses (data received from district)	Number of PHC nurses at the clinics during the period when the surveys were conducted	Number of nurses that participated at each clinic for the survey	Number of PHC nurses at the clinics during the period when the interviews were conducted	Number of nurses that participated at each clinic for the interview
A	3	1	1	2	1
B	2	2	1	2	1
C	4	4	2	2	2
D	5	5	3	5	1
E	2	4	2	4	1
F	1	2	1	1	1
G	1	2 (were not PHC trained	1	2 (were not PHC trained	1
Total	**18**	**20**	**11**	**18**	**8**

Table 2: The number of patients attended to per site selected

Region	Number of patients	Number of scripts reviewed by the researcher
A	5 310	76
B	2 031	29
C	5 900	84
D	4 069	58
E	3 200	46
F	6 500	93
G	715	10

Appendix P: Covering letter for nurses at the PHC clinics



09/06/2009

[redacted] CLINIC

[redacted]

AUTHORISATION UNDER SECTION 38 (A) OF THE NURSING AMENDMENT ACT 1991 AND SECTION 22 (A) OF THE MEDICINES & RELATED SUBSTANCES CONTROL ACT 1997 AS AMENDED.

I, Rafik Bismilla, in my capacity as Executive Director for Health for the City of Johannesburg hereby authorize [redacted] SANC Ref. No. [redacted] to perform her duties according to the SANC Regulations and Scope of Practice as defined in Section 38 (A) of the Nursing Amendment Act 1991 and Section 22 (A) of the Medicines & Related Substance Control Act, Act 90 of 1997 as amended and within the scope/limits of training undertaken.

This authority is only valid whilst you are in the employ of the City of Johannesburg.

Yours faithfully

DR. R. BISMILLA
EXECUTIVE DIRECTOR
HEALTH DEPARTMENT

Tel 011 407 7513
Fax 011 339 2866