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ANALYSIS OF LOWER RESPIRATORY TRACT ANTIBIOTIC PRESCRIBING PATTERNS AT PARIRENYATWA GROUP OF HOSPITALS IN HARARE, ZIMBABWE

BY

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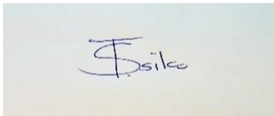
Abstract

Antimicrobial resistance is an escalating global public health crisis threatening the effectiveness of antibiotics. In Zimbabwe like many nations the implication of antimicrobial resistance are becoming increasingly evident. One of the leading causes of morbidity and mortality globally, lower respiratory tract infections have a significant impact on healthcare-related costs. The prescription of last-line antibiotics which are often reserved for the most serious and resistant infection, without proper diagnostic support is a complex issue.The growing problem of antimicrobial resistance makes it harder to choose the right medicines, which increases the likelihood that empirical therapy will fail. Patients with LRTIs frequently experience treatment failure as a result of antibiotic resistance. The purpose of the study was to analyse antibiotic prescribing patterns at Parirenyatwa Hospital in Zimbabwe. The study used a descriptive cross-sectional approach and subscribed to a social model. Thirty (30) participants were interviewed using a structured questionnaire. Data was analysed using STATA for the quantitative data and NVIVO for the qualitative. The result findings revealed that, (60%) identified that there were new strains of microbes and (93.3%) confirmed that there were existing microbes exhibiting resistance to conventional drugs. The most (73.3%) of clinicians discovered that drugs such as ceftriaxone, ciprofloxacillin, azithromycin, gentamycin and anti-TB drugs were the most resistant drugs to microbes. The most popular sources of antimicrobial resistance in Zimbabwe from the results were overuse and misuse of antibiotics, inadequate infection control and poor patient compliance, as well as treating flus and other viral infections that do not need antibiotics. Other sources included lack of proper laboratory support for culture and sensitivity and lack of antibiotic stewardship. The study findings revealed that (73.3%) of participants confirmed that according to EDLIZ, a prescription is required to purchase antibiotics, antibiotics are not sold over the counter. The results showed that (46. 7%) recommended the need for new policies and (66.6%) also recommended the need for new legislation on the use of antibiotics. The results discovered that (73.3%) recommended to retrain clinicians on the current and new evidence-based prescription guidelines.

Key words: Antimicrobial resistance, public health crisis, prescribing patterns, Lower Respiratory Tract Infections(LRTIs)

Declaration

I declare that this proposal is my original work except where sources have been cited and acknowledged. The work has never been submitted, nor will it ever be submitted to another university for the award of a degree

Tsiko Samantha Mutsawaishe _______ 

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Dedication

This work is dedicated to my devoted mother, who inspires me to work hard and never give up.

List of Acronyms and Abbreviations

AMR	Antimicrobial resistance
FAO	Food and Agriculture Organization (of the United Nations)
WHO	World Health Organization
LRTIs	Lower respiratory tract infections
UTIs	Urinary tract infections
TB	Tuberculosis
HIV	Human Immune-Deficiency Virus

Definition of Key Terms

Anti-microbial resistance	This is the ability of pathogenic microorganisms, including bacteria, viruses, fungi and parasites, to alter in ways that make previously prescribed drugs useless.
Lower tract respiratory infections	Refers to acute infections that affect the bronchi, bronchioles, lungs, alveoli and pleura. Other infections include pharyngitis, sinusitis and tracheobronchitis, although the common cold is the archetype.
Antibiotics	Are chemicals that microorganisms like bacteria, yeasts and molds create that either stop the growth of other microbes or kill them.

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CHAPTER 1 INTRODUCTION

1.1 Introduction

One of the leading causes of morbidity and mortality globally, lower respiratory tract infections have a significant impact on healthcare-related costs. Generally speaking, the recovery of an illness is contingent upon the accurate diagnosis of the causative agent and the appropriate prescription of antibiotics. Unfortunately, the findings of bacterial culture and susceptibility testing are sometimes delayed by several days, which might expose patients to potentially ineffective treatments with serious safety implications. As a result, doctors frequently use empirical therapy with antimicrobial medicines. Frequently, the patient's profile, the pattern of local resistance, the antimicrobial agent's cost, and its availability on the market are taken into consideration. However, the growing problem of antimicrobial resistance makes it harder to choose the right medicines, which increases the likelihood that empirical therapy will fail. Patients with LRTIs frequently experience treatment failure as a result of antibiotic resistance.

Zimbabwe’s healthcare system has achieved commendable progress in the post-Millennium Development Goals era, successfully reducing the prevalence of HIV, malaria-related fatalities and other infectious diseases (Government of Zimbabwe, 2015). Despite these advancements, a burgeoning concern looms in the form of antimicrobial resistance (AMR), as evidenced by its emergence in common infections within the nation. The rise of AMR not only jeopardises the hard-won gains of Zimbabwe’s healthcare endeavours since 2000 but also threatens the very foundation of modern medicine and the sustainable efficacy of public health responses against persistently looming infectious threats.

Vital to both preventive and curative measures against infectious diseases, effective antimicrobial drugs constitute a fundamental necessity. However, the systematic misapplication and excessive utilization of antibiotics in human medical practices and food production heighten the vulnerability of Zimbabwe to the dire consequences of AMR. The Government of Zimbabwe (2017) underscores that AMR is not confined to a singular domain; it pervades human, animal, agricultural and environmental sectors. Consequently, AMR casts an ominous shadow over health outcomes for humans, economic vitality within the agricultural realm particularly the livestock sector and even the integrity of the physical environment.

Though the roots of AMR are multifaceted, empirical investigations have revealed a concerning nexus between the misuse of antibiotics and the escalating quandary of antibiotic resistance. This predicament, as acknowledged by reputable sources such as the CDC (2014) and Lapi et al. (2017), stands as one of the most acute and escalating threats to public health. Compounding the gravity of the situation, the potential dissemination of antimicrobial-resistant organisms extends the negative repercussions of antibiotic misuse to patients who might not even have direct exposure to these medications. In illustrating the tangible consequences, the Government of Zimbabwe (2017) has documented alarming instances of AMR, including ciprofloxacin-resistant typhoid, ceftriaxone-resistant gonococci, multi-drug-resistant tuberculosis (MDR-TB) and first-generation anti-malarial resistance. In this milieu, enhancing antibiotic prescribing practices across the entire spectrum of healthcare settings assumes paramount importance in the crusade against antibiotic-resistant pathogens.

This research seeks to delve into the complex realm of analysing prescribing patterns concerning antibiotics at Parirenyatwa hospital in Zimbabwe. The study seeks to foster a scientific interrogation of the prevailing patterns of antibiotic prescription. Therefore, it will methodologically examine the underlying factors that contribute or mitigate against, the emergence and perpetuation of AMR in this vital healthcare context. Through this inquiry, a comprehensive understanding can be gleaned, potentially yielding insights and recommendations that fortify the efforts to curtail the ominous trajectory of AMR while safeguarding the integrity of healthcare provisions in Zimbabwe.

1.2 Background to the Study

The most common infectious diseases identified and managed in clinical settings globally are lower respiratory tract infections (LRTIs). One of the leading causes of morbidity and mortality globally, lower respiratory tract infections have a significant impact on healthcare-related costs. Generally speaking, the recovery of an illness is contingent upon the accurate diagnosis of the causative agent and the appropriate prescription of antibiotics. Unfortunately, the findings of bacterial culture and susceptibility testing are sometimes delayed by several days, which might expose patients to potentially ineffective treatments with serious safety implications. As a result, doctors frequently use empirical therapy with antimicrobial medicines. Frequently, the patient's profile, the pattern of local resistance, the antimicrobial agent's cost, and its availability on the market are taken into consideration. However, the growing problem of antimicrobial resistance makes it harder to choose the right medicines, which increases the likelihood that empirical therapy will fail. Patients with LRTIs frequently experience treatment failure as a result of antibiotic resistance.

Antimicrobial resistance (AMR) is an escalating global public health crisis, threatening the effectiveness of antibiotics and other antimicrobial agents that have long been considered essential tools in modern medicine. The history of antibiotics dates back to Nobel Laureate Alexander Fleming who in 1928, discovered that penicillin killed the bacteria he was examining in a laboratory experiment. O'Neill (2014) asserts that after the discovery of penicillin, there was a rapid expansion in the use of antibiotics in the treatment of various ailments caused by bacterial infections. Further antibiotics were discovered and went on to revolutionize healthcare, becoming the bedrock of many of the greatest medical advances of the 20th century that reduced mortality and increased life expectancy (O'Neill, 2014). A minor cut no longer had the potential to become fatal if it became infected, common but sometimes fatal diseases like pneumonia and tuberculosis (TB) could be efficiently treated and the risks associated with routine surgery and delivery were greatly diminished.

Antimicrobial resistance (AMR) is an escalating global public health crisis, threatening the effectiveness of antibiotics and other antimicrobial agents that have long been considered essential tools in modern medicine (O'Neill, 2014). The emergence and spread of resistant bacterial strains compromise the treatment of infectious diseases and jeopardize the success of medical procedures such as surgery, organ transplantation and cancer therapy (Kardas et al., 2015). In Zimbabwe, like many other nations, the implications of AMR are becoming increasingly evident, particularly within the healthcare system.

One concerning aspect of the AMR landscape in Zimbabwe is the observed practice of clinicians in tertiary hospitals prescribing last-line antibiotics without the support of laboratory tests and due medical processes. This practice stands in direct contradiction to the guidelines outlined in the Essential Medicines List for Zimbabwe (EDLIZ), which serves as a fundamental resource for healthcare practitioners, providing guidance on the selection and utilization of medicines, including antibiotics, to ensure the safe and effective treatment of various medical conditions.

The prescription of last-line antibiotics, which are often reserved for the most serious and resistant infections, without proper diagnostic support is a complex issue with multifaceted implications (O'Neill, 2014). While this practice may be driven by a desire to combat severe infections swiftly, it carries significant risks.

First and foremost, the indiscriminate use of last-line antibiotics accelerates the development of antimicrobial resistance, as bacteria exposed to these potent drugs are more likely to mutate and become resistant (Kardas et al., 2015). This exacerbates the AMR crisis, reducing the effectiveness of the very antibiotics that are essential for saving lives.

Furthermore, the prescription of last-line antibiotics without appropriate diagnostic support raises concerns about the appropriateness of clinical antibiotic prescribing patterns in Zimbabwe's tertiary hospitals. It underscores the need to critically evaluate the factors that influence antibiotic prescribing patterns in these healthcare settings. Such factors may include the availability of diagnostic resources, healthcare provider knowledge and training, patient expectations and institutional practices.

The emergence of antimicrobial resistance (AMR) presents a serious risk to international healthcare systems, warranting in-depth investigation and interventions to safeguard public health. The history of antibiotics reveals their pivotal role in revolutionizing medicine, effectively combating bacterial infections and extending human lifespans (O'Neill, 2014). However, the subsequent development of resistance by bacteria to these vital medications has created a pressing challenge. Despite progress in antiviral research, bacterial and pathogenic agents have continually adapted, rendering many antibiotics less effective. This phenomenon is exacerbated by a dwindling pace of new antibiotic discovery and an upward trend in antibiotic consumption, endangering the remarkable strides made in disease management (O'Neill, 2014).

The irrational utilization of antibiotics has exacerbated the global problem of AMR. This predicament is particularly pronounced in developing countries due to shortcomings in healthcare systems. Incomplete treatment courses, erratic dosing and the inappropriate reuse of antibiotics contribute to the evolution of resistant strains (Kardas et al., 2015). The consequence is diminished drug efficacy, amplified toxicity and the persistence of infectious agents, culminating in the propagation of resistance.

This scenario portends a disconcerting future where previously treatable infections regain their potency, prompting the World Health Organization (WHO) to caution against the emergence of a post-antibiotic era (WHO, 2012). Zimbabwe, like many nations, faces this threat. The country has embraced the 'One Health' approach to address the multifaceted dimensions of AMR, recognizing the interconnectedness of humans, animals and the environment in the transmission of resistant microorganisms. WHO, the Food and Agriculture Organization (FAO) and the World Organisation for Animal Health (OIE) jointly advocate collective action to mitigate AMR.

However, addressing AMR's complexity is hampered by a dearth of comprehensive data. Surveillance of drug resistance remains incomplete, limiting insights into the full extent of the problem. More recently, progresses in antiviral developments in the 21st century have transformed other diseases and conditions like HIV largely manageable conditions. Nevertheless, pathogens and bacteria have always changed to become resistant to the new medications that have been employed to treat them. Resistance has increasingly become a problem in recent years because the pace of discovering novel antibiotics has slowed down significantly, while antibiotic use is rising (O'Neill, 2014). The significant progress gained in the last few decades in controlling HIV and malaria might be undone and these illnesses would once more become unmanageable.

The improper and irrational use of antibiotic is a worldwide problem and is particularly more noticeable in developing countries where health delivery systems are still poor. Kardas, Devine, Golembesky and Roberts (2005) attribute antimicrobial resistance to the irrational use of antibiotics through failure to complete treatment, skipping of doses and reuse of leftovers. Kardas et al (2015) further assert that the irrational use of antibiotics leads to or toxicity of the drugs as well as failure of eradicating infectious bacteria and potentially promoting the emergence of resistance.

WHO (2012) declares that without a harmonized and immediate action on a global scale, the world is heading towards a post-antibiotic era in which common infections could once again kill and Zimbabwe is not exempted. Zimbabwe has embraced the 'One Health' idea since it takes an integrated approach that takes into account how humans, animals and the environment interact through the transmission of microorganisms. This is consistent with the strategy adopted by the World Organization for Animal Health (OIE), the Food and Agriculture Organization (FAO) and the WHO, who have all adopted a stance to work together to reduce the emergence and spread of AMR. Due to the fact that drug resistance surveillance is restricted to a small number of countries, it is difficult to fully comprehend the problems associated with antimicrobial resistance and its size. This research therefore, will attempt to uncover the prevalence of last-line antibiotic prescriptions without proper diagnostic support, identify the factors contributing to this practice and assess its impact on AMR and patient outcomes.

1.3 Statement of the Problem

Antimicrobial treatment has revolutionized health care and is often addressed as one of the most important innovations in medical history. CDC (2014) asserts that the discovery of antibiotics has transformed the practice of medicine and has made once lethal infections tenable. Moreover, antibiotics have made other medical advancements, such as organ transplants and treatment for cancer. However, resistance is now posing a danger to the advancements made possible by the use of antibiotics. O'Neill (2014) estimates that by 2050, antimicrobial resistance (AMR) if unchecked, will be causing 10 million annual deaths worldwide at a cost of 100 trillion dollars to the global economy.

If left unattended, the effects of the crisis will be worse than the combined effects of HIV and TB. The unnecessary prescription of antibiotics, particularly in lower respiratory tract infections is common. According to WHO (2012), antimicrobial resistance is a continuous phenomenon in microorganisms and its amplification and spread is through the improper utilisation of antibiotics, the use of fake and counterfeit medicines, poor prescribing habits and non-compliance to prescribed treatments. According to the MOHCC Situational in 2016, the increased use of antibiotics by both humans and animals is a factor in resistance, although, data on the extent of unnecessary antibiotic consumption is limited. Data on the appropriateness of prescription in management of LRTIs in Zimbabwe is unknown and the research seeks to establish the rate of inappropriate antibiotic use and recommend corrective measures in the event of significant deviations.

Furthermore, there is growing evidence to suggest that clinicians within Zimbabwe's tertiary hospitals may be prescribing last-line antibiotics without the support of laboratory tests and due medical processes, contravening the guidelines outlined in the EDLIZ. This practice not only exacerbates the development of AMR but also raises concerns about the appropriateness of clinical decision-making in the face of an evolving public health crisis. Research on the escalating threat posed by antimicrobial resistance (AMR), emphasizing its profound ramifications for global healthcare systems is still nascent. O'Neill's (2014) research, interrogates the fragility of antibiotic efficacy becomes evident due to the emergence of resistant bacterial strains, further compounded by the scarcity of novel antibiotic discoveries and the rising rates of antibiotic consumption. O'Neill's study underscores the collective impact of these factors on a pivotal crossroads in public health. In a similar vein, the work of Kardas et al. (2005) furnishes empirical support for the adverse consequences stemming from irrational antibiotic utilization, particularly pronounced in developing nations grappling with inadequate healthcare infrastructures.

Their findings illuminate how incomplete treatment protocols, erratic dosing practices and the improper utilization of antibiotics contribute to the emergence of resistant strains, exacerbating the issue at hand. These concerns align harmoniously with the World Health Organization's apprehensions (WHO, 2012) about the impending advent of a post-antibiotic era. This research accentuates the urgency of coordinated strategies to grapple with AMR’s multifaceted complexities and to uphold the enduring efficacy of healthcare interventions in Zimbabwe.

1.4 Research Objectives

1.4.1 Broad Objective

The main objective of the study was to evaluate the antibiotic prescription rates for LRTIs at Parirenyatwa group of hospitals in Harare, 2024.

1.4.2 Specific Objectives

The specific objectives of the research were:

1. To examine the commonly prescribed antibiotics for LRTIs at Parirenyatwa group of hospitals in Harare, 2024;
2. To establish the level of alignment of antibiotic prescription with current recommendations derived from EDLIZ; and
3. To determine the best practice approaches for antibiotic prescription in the treatment of LRTIs in line with EDLIZ guidelines

1.5 Research Questions

The study findings aimed to address the following questions:

1. What are the most common antibiotics prescribed for LRTIs by health care providers?

2. To what extent do health care workers prescribe antibiotics in accordance with EDLIZ guidelines?
3. How best can health care workers prescribe antibiotics for antimicrobial infection?

1.6 Significance of the Study

This study has added new insights to the existing body of knowledge on the antibiotic prescribing habits for upper respiratory tracts infections by clinicians. The results of this study will assist clinicians to improve their antibiotic prescribing habits for LRTIs and hence, reduce the burden of antimicrobial resistance. The results will also assist policy makers like the Ministry of Health and Child Care to regulate antibiotic use in, hospitals where there is heavy use of antibiotics.

1.7 Delimitation of the Study

This study was conceptually delimited to the study of antibiotic prescription habits by clinicians at Parirenyatwa group of hospitals in Harare. Geographically, it focused on one tertiary hospital in Harare.

1.8 Limitations of the Study

The researcher faced difficulties in getting clearance to conduct the study at Parirenyatwa group of hospitals in Harare. The research participants took long in giving back their questionnaires.

1.9 Chapter Summary

introduces the study by framing the global and national urgency of antimicrobial resistance with a focus on Zimbabwe’s healthcare system. The problem statement underscores how unchecked AMR could erase medical progress and place enormous strain on public health systems. The chapter also outlines the study’s objectives, research questions, significance, scope, and limitations setting the foundation for a focused inquiry that aims to strengthen antimicrobial stewardship and preserve the efficacy of antibiotics in Zimbabwe.

CHAPTER 2 REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter explores the information available in literature for the researcher to get an understanding of antimicrobial resistance from a theoretical perspective. The chapter will also examine how clinicians are reacting to antimicrobial resistance through their antibiotic prescribing habits. The chapter opens with a discussion on the theory of antimicrobial resistance and the section that follows deals with the debate on alignment of antibiotic prescription with established guidelines like EDLIZ. Thereafter, the next section deals with best practices for the administration of antibiotics. The chapter will then close with a concluding statement of the findings from literature.

2.2 The theoretical framework of antimicrobial resistance

This study adopted the social model theoretical framework. According to WHO (2015), antimicrobial resistance is 'a wider term which describes the resistance to drugs by a wide range of pathogens including bacteria and other microbes, parasites, viruses and fungi'. The im0pact of antimicrobial resistance could be dramatic (Diminskyte, 2016) and Ladenheim, Rosembert, Hallam and Micallef (2013) posit that antibiotic use is considered as the main factor of antibiotic resistance the world over.

Diminskyte (2016) asserts that each time a new antibiotic is used extensively, a small number of bacterial organisms manage to become resistant to the antibiotic and thus, develop genome mutations or resistant genes. After periods of reproduction, the resistant forms of bacteria create a population of organisms resistant to antibiotics and form superbugs. Drug-resistant bacteria that cause common diseases like pneumonia, urinary tract infections and bloodstream infections are becoming more prevalent as a result of antimicrobial resistance. Figure 2.1 shows the theoretical framework for antimicrobial resistance where science, policy and practice interact through various backward and forward linkages.

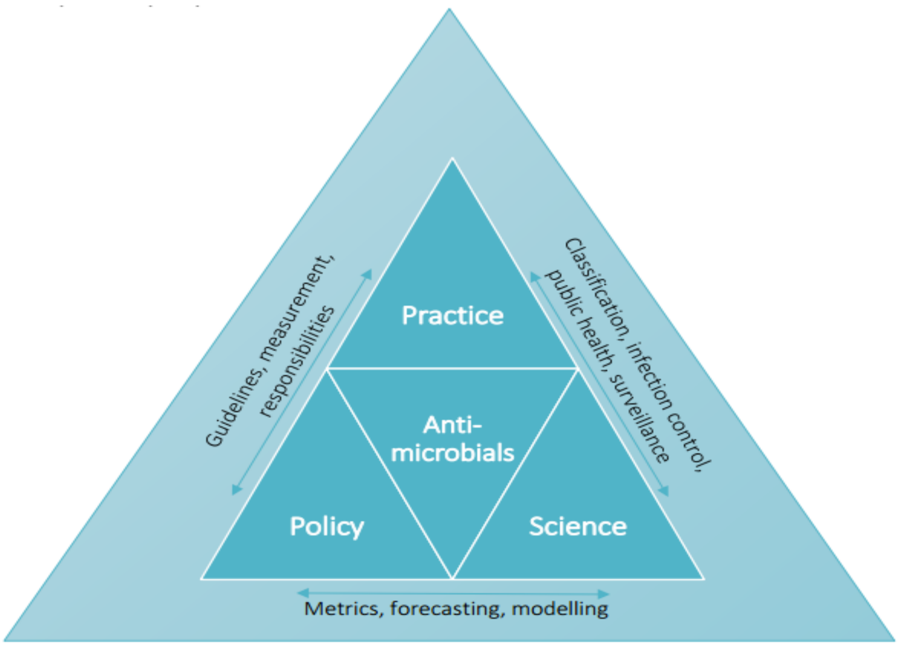


Figure 1: Theoretical framework for the interactions between science, policy and practice in the governance of antimicrobials

Source: Chandler, C.I.R., Hutchinson, E. and Hutchison, C. (2016)

According to the framework, science and policy interact through metrics, forecasting and modelling which produces evidence for use in policy making. On the other hand, policy and practice interact in forward and backward linkages through provision of guidelines like EDLIZ, measurement of progress and assignment of responsibilities to regulators. Science and practice also interact through classification of antimicrobials, infection control, public health and disease surveillance in a way that fosters the practicality of scientific guideline and inventions.

2.3 Alignment of antibiotic prescription with current recommendations derived from EDLIZ

The national vision of the Government of Zimbabwe like any other government, is to have the uppermost level of health and quality of life for all its citizens. In particular, the mission statement of the Ministry of Health and Child Care is 'to promote good health and quality of life for all Zimbabweans by ensuring equal access to comprehensive quality health care.' The government of Zimbabwe (2017) claims that life expectancy has increased since 2010, alongside reductions in maternal mortality and smaller reductions in neonatal mortality.

Nevertheless, Zimbabwe faces a high burden of infectious disease, including upper tract respiratory infections and the pandemics tuberculosis, malaria and human immunodeficiency virus (HIV). In response to growing misuse of drugs and medicines, an essential drugs list was developed by Ministry of Health and Child Care's (MoHCC) National Medicines and Therapeutics Committee. That list is code named EDLIZ and contains all the major drugs used in the treatment of common diseases using standardized guidelines.

The development of EDLIZ guidelines was critical given that WHO (2006), reports that globally, more than 50 percent of all medicines are pre-scribed, dispensed, or sold inappropriately, while 50 percent of patients fail to take them correctly. While clinicians may overprescribe antibiotics, Nambiar (2003) asserts that there is a common cultural belief among African communities about antibiotics, that there is a pill for every symptom and that antibiotics can heal many illnesses and the belief that injections are more powerful than pills. Moreover, Brahma, Marak and Wahlang, (2012) assert that demands by patients and the satisfaction of their expectations and demands of quick relief, clinician prescribe drug for every single complaint leading to a belief that “every ill has a pill” thus contributing to the polypharmacy and hence, a build-up of antimicrobial resistance.

Bbosa, Wong, Kyegombe and Ogwal-Okeng (2014) show that clinicians may have a number of obstacles to prescribing antibiotics appropriately, such as a lack of knowledge about clinical practice guidelines and best practices, a perception of patient expectations regarding antibiotics, a sense of urgency to see patients promptly, or worries about a decrease in patient satisfaction with clinical visits when antibiotics are not prescribed.

Regionally, it has been found out that many developing countries misuse antibiotics in various ways. A review study by O’Neill (2014) proved that antibiotics were irrationally used in various healthcare facilities; particularly in developing countries. Among the most widely utilized antimicrobial medications in the treatment of bacterial infections globally are antibiotics. While antibiotics that are supposed to be prescription Preparation (PP), O’Neill (Ibid) asserts that these drugs are easily accessible without prescription in developing countries particularly in Africa where regulatory capacity is limited.

Studies on the present microorganisms that cause frequent diseases are scarce in Zimbabwe. Streptococcus pneumonia, which has a 50% penicillin resistance rate, was the most often identified cause of pediatric pneumonia, according to earlier research on acute respiratory infections. Pneumocystis pneumonia was also recognized in previous research as a serious infection in both adult and pediatric HIV-positive individuals.

Zimbabwe has a list of essential medicines list, but stock-outs of some of the medicines including antimicrobials, are common at public health facilities (Government of Zimbabwe, 2017). Patients may be compelled to buy antimicrobials over-the-counter, where counterfeit medications are a significant concern, due to the high cost of necessary medications in the private sector and limited access to healthcare. Despite the fact that most antimicrobials need a prescription, reports from the Government of Zimbabwe (2016) show that this need is not strictly enforced.

2.4 Best practices in antibiotic prescription

National clinical practice guidelines issued by national regulatory agencies like the Medicines Control Authority of Zimbabwe (MCAZ) or, if relevant, clinical practice guidelines specific to an institution or system can serve as the foundation for standards for the prescription of antibiotics. Zimbabwe has the chance to lower antibiotic use, which will lower AMR. Increased vaccination, better nutrition, enhanced biosecurity on farms, better food hygiene practices, infection prevention and control (IPC) for humans and animals and improved water, sanitation and hygiene (WASH) can all help avoid disease.

Nathwani and Sneddon (2013) recommend a three-pillar approach to overcome the threat of antimicrobial resistance through practice. The first pillar is to optimise the use of existing antimicrobial agents, the second pillar is to prevent the transmission of drug-resistant organisms through infection control and the third and final pillar is to improve environmental decontamination. These pillars according to Nathwani and Sneddon (Ibid), can reduce the spread of microbial resistance the world over if properly adhered to.

2.5 Approaches to combat Antimicrobial Resistance

2.5.1 Antimicrobial Stewardship Programs

Antimicrobial stewardship programs are defined as the best possible antimicrobial selection, dosage and cure time that results in the best possible clinical outcome for infection prevention and full infection treatment, with the least amount of toxicity to the patient and the least amount of adverse effect on subsequent antibiotic resistance. There are three objectives for antimicrobial stewardship programs. The initial objective is to collaborate with all medical professionals to help each patient receive the best antimicrobial agent at the right dosage for the right amount of time. When a patient is treated for an infection, the appropriate antibiotic dosage is used to cure the condition with the least amount of side effects. These initiatives that aim to maximize antibiotic use also have the added benefit of typically saving money because fewer antibiotic dosages are taken and comparatively inexpensive antimicrobials are used.

The second goal is to forbid the misuse of antimicrobial agents in addition to overuse and abuse. Antibiotics may be provided when they are not necessary in both inpatient and outpatient settings. Antibiotic self-dispensing and self-medication are widespread practices in underdeveloped nations. Antibiotics can be used to treat viral infections or noninfectious conditions such as minor cutaneous abscesses that will go away with drainage and incision or feverish patients with acute pancreatitis (WHO, 2017).

Antibiotics are also commonly abused, such as when broader range antibiotics are prescribed to treat infections obtained in the community or when sensitivity and culture testing are not done. Although it's hard to define, antibiotic misuse could be defined as using one antibiotic over another for commercial or financial gain. Since the use of antibiotics alters susceptibility patterns, the third objective of Antimicrobial stewardship programs is to reduce the formation of resistance at the community and patient levels. Antimicrobial-exposed patients are more likely to contract an infection or have drug-resistant organisms invade them. Antimicrobial exposure is the most frequent cause of Clostridium difficile pseudomembranous colitis diarrhea. Broad-spectrum antimicrobial drugs have been shown to promote Gram-negative bacterial resistance to cephalosporins and carbapenems by 10–12 times.

2.5.2 Techniques for enhancing antibiotics include developing new compounds and refining current structures.

Changing the structure of current medicines and creating new ones are two essential tactics in the fight against antibiotic resistance. Improving the chemical makeup of antiquated antibiotics is the first tactic. Scientists can alter an antibiotic's structure to increase its killing potential. resistant microorganisms or to get to its bacterial target more efficiently. Structural changes can also reduce the antibiotic's toxicity to the patient. As an example of how antiquated medicines could be structurally enhanced, penicillin was modified to create β lactam antibiotics. Resistance to β lactams is increasing, despite the fact that they are commonly used as antibiotics to treat bacterial infections. To tackle this problem, researchers have developed new β lactam antibiotics, or third generation cephalosporins, which are more effective and powerful against resistant bacteria.

Ceftaroline, an agent developed in 2008 and belonging to the same family as beta lactams, has been shown to be helpful in clinical studies involving over 2,500 patients with skin and soft tissue infections as well as community-acquired bacterial pneumonia. According to Zhanel et al. (2009), this molecule represents a significant advancement in the fight against antibiotic resistance. Parallel to this, plazomicin is a novel compound from the class of aminoglycosides that was developed to lessen antibiotic resistance. On the other hand, eravacyline, a member of the new tetracycline generation, was developed with the same objective as plazomicin: to limit bacterial resistance, specifically against specific active efflux and ribosome protection (Grossman et al., 2015).

The structural enhancement of earlier antibiotics can be strengthened by the use of β lactamase inhibitors like avibactam, relbactam, sulbactam, tazobactam and clavulanic acid. These inhibitors make it possible to neutralize the enzymes that certain bacteria manufacture to fend against antibiotics. Additionally, Helicobacter pylori, the bacteria that causes gastrointestinal illnesses, can be successfully defeated by using selenium (sodium bismuth citrate) in combination with metronidazole and tetracycline. These strategies are essential for improving the efficacy of presently prescribed antibiotics and increasing their resistance to bacterial resistance.

The cumulative susceptibility (sensitivity) of clinical bacterial isolates in a particular hospital or area to formulary antibiotics is summarized by an antibiogram (ABG). It is primarily used to track resistance patterns and advise the selection of empirical therapy, assisting ASP in establishing and monitoring its success. In order to provide periodic reports based on updated antibiotic use and consumption, the antibiogram itself needs to be well-designed to reflect changes in hospital antimicrobial drug use.

Previous studies have demonstrated that less than necessary ABG was used to guide the selection of cautious antibiotics. Antibiotic prescribing had not been in line with stewardship objectives and use by practitioners who did not treat infectious disorders had been restricted. Subsequent studies suggest using cross-tabulation of susceptibility, education and stratification to increase the usefulness of antibiograms.

2.5.3 Antimicrocial Peptides

Alexander Fleming's 1922 discovery of the enzyme lysozyme was a significant advancement in our knowledge of how the immune system combats bacterial infections. The first antibacterial agent discovered to be naturally present in the body was lysozyme. The discovery of further antimicrobial peptides (AMPs), which are microscopic molecules the body produces in reaction to bacterial or fungal infections, took decades, though. More research into the creation of antimicrobial drugs and a better comprehension of how AMPs can prevent infections were made possible by the discovery of the first AMPs in Drosophila in the 1990s.

In the battle against a variety of pathogens, such as harmful bacteria and fungus, AMPs are a crucial weapon. Since AMPs only cause a limited amount of bacterial resistance in comparison to other antibiotics, their potential to fight antibiotic resistance is among their most exciting features. The majority of AMPs have a bactericidal action by rupturing the bacterial cell membrane, which results in permeabilization and cell lysis. Certain AMPs have the ability to pass through the bacterial membrane and target anionic molecules that interfere with the biological processes of the bacterial cell, including enzymes or nucleic acids. AMPs are an interesting target for further study and medication development because of their dual mode of action (O'Neill, 2014)

2.5.4 Riboregulators

RNA molecules known as riboregulators work with target mRNAs to control the expression of particular genes. By attaching themselves to the mRNA and preventing its translation, they can either initiate or halt protein synthesis. As an alternative to the traditional tactic of targeting bacterial proteins, researchers in 2007 suggested employing ribregulators as possible targets to obstruct the synthesis of essential proteins in bacteria (Ogawa & Maeda,2007).

Antibiotic resistance genes are often controlled by intricate processes that cause gene expression in response to antibiotic exposure. Recent studies have shown that cis active non-coding R NAs called riboregulators strongly influence the expression of a number of resistance genes. Located in the 5’UTR region of regulated genes, these RNAs also referred to as riboregulators direct translating ribosomes to short, non-coding upstream reading frames (uORFs) embedded in the RNA in order to detect the presence of antibiotics. The structure of the regulator RNA is altered by antibiotics that inhibit translation, which stops the ribosomes on the uORF and activates the expression of the resistance gene.

Research has demonstrated that by attaching to the regulatory region of the target RNA, a chemical called PC1 selectively binds to a guanine riboregulator in S. aureus, inhibiting bacterial growth in vitro and in vivo in mice. These findings imply that by preventing bacteria from producing essential proteins, rioregulators may hold promise for the creation of novel antibiotics.

2.5.5 Preventing the passage of horizontal genetic material across microorganisms

The transfer of genetic material between bacterial communities is one of the primary causes of the development of antibiotic resistance. Bacteria can actually evolve resistance to novel drugs by swapping resistance genes with one another. This tactic depends on the use of conjugation inhibitors since blocking conjugation-related proteins stops plasmides from spreading to other hosts, which aids in the removal of plasmides from bacterial populations. (Dimitriu et al 2014)

A number of tactics have been studied to limit the horizontal spread of antibiotic resistance, such as the use of ionophores, chlortetracycline, bacitracin and combinations of antimicrobials. These methods are very effective at stopping the horizontal spread of antibiotic resistance in E. coli, according to research. Other studies have demonstrated the ability of a variety of natural compounds, such as flavonoids, plant extracts and antimicrobial peptides, to stop horizontal gene transfer. In a similar vein, synthetic substances that specifically target the proteins involved in bacterial conjugation have been developed. (Dimitriu et al 2014)

2.5.6 ATP synthase inhibitors

Bedaquiline is a member of a novel class of antibiotics called ATP synthase inhibitors. It functions by blocking the manufacture of ATP, which is essential for the growth and survival of bacteria, particularly Mycobacterium TB, the causative agent of tuberculosis. By blocking ATP synthase specifically, bedaquiline inhibits the energy metabolism of bacteria, hence limiting their growth. Mycobacterium tuberculosis strains that are resistant to commonly used medications respond well to this strategy (Hards et al.,2015).

Numerous studies have demonstrated the effectiveness of bedaquiline in treating tuberculosis, particularly in individuals with multidrug-resistant forms of the disease. Bedaquiline is commonly used in combination with other antibiotics to boost its effectiveness and lower the chance of resistance developing. In order to enhance the treatment of TB and other bacterial illnesses, research is also still being conducted to investigate more ATP synthase inhibitors and comprehend their method of action (Hards et al., 2015).

In both prokaryotes and eukaryotes, ATP synthase is an essential enzyme complex for the synthesis of ATP, which is required for cellular viability. Protonation through the F0 domain causes the c and γ subunits of the F1 domain to rotate, which in turn causes ATP synthesis. The complex is made up of a transmembrane domain (F0) and a cytoplasmic domain (F1). The binding location between the F0 domain synthesis's a and c subunits is where bedaquiline binds.

2.5.7 Nanoparticles

One innovative approach to improving the treatment of numerous severe illnesses is the application of nanotechnology in medicine. This technology is used to distribute drugs by use of nanovectors, which are extremely small particles (on the range of nanometers) that can carry active substances to their pharmacological target in the body (Haleem et al.,2023) Nanovectors offer better bioavailability and more regulated release of active ingredients than conventional drug delivery methods. Additionally, they can directly target injured tissues or diseased cells, reducing side effects and incidental damage to healthy organs.

Several alternative modes of action have been proposed to explain the antibacterial activity of nanoparticles. One of the most extensively studied mechanisms is the electrostatic interaction between positively charged nanoparticles and the negatively charged bacterial cell membrane, which can lead to cell membrane breakdown, the release of toxic metal ions and the eradication of bacteria. Additionally, nanoparticles can obstruct in order to hinder bacterial metabolic activities, nanoparticles can also disrupt biological processes like respiration, protein synthesis and DNA replication. Free radicals disrupt the metabolic activities of bacteria.

Nanoparticles can also form free radicals, which are unstable molecules with unpaired electron atoms that can damage proteins and bacterial membranes. Furthermore, nanoparticles can interact with bacterial biofilms, which are bacterial colonies encased in a protective extracellular matrix. Biofilms, which are infamous for their resistance to traditional medications, are commonly associated with chronic infections. Nanoparticles have the ability to penetrate biofilms and disturb the extracellular matrix, which can increase the susceptibility of bacteria to antibiotic treatment.

The antibacterial properties of particular nanoparticle constituents, including iron, zinc, copper and silver oxide, have also been highlighted in recent research. These powers have been observed, especially against Gram negative bacteria like P. aeruginosa and E. coli and Gram positive bacteria like S. aureus and Bacillus subtilis (Yu et al., 2020).

2.5.8 Shortening interfering RNA

One possible tactic to counteract antibiotic resistance is to use short interfering RNA (siRNA) (Edson & Kwon, 2014). This technique targets particular bacterial DNA or RNA sequences that are essential for the production of proteins linked to antibiotic resistance. Potential targets include genes that produce the β lactamases that break down medications from the β lactam family.These locations result in the production of RNA segments of about 20 base pairs. This RNA segments' ability to precisely bind to particular locations creates a double-stranded RNA pair that ribonucleases can identify. The resulting destruction of the double-stranded RNA prevents the synthesis of proteins linked to resistance.

2.5.9 Bacteriophages

Phage treatment is an ancient method of treating bacterial diseases that kills harmful bacteria by using viruses called phages. Phages are viruses that specifically target and infect bacteria, causing them to rupture or lyse. Lysing them or making them burst even before the invention of antibiotics. This strategy was considered even before to the discovery of antibiotics, but it was eventually dropped because of its negative effects. Although this strategy was considered, it was eventually dropped because of its detrimental effects on the immune system, immunological repercussions. However, phage treatment has recently drawn considerable interest.

However, because of the rise in antibiotic resistance, phage treatment has recently drawn considerable interest. The benefit of phages is that they reduce the likelihood of phage resistance because they are specific to their bacterial target and do not disrupt the gut flora.

For phage therapy to be successful, two issues must be resolved: phage variety and the need to choose the right phage for each bacterial disease. Since bacteria can rapidly develop phage resistance, a new phage needs to be selected for each new resistant bacterial strain.

Another tactic is to use phage-derived peptides, which are protein fragments made by phages that have the ability to rupture or cytolyze bacterial cell membranes.
These peptides have the advantage of being more stable than entire phages and can be produced in a lab. Additionally, they can be modified to target specific bacterial strains more persistently and efficiently or to increase their stability.

2.5.10 CRISPR Cas

The cutting-edge genome editing technique known as CRISPR Cas may be able to help fight antibiotic resistance. The CRISPR Cas system allows scientists to target and cut particular DNA regions in bacteria. Drugs might once again become effective if the genes in bacteria that cause antibiotic resistance were targeted and made inactive.

Numerous studies have demonstrated the potential of the CRISPR Cas system in combating antibiotic resistance. Because the CRISPR Cas system can target genes on chromosomes and plasmids, it can kill bacteria directly. To restore the efficacy of antibiotics against E. coli bacteria, for example, Gomaa et al, 2023 employed CRISPR Cas to target and deactivate an antibiotic resistance gene in the bacteria. Previous research have demonstrated that the CRISPR Cas system can be utilized to target antibiotic resistance genes in important bacteria, such as S. aureus, S. aureus and S. pneumoniae.

2.6 Antimicrobial resistance surveillance

One crucial public health function is surveillance. Monitoring a health problem, in this case antibiotic resistance, provides information that guides research efforts and informs public policy and communication (OPHSS and CDC, 2018). In this context, surveillance is defined as the prompt gathering, examination and dissemination of information on resistance patterns for diseases that are significant for public health (WHO, 2014). Global and national action plans to prevent antimicrobial resistance must include improved surveillance.

Some disease surveillance programs also include resistance monitoring. One significant aspect of national tuberculosis surveillance, for instance, is resistance to the medications used to treat the disease. However, in contrast to disease surveillance systems, antimicrobial resistance surveillance necessitates tracking a variety of targets, including those related to human health, animals, agriculture and the environment. Antimicrobials and their metabolites, mobile genetic elements, resistance genes and resistant infections or indicator organisms are among the goals for surveillance. Because of these factors, the environment that supports antimicrobial surveillance encompasses not only clinical microbiology labs and hospitals, despite their significance, but also regular animal health surveillance, watershed and soil monitoring programs and animal health laboratories.

Understanding the burden of antimicrobial resistance, identifying the formation and spread of resistant organisms, focusing treatments to stop and manage the establishment of resistance and assessing their efficacy all depend heavily on surveillance systems. The goals, scope and techniques of antimicrobial resistance surveillance systems can vary greatly, whether they are local, national, or international in nature**.**

Both passive and active surveillance systems are possible. Depending on the system's monitoring scope, a passive system depends on self-reporting from organizations with pertinent data. Due to the minimal human expenses required to collect the data, passive surveillance is very cheap to operate; but, the information obtained is unlikely to be timely, comprehensive, or representative of the target population (Lee et al., 2010). Active surveillance in the context of antibiotic resistance might entail the use of public health personnel to keep an eye on a target disease by proactively reaching out to institutions and gathering data regarding the frequency of infections brought on by that pathogen.

Although active monitoring has a predictable timeline and can reduce issues with data representativeness and completeness, these benefits come at a price. The Centers for Disease Control and Prevention's (CDC) Active Bacterial Core, part of the Emerging Infections Program, is an example of active surveillance. Since the 1990s, the CDC has gathered resistance data and clinical information for infections of five invasive bacteria that are acquired in the community (Fridkin et al., 2015; GAO, 2020). Health policy and outreach initiatives to address the significant health disparities in community-acquired methicillin-resistant Staphylococcus aureus (MRSA) risk in some states were informed by the Active Bacterial Core surveillance program (Fridkin et al., 2015).

Instead of being all-encompassing throughout a region or population, sentinel surveillance systems are built on monitoring specific areas. For instance, these websites gather information from a sizable population in regions where hospitals or clinical labs are likely to have antimicrobial resistance (Lee et al., 2010). Sentinel surveillance for resistant organisms is exemplified by the CDC's Gonococcal Isolate Surveillance Program, which monitors antibiotic resistance in gonococcal isolates reported by 33 health departments nationwide (CDC, 2021).

Human medicine, particularly acute care, has historically served as the foundation for antimicrobial resistance surveillance. Since clinical microbiology services in hospitals provide high-quality data on the resistant microorganisms causing infections in hospitalized patients, data from acute care hospitals are frequently the starting point for surveillance. In order to better understand the impact of antibiotic resistance, newer surveillance technologies such as genomic analysis can be utilized to track the origin of infectious outbreaks.

Choosing the target to monitor such as the microbial species and the pertinent public health issues will determine how a surveillance system to track antibiotic resistance is designed. An interest in characterizing the resistome of a largely healthy population would lead to monitoring of a sample representative of this population, such as sewage, while a concern about the impact of antimicrobial resistance on the environment might lead to a comparatively greater interest in monitoring effluent, or the wastewater discharged into the natural environment from treatment plants.

There are various ways to report laboratory data into surveillance systems. Manual reporting using online questionnaires to enter data is a labor-intensive method. Manual file extraction followed by uploading to a central webpage or online database is another typical way for reporting resistance data into surveillance systems. Both these ways add to the effort for laboratory staff and health workers and to delays on data availability. Direct, automated transfer between the surveillance system and the laboratory information system is a more effective method. This can make it easier to report in real-time or almost real-time, which makes it possible to analyze new patterns more effectively.

Cloud-based, real-time surveillance occasionally uses confidential information. Medical device companies can obtain valuable data regarding resistance developments in the United States, where automated testing for antimicrobial susceptibility is common, provided that the laboratories utilizing their systems are open to sharing test results (Ruzante et al., 2021). Although the relative rank and proportion of pathogens detected were largely similar to CDC surveillance data, these results should be interpreted cautiously because they were not derived from a purposeful sampling frame intended to be representative of the population (Ruzante et al., 2021). Because patient confidentiality necessitates that the data be de-identified, it can also be challenging to evaluate some of the findings from the medical device firm.

The benefits of automated surveillance systems over techniques that depend on human data reporting are obvious. Automation simplifies and speeds up reporting while causing the least amount of disturbance to daily tasks. However, a 2018 evaluation of automated reporting from clinical diagnostic labs throughout Europe discovered that financial and technological obstacles were the most prevalent ones to automated reporting to the national surveillance systems (Leitmeyer et al., 2020). Since this is not their main business, the vendors and developers of laboratory software may not have created methods to make their data compatible with the national monitoring systems (Leitmeyer et al., 2020). One obstacle to automated monitoring is the protection of private data, particularly in nations without the legislative structure necessary to enable automated surveillance.

Comprehensive surveillance for antimicrobial resistance in low- and middle-income countries is frequently hampered by a lack of information technology (Vong et al., 2017). The expense of the technology, software and personnel needed to maintain automated surveillance networks is another issue, as is the lack of internet connectivity (Vong et al., 2017). WHONET is a free Windows-based program created by the WHO Collaborating Center for Surveillance of Antimicrobial Resistance that microbiology labs can use to analyze susceptibility test results. WHONET also provides a data conversion tool to enable the transfer of raw susceptibility data from the laboratory system to surveillance systems such as GLASS. To get the data transferred to a surveillance system, lab supervisors only need to choose to participate.

The two primary sets of methods for determining antibacterial resistance are genotypic and phenotypic. Tests of phenotypic antimicrobial susceptibility establish how well an antimicrobial substance kills or stops the growth of particular bacterial species. Clinical decision-making, including the choice of medication and antimicrobial treatment plan, depends on the outcomes of such tests. Susceptibility statistics are useful markers of antimicrobial resistance trends at the population level (Cusack et al., 2019). Additionally, there are other genotypic methods that are more frequently employed in research and can contribute to a better understanding of the burden of resistance. Among them are multiplexed molecular panels with resistance markers, which are becoming more and more popular in environmental and clinical laboratories and provide next-generation sequencing techniques as well as quick and precise genotypic susceptibility data.

Diffusion and microdilution are the two most widely used techniques for testing antimicrobial susceptibility. In order to ascertain whether an organism is resistant to an antimicrobial compound, susceptible to it, or at a point in between, both test types rely on established clinical breakpoints. From these, the microbiologist can calculate the lowest drug concentration required to stop microbial growth. Comparing susceptibility profiles over time and space is made easier by the broth microdilution method, which offers more information on the degree of susceptibility or resistance than the other method.

In medicine, both diffusion and microdilution assays are used to determine a pathogen's clinical susceptibility to an antibiotic. To diagnose a resistant infection and treat a patient, a doctor or veterinarian would require this information. At the molecular level, characteristics of the bacterium that transmit resistance to antibiotics are what drive this clinical resistance. Better understanding of the genetic basis of resistance has been provided by recent testing developments; this information can be tracked in academic and public health surveillance initiatives (CDC, 2021).

Genotypic techniques for resistance detection search for genetic code sequences that point to antimicrobial resistance mechanisms. Numerous molecular analysis-based methods used in genotypic investigations amplify portions of bacterial DNA in order to find resistance characteristics. Molecular tests in clinical contexts usually search for genes that are known to transmit resistance to pertinent medications. By excluding therapies for which the target pathogen possesses resistance genes, the data can help guide clinical treatment. However, particularly in gram-negative organisms, the absence of resistance genes does not always signal the pathogen's clinical vulnerability, nor does the presence of resistance genes always predict treatment failure (Bard and Lee, 2018; Galhano et al., 2021).

In addition to detecting the existence of a resistance gene, quantitative PCR (qPCR), sometimes referred to as real-time PCR, can also determine the gene's quantity in the sample. Because of this, qPCR is widely employed to find environmental resistance genes. With the advent of high-throughput, real-time quantitative PCR, a method that can perform many experiments using samples as small as nanoliters, its utility has grown. This technology can simultaneously examine the presence and quantity of several resistance genes or mobile genetic components.

Because they are quick and require comparatively small sample volumes, genotypic technologies are helpful in surveillance. In surveillance, it is helpful to be able to identify the existence of a resistance mechanism, even at low concentrations. When researching bacteria that are challenging to cultivate, genotypic methods are useful (Franklin et al., 2021). They may be able to pinpoint the causes of resistance, like the existence of genes linked to resistance to numerous medications, heavy metals, or mobile genetic elements. Additionally, they can identify resistance mechanisms without relying on phenotypic breakpoints, which can vary depending on the testing standard employed and regardless of whether the pathogen is alive (Sundsfjord et al., 2004).

However, compared to phenotypic susceptibility tests, genotypic tests are currently more costly and necessitate more advanced equipment and processing (Wellcome Trust, 2018). Furthermore, genotypic approaches based on sequencing will overlook resistance encoded by a gene that has not yet been identified. Moreover, a phenotypic susceptibility test assesses whether a resistance gene or determinant is present or not, as opposed to its functional expression in a pathogen (Dunne et al., 2017). Understanding the genetically active and inactive elements of a genome or microbiome can be gained by examining the RNA in a transcriptome (Shakya et al., 2019). Metatranscriptomics, the sequencing of RNA in microbial communities, can shed light on how genes work.

According to Luby et al. (2016), PCR analysis of an environmental sample to look for specific resistance markers cannot identify the microbial host of the resistance gene, which makes it challenging to assess whether or how the resistance is transferred to important diseases. Despite their ability to test for numerous resistance genes simultaneously, the new high-throughput, real-time PCR techniques cannot detect novel resistance genes or emerging genetic elements (Franklin et al., 2021). Additionally, protocols need to be standardized, particularly for metagenomic analysis and whole genome sequencing.

Certain antimicrobial resistance surveillance systems are made to track resistance to certain antibiotics or to specific diseases. However, coordinated monitoring across human, animal and environmental samples will become more practical as phenotypic detection procedures are simplified and genotypic technologies become more affordable and available.

The antibiogram is a frequently used instrument to track resistance trends.Antibiograms often gather aggregate data from a hospital or health system and display it in tables. Antibiograms are crucial in clinical medicine and surveillance because they can be used to track patterns in the phenotypic resistance of infections to various medications. The CDC’s Core Components of Hospital Antibiotic Stewardship Programs include the creation of antibiograms (CDC, 2019). Hospital reports then contribute to county and state antibiograms, which are used to track resistance trends and guide treatment choices.

2.7 WHo AwaRe

Our capacity to treat common diseases is still under danger due to the introduction and spread of drug-resistant bacteria that have developed new resistance mechanisms, resulting in antimicrobial resistance. The fast global expansion of pan- and multi-resistant bacteria, which cause diseases that cannot be cured by current antimicrobial medications like antibiotics, is particularly concerning.

There are no novel antimicrobials in the clinical pipeline. Only six of the 32 antibiotics in clinical development that WHO designated in 2019 as addressing the WHO list of priority pathogens were deemed novel. Moreover, a significant problem is still the lack of access to high-quality antibiotics. Countries at all stages of development are experiencing antibiotic shortages, particularly in their healthcare systems.As drug resistance increases throughout the world, antibiotics are losing their effectiveness, making diseases harder to cure and even causing deaths. For instance, to treat gram-negative bacterial infections that are resistant to carbapenem, as listed in the WHO priority pathogen list, new antibacterials are desperately needed. These new antibiotics will, however, meet the same end as the existing ones and lose their effectiveness if people do not alter the way they are now used.

Due to extended hospital stays and the requirement for more costly and intense care, AMR has a substantial negative impact on patient or caregiver productivity, which has a substantial financial impact on national economies and health systems (WHO, 2023).

The number of patients whose treatment is failing or who pass away from infections will rise in the absence of efficient instruments for the prevention and proper management of drug-resistant infections as well as better access to both novel and existing quality-assured antibiotics. Medical treatments including organ transplants, cancer chemotherapy and surgery like caesarean sections or hip replacements will grow riskier.

The WHO Expert Committee on Selection and Use of Essential Medicines created the AWaRe categorization of antibiotics in 2017 as a means of assisting local, national and international initiatives to promote antibiotic stewardship. To highlight the significance of their proper usage, antibiotics are categorized into three groups: Access, Watch and Reserve. This is done by taking into consideration the effects of various antibiotics and antibiotic classes on antimicrobial resistance. Updates are made every two years.

The purpose of the AWaRe categorization is to serve as a tool for tracking antibiotic use, setting goals and assessing the results of stewardship initiatives that seek to maximize antibiotic use and reduce antibiotic resistance. The WHO 13th General Programme of Work specifies a country-level aim of at least 60% of total antibiotic usage being Access the group.

ACCESS GROUP- which identifies the recommended antibiotic for each of the top 25 infections; these medicines have to be consistently accessible, reasonably priced and of guaranteed quality.

WATCH GROUP- comprises the most significant and high priority antibiotics for use in human and veterinary medicine; these antibiotics are only advised for a few, particular reasons.

RESERVE GROUP- contains medications that should only be used as a final resort after all other antibiotics have been exhausted. (WHO AWaRe 2023 Antibiotic Classification).

Limiting at least 60% of the world's antibiotic use to the ACCESS category is the main goal of the WHO AWaRe categorization. In order to maintain antibiotics' efficacy for future generations, the goals are to promote their responsible use, stop the emergence of antibiotic resistance and guarantee their prudent usage.

A quick and easy method for identifying important features of drug use is to use the WHO Core Drug Use Indicators. They aid in drawing attention to drug use issues, evaluating the effectiveness of healthcare facilities and directing future initiatives to address concerns about antibiotic stewardship and pharmaceutical usage.

The three primary strategies that promote responsible pharmaceutical use are audit, feedback and supervision. As part of the prescription audit and feedback process, drugs must be evaluated for appropriateness prior to feedback. Promoting responsible drug use requires first evaluating drug use patterns using WHO drug use indicators.

WHO is the most widely utilized indicator. Prescription indicators are used to pinpoint drug usage problems and help physicians understand how important it is to take medications responsibly.

The percentage of antibiotic prescriptions per inpatient day, the average number of drugs prescribed per inpatient day, the percentage of drugs prescribed from the Essential Drugs List (EDL) or formulary, the number of antimicrobial sensitivity tests conducted per hospital admission and the prescription of medications by their generic names are all examples of prescribing indicators. The WHO AWaRe classification shows the proportion of antibiotic prescriptions from the Access, Watch and Reserve groups; more than 60% from the Access group is the ideal number.

2.8 Who One health concept

The goal of One Health is to optimize and sustainably balance the health of people, animals and ecosystems through a unified, integrated approach.It acknowledges the tight connections and interdependencies between the health of people, domestic and wild animals, plants and the larger environment, including ecosystems. (WHO, 2023).Although food, energy, water, health and the environment are all broad subjects with sector-specific issues, cooperation between disciplines and sectors helps to safeguard health, address health issues like the rise of infectious diseases, antibiotic resistance and food safety and support the integrity and well-being of our ecosystems.

One Health can cover the entire spectrum of disease control, from prevention to detection, readiness, response and management and contribute to global health security by tying humans, animals and the environment together. (WHO, 2017).

The strategy depends on effective and shared governance, communication, cooperation and coordination and can be implemented at the local, subnational, national, regional and international levels. People can more easily comprehend the co-benefits, dangers, trade-offs and possibilities to promote equitable and comprehensive solutions when the One Health approach is implemented.

An ecologically balanced environment is essential to population health and quality of life. Together with rainfall, floods, urban trash and a dense population, a lack of basic sanitation creates big populations that are susceptible to endemic infectious and parasitic diseases. The human-animal relationship is actually the perfect topic to demonstrate the added value that the One Health concept offers. Numerous studies show how beneficial animals are for people of all ages, with many of these benefits lasting over time, especially the reduction of stress, blood pressure and depression. Additionally, sedentary people can be encouraged to exercise and their interactions with animals can promote lifestyle changes. Adherence to a physical activity program can be difficult, especially for patients with multiple chronic diseases and the animal may serve as a motivator to stick with the program.

Growing recognition of the necessity of involving transdisciplinary teams in the solution of complex problems in response to the challenges of the 21st century and the Sustainable Development Goals has led to the application of the One Health concept to the creation and execution of public policies.

Establishing connections and cooperative efforts between the environmental, animal and human health sectors involving various public and private actors and institutions is essential to this holistic approach. One sector’s reaction must include impact assessment and minimize negative effects on downstream sectors by cutting down on duplication of policy guidelines and redundancies (WHO, 2017.

2.9 Chapter Summary

This chapter discussed the concepts underpinning the study and the antibiotic prescribing habits of clinicians globally, regionally and locally. The chapter further discussed the conceptual framework of the governance of antimicrobials through the interactions between science, policy and practice and the alignment of antibiotic prescription with EDLIZ guidelines in Zimbabwe. Further to that, the chapter also discussed the recommended antibiotic prescribing habits from a global, regional and local perspective. The chapter closes with a summary and the next chapter will discuss the methodology to be used in this study.

CHAPTER 3 METHODOLOGY

3.1 Introduction

To comprehend antibiotic resistance, the previous chapter examined theoretical literature from both published and unpublished sources.and clinical decision patterns in antibiotic prescribing at Parirenyatwa group of hospitals in Harare. Other determinants of antibiotic prescribing patterns at Parirenyatwa group of hospitals along the public health expectations will also reviewed. The data collecting and analysis procedure that will be used in this study is described in this chapter. The research design is explained in the first section, which is followed by sections that describe the demographic, sample size, data analysis and study circumstances. This is followed by the sampling framework and the research techniques to be used to gather data from respondents. Procedures for data analysis and the research ethics that must be adhered to in this study are the main topics of the next sections. A summary concludes the chapter.

3.2 Research design

Coorper and Schindler (2016) assert that a research design is a general plan of how the researcher attempts to answer the research questions and it assists the researcher in allocating resources. This research investigated the antibiotic prescribing habits of clinicians at Parirenyatwa Hospital by means of a descriptive cross-sectional study. Methods used include a combination of questionnaires and checklists. Cross sectional data has a distinct advantage of using routinely collected data which makes the research process less cumbersome and less costly?

This design studied the dynamics of antibiotic prescription by investigating the problem that exists (Coorper and Schindler, 2016). This research adopted a social theory model. The study was hinged on the social model because the researcher was working with the interactions between science, policy and practice in the control of antimicrobials. Data was collected independently and analysed using statistical tools. The researcher was detached, neutral and independent from the hospital and clinicians being studied. However, the researcher also collected qualitative data which was analysed narratively. In this study, the antibiotic prescribing habits were interrogated using quantitative secondary data. Panel data was selected from the hospital sample for statistical analysis using STATA for the quantitative data and NVIVO for the qualitative.

3.3 Population and sample

The population in this study included clinicians at Parirenyatwa group of hospitals on 30 September 2024. This includes patients who had acute pharyngitis, acute cough, shortness of breath, acute chest pain acute wheezing, acute sputum production, acute cyanosis, increased heart rate, decreased oxygen saturation and common cold issued an antibiotic.

Simple random sampling of clinicians at Parirenyatwa Group of Hospitals Medical wards. The sample size was calculated using Dobson's formula:

$$n=\frac{z^2pq}{d^2}$$

where:

n= sample size at 95% Confidence Interval;

and Z=statistic for the confidence interval (1.96)

p= patients attended with LRTIs (30%)

d= degree of accuracy (5%)

Therefore, the researcher interviewed a total of 30 clinicians, at Parirenyatwa group of Hospitals that were selected for the research.

3.4 Inclusion and exclusion criteria

Inclusion criteria:

- Clinicians who were on duty on the day of data collection, 30 September 2024.
- Exclusion criteria:
- Clinicians who were not on duty on the day of data collection, 30 September 2024.

3.5 Data collection tool and techniques

The researcher made use of secondary data through document review and hence, used a data collection template. The researcher entered the documentary or historical figures on the excel sheet and then clean the data before exporting to NVIVO and STATA.

Questionnaires helped to obtain more insight from a few clinicians on their use of antibiotics in LRTIs.

3.6 Data analysis

Data entered was initially cleaned. Data was analysed using STATA for the quantitative data and NVIVO for the qualitative. Data from the questionnaires was also analysed narratively to expand the information obtained from historical figures. Tables, graphs and charts were used to present the data.

3.7 Ethical considerations

Academic studies must adhere to standard ethics acceptable in the particular field of study. Strydom, Fouch and Delport (2005:570) define ethics as "a set of moral principles which is suggested by the individual or group... and which offers rules and behavioural expectations about the most current conduct towards subjects..." These writers contend that study designs and techniques that do not adhere to ethical norms and treat people with dignity are likely to produce false, ambiguous and dishonest results. The researcher sought permission from the Clinical Director at Parirenyatwa group of Hospitals and Africa University Research Ethical Control (AUREC).

Therefore, the researcher in this study complied with and respected the ethical guidelines of maintaining confidentiality and anonymity, safeguarding research participants and upholding trust. An overview of the ethical considerations the researcher made to ensure that the study endeavour complies with accepted academic ethics is provided below.

3.7.1 Maintaining anonymity and confidentiality

Making data "anonymous" means removing the contributor's name. In this case, the researcher used codes in place of actual names except for institutions to ensure that no responses would be identified by any particular research participant. In this research, confidentiality was definite by assuring the participating clinicians that the information given was not to be made accessible to anyone who is not directly involved in the study.

3.7.2 Protecting research participants and honouring trust

The researcher in this study was committed to protect the physical, social and psychological well-being of the clinicians at participating clinics and respect their rights and interests. When there was conflict, the interests and rights of clinicians was respected. In this research therefore, the researcher assured the participants that the research findings will not be used against them or to victimise clinicians whatsoever. Neither will the results of the research be used as a measure of performance by the clinicians.

CHAPTER 4 DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

This chapter focused on data presentation as it was obtained from participants and data analysis. The purpose of the study was to analyse the prescribing patterns of antibiotics by clinicians. The chapter analysed the data objectively, it begins the analysis with description of the data collection template and then examined the commonly prescribed antibiotics for LRTIs at Parirenyatwa group of hospitals. The Chapter then established establish the level of alignment of antibiotic prescription with current recommendations derived from EDLIZ. The chapter also proffered recommendation as the best practice approaches for antibiotic prescription in the treatment of LRTIs in line with EDLIZ guidelines the chapter concluded with a summary.

4.2 Data Presentation and Analysis

4.2.1 Data collection template

Ten participants completed the data collection template. The most common lower respiratory infection treated recently were pneumonia (bacterial pneumonia, aspiratory pneumonia, community acquired pneumonia, *Klebsiella* pneumonia, *Staphylococcal* pneumonia and *Pneumocystic Carinii Pneumonia),* followed by tuberculosis and lung abscess as shown in the diagram below.

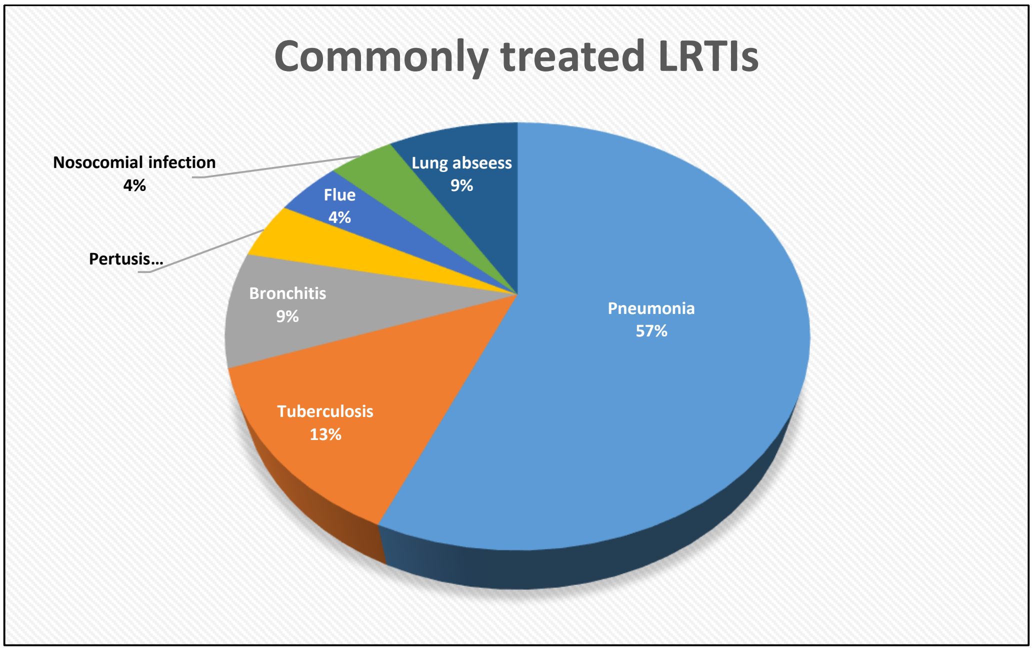


Figure 2: Commonly treated LRTIs

Of the 10 antibiotics that the participants prescribed for the different LRTIs, ceftriaxone and azithromycin were the most popular as shown in the diagram below.

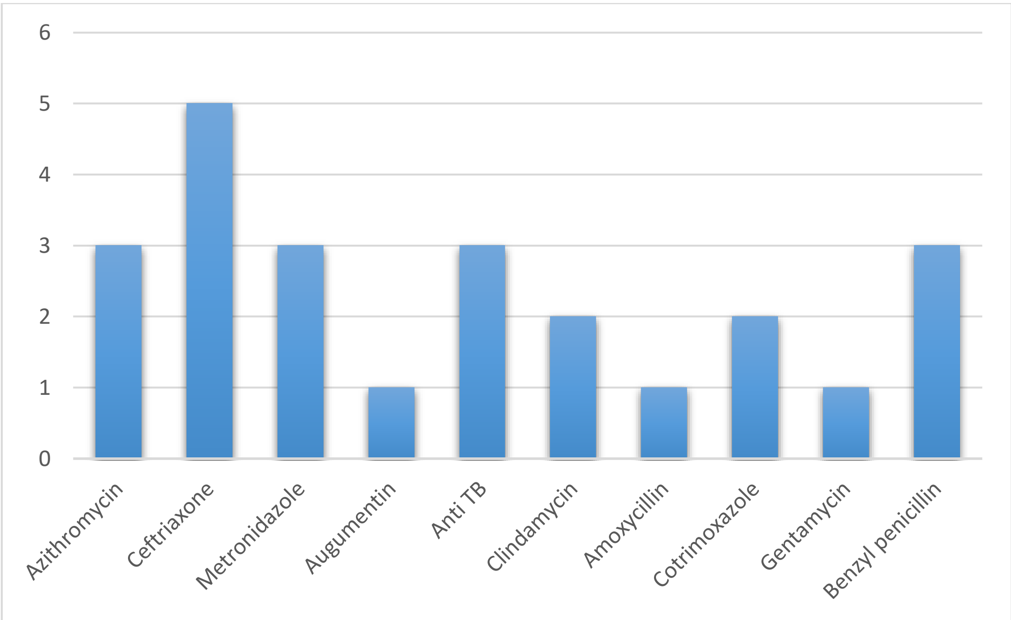


Figure 3: Commonly prescribed antibiotics for LRTIs

All the antibiotics prescribed by participants were recommended in the EDLIZ except for ceftriaxone that was used to treat bacterial pneumonia. However, all the prescribed antibiotics were within the EDLIZ recommended number of days.

4.3 Demographic Characteristics

A total of 30 medical practitioners participated in the study. The majority of the participants (60%) were males, whereas (40%) were females. Their ages ranged from 25 years to above 40 years, however the majority, (53.3%) of the participants were between 31 to 35 years and (33.3%) were between the ages of 25 to 30 years. Participants who were between 36 to 40 years were (6.6%) and those above 40 years were (6.6%). The results also discovered that (60%) were senior medical doctors who participated in the study, although (33.3%) were junior medical doctors. The specialist physicians were (13.3%) of the participants. The majority, (50%) had 1 to 2 years working experience, though (33.3%) had 3 to 5 years working experience and (16.6%) had 6 years and above working experience. Therefore, there was need for continued education through in-service training workshops to equip the junior and senior medical doctors, with adequate skills on prescribing antibiotics.

		Number of Participants	Percentage
Gender			
Male		18	60
Female		12	40
Age (Years)			
25-30		10	33.3
31-40		16	53.3
36-40		2	6.6
Above 40		2	6.6
Professional Qualification			

Junior Medical Doctors		10	33.3
Senior Medical Doctors		16	53.3
Specialist Physicians		4	13.3
Number of years in practice as doctors			
1 to 2		10	33.3
3 to 5		16	53.3
6 and above		4	13.3

4.3 Progression of microbial resistance to antibiotics in Zimbabwe

Thirty participants were interviewed using the structured questionnaire. Sixty percent (N=18) stated that there were new strains of microbes. The examples of new strains given by participants were methicillin-resistant *Staphylococcus aureaus*, Carbapenemase-resistant producing *Klebsiella,* Vancomycin-resistant *Enterococci, Pseudomonasis manteilli, Streptococcus pseudopneumoniae and* Monkey pox. Almost all participants (N=28, 93.3%) stated that there were existing microbes exhibiting resistance to conventional drugs. The table below shows some examples of microbes and the drugs they resist.

Table 1: Progression of Microbial resistance to antibiotics in Zimbabwe

Microbe	Drug resisted
Gram positive *Staphylococcus aureus*	Ceftriaxone
	Some penicillin e.g., Methicillin
Pseudomonas	Fluroquinolones
Gram negative microbes	Macrolides
Escherichia coli	Fluroquinolones
Neisseria gonorrhoea	Macrolides
	Penicillins
Enterococci	Vancomycin
Multidrug resistant TB (Mycobacterium TB)	Anti-TB drugs e.g., rifampicin
Coagulase Gram negative *Staphylococcus*	Ceftriaxone
	Gentamycin
	Ciprofloxacin
Helicobacter pylori	Amoxicillin

While some participants could not name the microbes that were resistant to certain drugs, the most agreed that drugs such as ceftriaxone, ciprofloxacillin, amoxicillin, gentamycin and anti-TB drugs were the most resistant drugs to microbes. Most of the participants (N=22; 73.3%) stated that there were no new diseases caused by the same microbes. However, only one participant gave Methicillin-resistant *Staphylococcus* *aureaus* as an example that causes other diseases such as necrotizing fasciitis, septic arthritis and haemolytic anaemic syndrome.

4.3.1 Sources of microbial resistance in Zimbabwe

Participants stated a number of sources of antimicrobial resistance in Zimbabwe as shown in the diagram below. The most popular sources of antimicrobial resistance in Zimbabwe as stated by participants were overuse and misuse of antibiotics, inadequate infection control and poor patient compliance. Poor patient compliance included not finishing doses, sharing antibiotics with family and friends as well as treating flus, diarrheal infections and other viral infections that do not need antibiotics. Other sources included lack of proper laboratory support for culture and sensitivity and lack antibiotic stewardship.

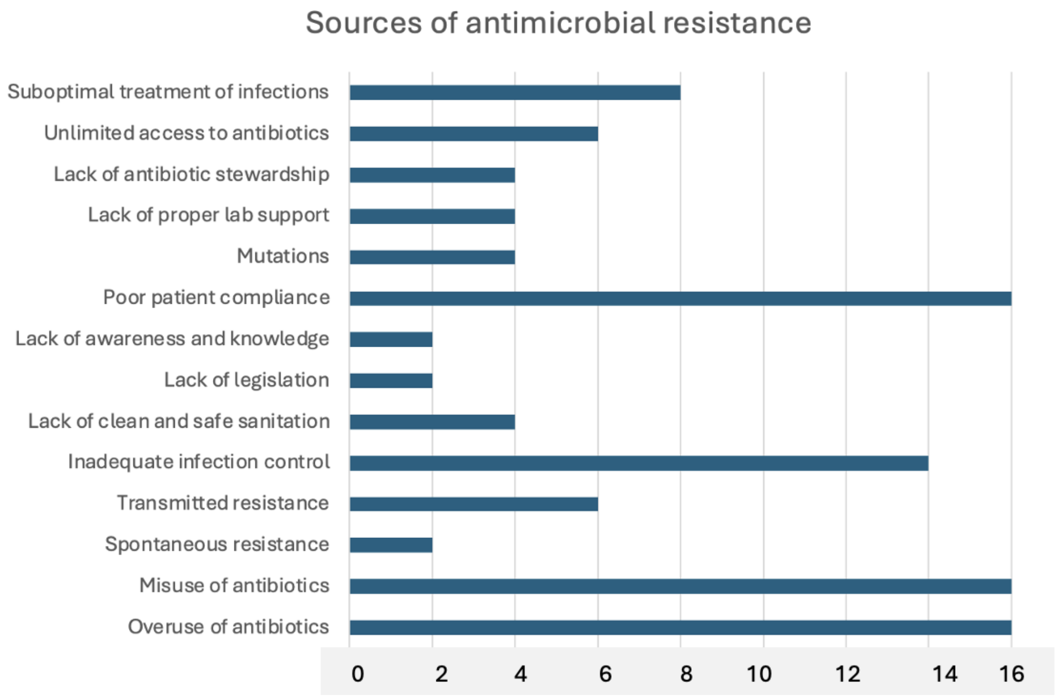


Figure 4: Sources of antimicrobial resistance

All the participants concurred that incorrect use of antibiotics is a cause of microbial resistance. For example, one participant said

"*If one takes an antibiotic, for example, for a viral infection, this can promote antibiotic resistant properties… … creating bacteria that are hard to treat"*

Another participant stated that incorrect use of antibiotics causes "spontaneous resistance". The participants gave the following as examples of incorrect use of antibiotics:

"Patients may deliberately or mistakenly omit doses once the symptoms resolve"

"Prescribing for ailments that do not require antibiotics for example viral infections"

"Exposure of antibiotics to inappropriate microbes"

"Under treatment of infections"

"People do not usually complete the antibiotic courses"

All these incorrect uses of antibiotics were said to cause "*progressive growth of microbes"* that are resistant to antibiotics.

Almost all participants (N=28) agreed that too much use of antibiotics causes microbial resistance. The following diagram shows the commonly prescribed antibiotics lower respiratory tract infections.

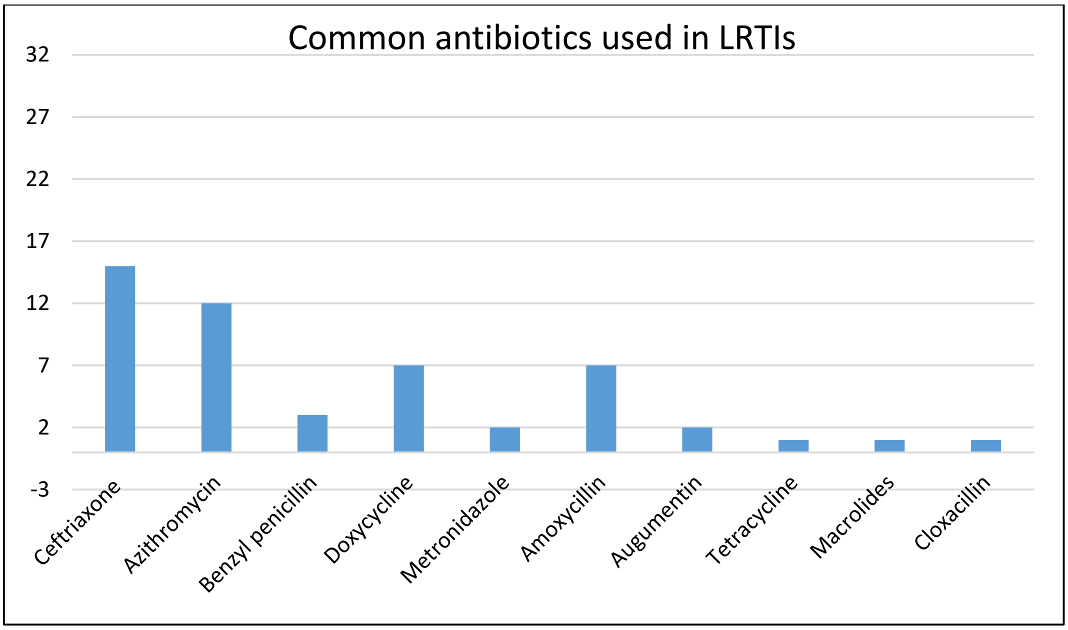
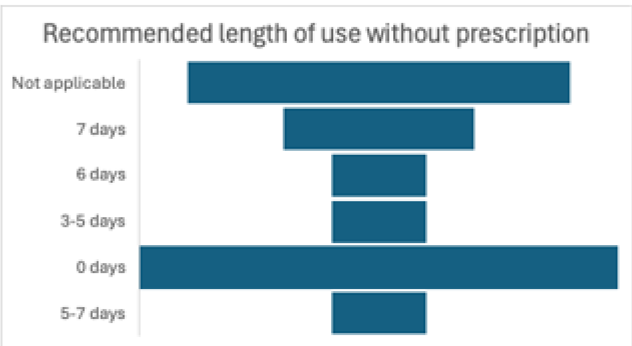


Figure 5: Common antibiotics used in LRTIs

4.3.2 Awareness of EDLIZ guidelines for the prescription of antibiotics

Most participants (N=22; 73.3%) of the participants stated that according to EDLIZ, a prescription is required to purchase antibiotics; antibiotics are not sold over the counter. One participant stated that the prescription should specify name of the drug, dose, route of administration and duration of treatment. Another participant stated that *"a registered medical practitioner should prescribe antibiotics".* According to another participant antibiotics should be prescribed to *"persons with likely bacterial infections requiring systemic therapy".* Ten (33.3%) participants stated that zero (0) days was



the EDLIZ recommended length of use of antibiotics without a prescription, eight (26.7%) stated that it was not applicable and the rest stated between three and seven

Figure 6: Recommended length of use without prescription

Most of the participants stated that either it was not recommended (N=16; 53.3%) nor applicable (N=10; 33.3%) to use antibiotics without a prescription. Only one participant stated that *"Typical antibiotics or eye drops require 7 days and oral antibiotics for minor respiratory infections require 3 days".* Most participants (N=20, 66.7%) stated that EDLIZ guidelines were being followed in the prescription of antibiotics. Participants stated different reasons that informs the prescription of antibiotics as shown in the diagram below.

4.4 Demographic characteristics

Figure 7: Demographic characteristics.

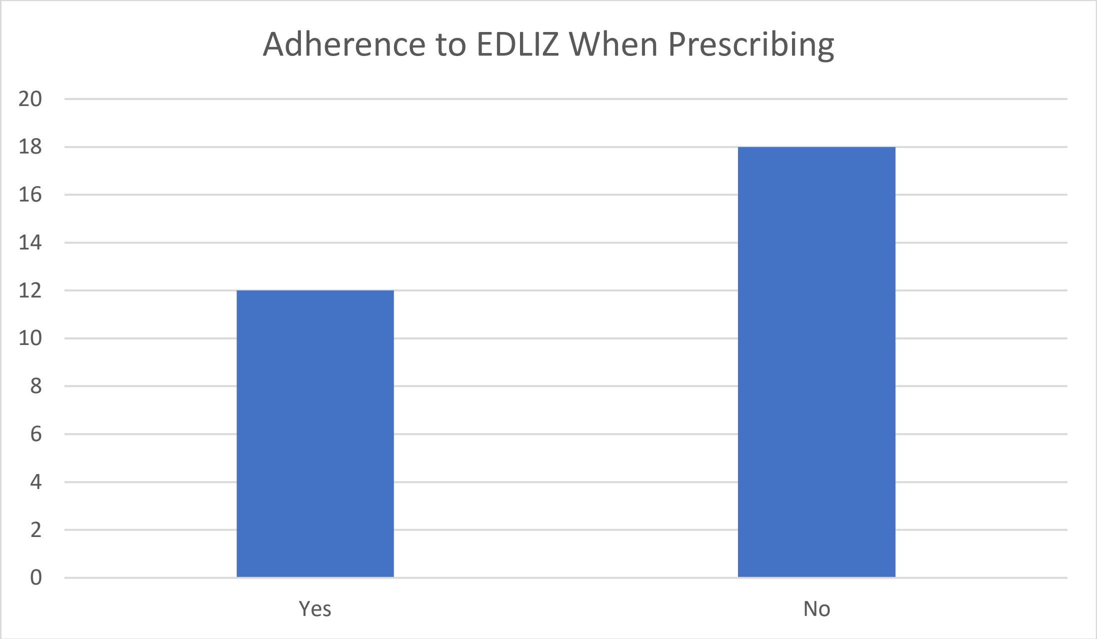


Figure 8: Adherence to EDLIZ when prescribing

The majority (60%) of the participants responded that they do not use EDLIZ when prescribing. The results show that 40% of participants are guided by EDLIZ when prescribing antibiotics. This significant deviation from the required standards of prescribing. This deviation can be explained by a number of factors like availability, affordability, previous experience among others as shown on the next diagram**.**

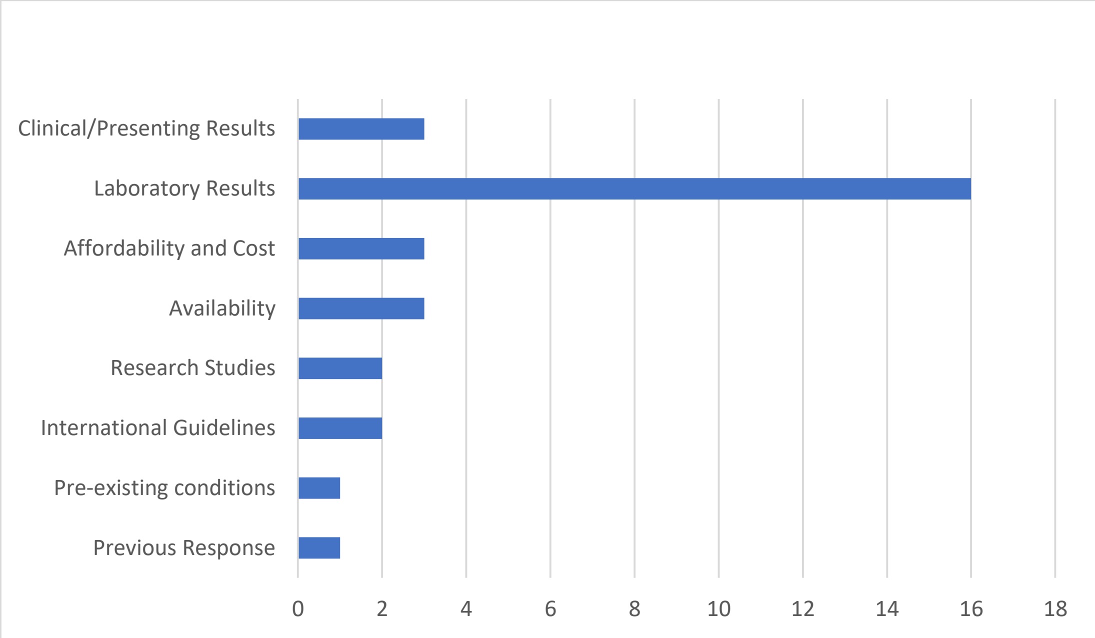


Figure 9 What informs prescription of Antibiotics

The results show that there is a significant degree of deviation from EDLIZ guidelines by clinicians when prescribing antibiotics. Whereas, the rules require clinicians to always consult EDLIZ; The majority of participants (53.3%) reported that they are guided by laboratory results when prescribing antibiotics.0.3% of participants revealed that they use previous experience which is not guided by EDLIZ.10% of participants reported that they use international guidelines for prescribing antibiotics.

Olaru et al. (2020) conducted a study that investigated antibiotic consumption in the pediatric department of Sally Mugabe Hospital in Harare. The study also examined whether antimicrobial prescriptions were being filled in accordance with National Guidelines. The most common antimicrobials were found to be ceftriaxone, gentamycin, and benzypenicillin. 57.7% of the children's prescriptions were in compliance with the national criteria. The study found that a significant percentage of prescriptions were not in compliance with national norms, and that children in Zimbabwe's hospitals were using antibiotics at high rates.

Similar to the aforementioned study, this one was able to highlight the problem of National Guidelines and the consumption of antimicrobials, a second study on the assessment of antibiotic consumption among patients with lower respiratory tract infections at the Parirenyatwa Group of Hospitals is necessary. The study employed questioners and data collection tables as the sources of data because evaluating prescription records can be quite time-consuming.

In contrary to the findings, another study by Skosana et al. (2022) in South Africa examined the usage of antibiotics in community health facilities throughout the country and its consequences. According to the findings, when antimicrobials were prescribed, there was a high level of adherence to the National Guidelines. However, the significant use of antibiotics for respiratory tract infections without microbiological testing raised concerns.

4.5 Recommendations on the way forward

Most participants (N=14; 46.7%) stated that there is need for new policies, 8 (26.7%) said there was no need and the rest were not sure.

Most participants (N=20; 66.7%) agreed that there is need for new legislature on the use of antibiotics, 4 (13.3%) did not think so and the rest were not sure. Examples of legislature required included:

I. Stiffer penalties for antibiotics sold over the counter
II. Culture and sensitivity results before prescribing antibiotics
III. Antibiotics to be sold and dispensed by trained health care professionals
IV. Use of limited number of antibiotics in primary care settings/clinics
V. Reinforce existing legislature

Most participants (N=22; 73.3%) agreed that there is need to retrain clinicians. These felt that the clinicians needed refresher courses on the current and new evidence-based prescription guidelines, information about local antibiotic resistance patterns, consequences of antibiotic resistance and prevention strategies, best practices when collecting samples for culture and sensitivity, infection control as well as antibiotic stewardship.

4.5 Chapter Summary

Chapter 4 explores the patterns of antibiotic prescription for lower respiratory tract infections (LRTIs) at Parirenyatwa Group of Hospitals, shedding light on the routine use of drugs like ceftriaxone and azithromycin and revealing some deviations from the guidance provided in the EDLIZ framework. While many clinicians generally followed the recommended duration of treatment, the findings raise red flags around the growing problem of antimicrobial resistance largely driven by inappropriate use of antibiotics, poor patient adherence and limited antibiotic stewardship. Although most practitioners were familiar with EDLIZ standards, the consistency in applying them varied, underscoring a need for stronger support systems. In response, the chapter captures calls from clinicians for targeted policy adjustments, tighter regulation around antibiotic access, enhanced diagnostic services and regular training to ensure prescribing is grounded in current, evidence-based practices that can help slow the spread of resistance.

CHAPTER 5 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Some studies have been conducted in the area of antibiotic prescribing patterns and their relationship with antimicrobial resistance. While the causes of antimicrobial resistance are many and varied, a few studies have analysed the antibiotic prescribing patterns in Zimbabwe and have shown that misuse of antibiotics has contributed to the rising problem of antimicrobial resistance. The literature offered an understanding that globally, more than 50 % of all medicines are prescribed, dispensed or sold inappropriately, while 50 % of patients fail to take them correctly (WHO, 2020). The study was hinged on the social model research philosophy as the researcher wanted to work with the observable reality of analysing the antibiotic prescribing patterns at Parirenyatwa Hospital in Zimbabwe. Using the social model approach helped the researcher to gain direct insights into how medical practitioners prescribe antibiotics and the extent to which they adhere to EDLIZ guidelines. This chapter focused on the discussion of findings, making use of literature that are available, the implications and recommendations will be based on research findings.

5.2 Discussion

5.2.1 Demographic Characteristics

Thirty medical practitioners participated in the study. The majority, (60%) were senior medical practitioners with 3 to 5 years working experience, while (33.3%) were junior medical doctors who had 1 to 2 years working experience. Therefore there was need for continued education through in-service training workshops to equip the junior and senior medical doctors, with adequate skills on prescribing antibiotics.

Ten participants (medical practitioners) responded to the questionnaire. The most common lower respiratory tract infections treated during the time of data collection were pneumonia, (bacterial pneumonia, aspiration pneumonia, community acquired pneumonia, Klebsiella pneumonia, Staphylococcal pneumonia and Pneumocystis Carinii Pneumonia), followed by tuberculosis and lung abscess.

The most popular prescribed antibiotic by participants for different LRTIs were recommended in EDLIZ except for ceftriaxone that was used to treat bacterial pneumonia. However, all the prescribed antibiotics were within the EDLIZ recommended number of days.

The results revealed that medical practitioners used recommended EDLIZ guidelines when prescribing antibiotics. Ceftriaxone and azithromycin were the most popular antibiotics used, making them likely contributors to antimicrobial resistance.

5.3 Progression of Antimicrobial Resistance in Zimbabwe

The research found out that sixty percent stated that there were new microbes. The examples of new microbes given by participants were Methicillin resistant Staphylococcus aureus, Carbapenemase resistant producing Klebsiella, Vancomycin resistant Enterococci, Psudomoniasismanteilli, Streptococcus pseudopneumoniae, Monkey pox. Almost all participants; 93.3% stated that there were existing microbes exhibiting resistance to conventional drugs.

While some medical practitioners could not name the microbes that were resistant to certain drugs, they agreed that the microbes were most resistant to drugs such as ceftriaxone, ciprofloxacin, amoxicillin, gentamycin and anti-TB drugs. Nevertheless, only one participant gave Methicillin- resistant Staphylococcus aureus as an example that causes other diseases such as necrotizing fasciitis, septic arthritis and haemolytic anaemia syndrome. The results showed that some medical practitioners were not aware of other infections caused by Staphylococcus aureus other than lower respiratory tract infections.

Olaru et al. (2020) conducted a study that investigated antibiotic consumption in the pediatric department of Sally Mugabe Hospital in Harare. The study also examined whether antimicrobial prescriptions were being filled in accordance with National Guidelines. The most common antimicrobials were found to be ceftriaxone, gentamycin, and benzypenicillin. 57.7% of the children's prescriptions were in compliance with the national criteria. The study found that a significant percentage of prescriptions were not in compliance with national norms, and that children in Zimbabwe's hospitals were using antibiotics at high rates.

5.4 Sources of Antimicrobial Resistance in Zimbabwe

The results showed that the most popular sources of antimicrobial resistance in Zimbabwe as stated by the participants, were misuse of antibiotics, inadequate infection control and poor patient compliance and lack of antibiotic stewardship. Poor patient compliance which included not finishing doses, sharing antibiotics with family and friends as well as treating flus, diarrheal infections and other viral infections which do not need antibiotics. The results also revealed that all participants concurred that incorrect use of antibiotics is a cause of microbial resistance, as one participant said, "*If one takes an antibiotic, for example, for a viral infection, this can promote antibiotic resistant properties creating bacteria that are hard to treat.*" Therefore, medical practitioners should have proper justification when prescribing antibiotics.

Another participant stated that incorrect use of antibiotics causes, "spontaneous resistance" and the participant gave the following examples, "*Patient may deliberately or mistakenly omit doses once the symptoms resolve, under treatment of infections and people do not usually complete the antibiotic courses.*" Consequently, there is need for medical practitioners to educate patients on the importance of completing a course of antibiotics, as all these incorrect uses of antibiotics cause progressive growth of microbes that are resistant to antibiotics.

Almost all participants agreed that too much use of antibiotics causes antimicrobial resistance.

Other sources included lack of proper laboratory support for culture and sensitivity, hence more laboratories are needed for culture and sensitivity test to ensure that the proper antibiotic has been prescribed.

5.5 Awareness of EDLIZ Guidelines for the Prescription of Antibiotics

Results showed that most participants 73.3% stated that conferring to EDLIZ, a prescription is required to purchase antibiotics and antibiotics are not sold over the counter. The prescription should specify name of drug, dose, route and duration of treatment. Only registered medical practitioners should prescribe antibiotics. The results also revealed that according to EDLIZ no antibiotics should be used without a prescription although some medical practitioners varied on the length of days for use of antibiotics without a prescription. The majority (66.7%) stated that EDLIZ guidelines were being followed in the prescription of antibiotics. Hence in-service training is recommended on guidelines for prescribing antibiotics to those medical practitioners who require the training. On use of antibiotics without a prescription most medical practitioners, 53.3% stated that it was not recommended and 33.3% stated that it was not applicable. However use of antibiotics without a prescription contributes to antimicrobial resistance.

Olaru et al. (2020) conducted a study that investigated antibiotic consumption in the pediatric department of Sally Mugabe Hospital in Harare. The study also examined whether antimicrobial prescriptions were being filled in accordance with National Guidelines. The most common antimicrobials were found to be ceftriaxone, gentamycin, and benzypenicillin. 57.7% of the children's prescriptions were in compliance with the national criteria. The study found that a significant percentage of prescriptions were not in compliance with national norms, and that children in Zimbabwe's hospitals were using antibiotics at high rates.

Similar to the aforementioned study, this one was able to highlight the problem of National Guidelines and the consumption of antimicrobials, a second study on the assessment of antibiotic consumption among patients with lower respiratory tract infections at the Parirenyatwa Group of Hospitals is necessary. The study employed questioners and data collection tables as the sources of data because evaluating prescription records can be quite time-consuming.

In contrary to the findings, another study by Skosana et al. (2022) in South Africa examined the usage of antibiotics in community health facilities throughout the country and its consequences. According to the findings, when antimicrobials were prescribed, there was a high level of adherence to the National Guidelines. However, the significant use of antibiotics for respiratory tract infections without microbiological testing raised concerns.

5.6 Recommendations on the way forward

Results revealed that the majority of participants (46.7%) revealed that there is need for new policies, while 26.7% reported that there was no need and the rest (26.6%) were not sure, Participants reported that there is need for implementation of new policies such as:

Use of evidence-based medicine when prescribing antibiotics to reduce antimicrobial resistance. Site support visits which are of paramount importance to check whether medical practitioners are prescribing antibiotics according to the required standards. There is also need for strict monitoring of antibiotic use and implementing of antibiotic stewardship when caring for patients.

When prescribing antibiotics medical practitioners should restrict on the use of Carbapenems and to ensure that antibiotics are prescribed after a full assessment by a trained medical practitioner.

Involvement and embracing new technology in disease prevention and control for example bacteriophages. Bacteriophage is a type of virus that infects and replicates within bacteria and destroys the bacteria host cell thus killing it. They attach to a susceptible bacterium, inject their genetic material, DNA or RNA and hijack the bacterium cellular machinery to replicate themselves. This could be a significant way to minimize bacterial variants which are resistant to antibiotics.

To check for appropriateness of prescribed antibiotics according to the WHO AWaRe classification 2023 which consists of;

ACCESS GROUP- which identifies the recommended antibiotic for each of the top 25 infections; these medicines have to be consistently accessible, reasonably priced and of guaranteed quality.

WATCH GROUP- comprises the most significant and high priority antibiotics for use in human and veterinary medicine; these antibiotics are only advised for a few, particular reasons.

RESERVE GROUP- contains medications that should only be used as a final resort after all other antibiotics have been exhausted. (WHO AWaRe 2023 Antibiotic Classification).

The research also discovered that there is need to have a wider range of antibiotics in EDLIZ, so that medical practitioners will be able to prescribe a variety of antibiotics without repeating the same antibiotics several times for the same infection to prevent antimicrobial resistance. The results also showed that further research is required. The study also found that use of evidence-based prescribing guidelines and always ensuring culture and sensitivity tests when prescribing antibiotics to prevent antimicrobial resistance is important.

From the results, most participants, (66.6%) agreed that there is need for new legislation on the use of antibiotics while (13.3%) did not think so and the rest were not sure. The new legislation suggested included, stiffer penalties for antibiotics sold over the counter to prevent antimicrobial resistance due to misuse of antibiotics. There is need for culture and sensitivity results before prescribing antibiotics to ensure that the correct antibiotic has been prescribed. Antibiotics to be sold and dispensed by trained health care professionals to prevent misuse of antibiotics which contributes to antimicrobial resistance. Participants also suggested that the new legislation should include use of limited number of antibiotics in primary settings/ clinics and to reinforce on existing legislation.

The results also revealed that 73.3% of participants believe there was need to train clinicians on prescribing antibiotics. They also felt that the medical practitioners needed refresher courses on the current new evidence-based prescription guidelines, information about local antibiotic resistance patterns, consequences of antimicrobial resistance and prevention strategies, best practices when collecting samples for culture and sensitivity, infection control as well as antibiotic stewardship.

5.7 Limitations of the Study

Financial issues were the main limitation of the study. The study was conducted at one hospital; Parirenyatwa hospital. The results may not be generalized to other hospitals. The research was going to be more reliable if data was collected from other departments, specialties and private hospitals as well as the general public accessibility to detailed information. Time and resources was also a major constraint especially to reach out to other health institutions.

5.8 Implications

As a nation, our capacity to treat common diseases is still under danger due to the introduction and spread of drug-resistant bacteria that have developed new resistance mechanisms, resulting in antimicrobial resistance. The fast global expansion of pan- and multi-resistant bacteria, which cause diseases that cannot be cured by current antimicrobial medications like antibiotics, is particularly concerning.There are no novel antimicrobials in the clinical pipeline.

Moreover, a significant problem is still the lack of access to high-quality antibiotics. Countries at all stages of development are experiencing antibiotic shortages, particularly in their healthcare systems. As drug resistance increases throughout the world, antibiotics are losing their effectiveness, making diseases harder to cure and even causing deaths. For instance, to treat gram-negative bacterial infections that are resistant to carbapenem, as listed in the WHO priority pathogen list, new antibacterials are desperately needed. These new antibiotics will, however, meet the same end as the existing ones and lose their effectiveness if people do not alter the way they are now used.

Due to extended hospital stays and the requirement for more costly and intense care, AMR has a substantial negative impact on patient or caregiver productivity, which has a substantial financial impact on national economies and health systems.

The number of patients whose treatment is failing or who pass away from infections will rise in the absence of efficient instruments for the prevention and proper management of drug-resistant infections as well as better access to both novel and existing quality-assured antibiotics. Medical treatments including organ transplants, cancer chemotherapy and surgery like caesarean sections or hip replacements will grow riskier.

5.9 Recommendations

Recommendation	When	Who
Evaluation of efficiency of National Guidelines when prescribing antibiotics.	Yearly	Policy makers
Random and regular site support visits to assess antibiotic prescribing patterns must be conducted.	Ongoing	Policy makers
Clinicians should be monitored so that they obtain culture and sensitivity results before prescribing especially for restricted antibiotics.	Always	Pharmacists

Provision of more laboratory facilities for quicker evidence-based drug administration to eliminate possible resistance.	Ongoing	Policymakers

The conclusions from the study strongly indicate for the uregent development of antimicrobial stewardship programs which are lacking in Zimbababwe.

5.9 Chapter Summary

This chapter discussed the findings of the study, conclusions which were made and recommendations for future studies. The study found that there is a gap in the understanding of antibiotic prescribing among medical practitioners with participants giving varying answers on questions such as the duration of antibiotic treatments and whether they require prescriptions. As such, a number of recommendations were made in this chapter relating to guidelines, training and the strengthening and enforcement of legislation regarding the prescription, sale and dispensing of antibiotics with the view to reduce antimicrobial resistance resulting from the improper use of antibiotics.

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Appendices

Appendix 1: Consent form for Clinicians

Research Title: Analysis of antibiotic prescribing patterns at Parirenyatwa Group of Hospital in Harare, Zimbabwe.

Principal Investigator: Tsiko Samantha Mutsawaishe

Phone number: 0777990423

What you need to know about the research:

You are invited to participate in a research study of 'Analysis of antibiotic prescribing patterns at Parirenyatwa Group of Hospitals in Harare Zimbabwe. We provide you with this consent form so you can learn about the study's goals, risks and benefits and ask any questions you may have before deciding to take part.

Project description:

Antimicrobial resistance (AMR) is an escalating global public health crisis threatening the effectiveness of antibiotics and other antimicrobial agents that have long been considered essential tools in modern medicine. The study is going to investigate Antimicrobial resistance and clinical decision-making: An in-depth assessment of antibiotic prescribing at Parirenyatwa Group of Hospitals.

You're Rights

Before you decide to volunteer to participate in this study or not to participate you must understand its purpose, risks and benefits and procedures involved. You can choose not to participate or decide to participate now and then change your mind. Your participation is voluntary. We refer to this procedure as informed consent.

The purpose of the study:

The purpose of the research is to ascertain the antibiotic prescribing habits by clinicians at Parirenyatwa Group of Hospitals in the face of antimicrobial resistance. It is expected that this study will help to improve the prescribing habits of clinicians in line with EDLIZ guidelines.

Study procedures

If you agree to take part in this study, we will ask you some questions concerning antibiotic prescribing habits of clinicians. We will review the antibiotic prescribing records for analysis.

Potential risks and discomforts.

Given the nature of the study, insignificant risks are predictable during the interviews. You might be disturbed in your work schedule and it may be uncomfortable to you

You can ask the supervisor for clarification if you believe the researcher is not being completely honest about the study's or the questionnaire's goal. If the questions' format makes you uncomfortable, the investigator will emphasize that the study has nothing to do with your performance assessment. There are no foreseeable study related injuries.

Potential benefits and compensation

There will be no monetary or form of material benefits for participation. It is hoped that the outcomes of the study will help to improve the prescribing habits of clinicians in line with EDLIZ guidelines.

Study withdrawal

You may choose not to participate in the study or pull out from the study at any time without penalty or mistreated for doing so.

Confidentiality

Your information will be kept confidential at all times. Your identity will not be linked to any information collected for this study. Furthermore, the information is private and won't be shared unless you consent or the law requires it. Putting your name on the questionnaire is not mandatory. Completed surveys will always be stored in a locked, secure location. The data will only be accessible to the investigator. Only the supervisor or Africa University's research department may access the material. Your name will not be published.

Voluntary participation

There is no obligation to participate in this study. Your treatment won't be impacted by your choice to take part in this study or not.

Offer to answer any questions

Please feel free to ask questions about any component of the study that is unclear to you before signing this form. You can think about it for as long as you need to.

Offer to answer questions

The investigator conducting this study is **Tsiko Samantha Mutsawaishe**. You may ask any questions now, or if you have any questions later, you are encouraged to contact the researcher on +263 777990423 or email samanthatsiko@gmail.com.

Please feel free to contact the researcher if you have any questions or concerns about the study and would prefer to speak with someone other than the researcher. This includes questions about the study, the research, your rights as a research participant, injuries related to the study, or if you believe you have been treated unfairly and would prefer to speak with someone other than a member of the research team, Africa University Research Ethics Committee (AUREC) on telephone (020) 60075 or 60026 extension 1156 email aurec@africau.edu

Authorization

You are making the decision to take part in the study or not. By signing, you attest that you have read and comprehended the material above, that all of your questions have been addressed and that you have made the decision to take part.

All pages will be stamped to indicate form of validity as approved by Africa University Research Ethics committee (AUREC)

Statement of consent

I have read the information above. I have attained responses to the questions I have asked.

I give my permission to take part in the research.

-- -------------------------- ----

Name of research participant (Please Print) Signature Date

-- --------------------- -----

Name of Investigator /Research Staff obtaining consent Signature Date

Appendix 2: Gwaro retenderano revana chiremba varikupinda mutsvakurudzo

Musoro wetsvakurudzo: Analysis of antibiotic prescribing patterns at Parirenyatwa Group of Hospitals in Harare, Zimbabwe.

Mutsvakutudzi mukuru: Tsiko Samantha Mutsawaishe

Runhare: 0777990423

Zvamunofanira kuziva nezve tsvakurudzo:

Muri kukokwa kupinda mutsvakurudzo inoti "Antimicrobial resistance and clinical decision-making: An in-depth analysis of antibiotic prescribing patterns pachipatara chepa Parirenyatwa mu Harare mu Zimbabwe. Tinokupai iri gwaro retenderano kuitira kuti muverenge chinangwa chetsvakurudzo, njodzi, nezvino kubatsira uye bvunzai mibvunzo chero ipi zvayo ine chekuita ne tsvakurudzo yamunoda kunzwisisa musati mabvuma kupinda mutsvakurudzo.

Tsanangudzo Yetsvakurudzo

Kusashanda kwemishonga inouraya hutachiona pachirungu 'Antimicrobial resistance (AMR) idambudziko rezvehutano ririkuramba richikura zvakanyanya mupasi rose ravekutyisa mukushanda zvakanaka kwemishonga inouraya hutachiona, yanga ichizivikanwa mukurapa kwemazuva ano. Tsvakurudzo ino iri kuda kuongorora kusashanda zvakanaka kwemishonga inouraya hutachiona zvichibva nemafungiro avana chiremba sekuona kwavo pakunyora mishonga pazvipatara zve Parirenyatwa.

Kodzero yenyu

Musati mazvipira kupinda mutsvakurudzo ino kana kusapinda munofanira kunzwisisa chinangwa chetsvakurudzo, njodzi, kuti ichakubatsirai sei uye zvichaitwa mutsvakurudzo. Mune kodzero yekuramba kupinda mutsvakurudzo, kana kubvuma kupinda mutsvakurudzo iko zvino kana kuzoshandura pfungwa dzenyu munguva inotevera. Kupinda mutsvakurudzo kuzvipira pachenyu. Iri danho rinoreva kupa mvumo yekupinda mutsvakurudzo manzwisisa.

Chinangwa chetsvakurudzo

Chinangwa chetsvakurudzo ndeche kuda kubata chokwadi nezvekunyorwa kwemishonga inouraya hutachiona navana chiremba pazvipatara zvepa Parirenyatwa tichitarisa kusashanda kwemishonga inouraya hutachiona.Izvi zviri kutarisirwa kuti tsvakurudzo ino ichabatsira kusimudzira tsika yekunyorwa kwemishonga navana chiremba inouraya hutachiona sezvinofanirwa kuitwa munhungamiro yemishonga zvichienderana yemu EDLIZ.

Zvichaitwa mutsvakurudzo

Kana mabvuma kupinda mutsvakurudzo ino, tichakubvunzai mibvunzo ine chekuita nekunyorwa kwemishonga inouraya hutachiona navana chiremba.Tichazotarisa zvinyorwa zvemishona inouraya hutachiona tichonyatso wongorora.

Njodzi nekusagadzikana zvingawanikwa

Tichiona maitirwa etsvakurudzo, njodzi shomanini ndzingango wanikwa muhurukuro Munogona kukanganisika pakuronga kwemabasa amunoita pazuva rega-rega uye zvokonzera kusagadzikana kwenyu. Kana mukafunga kuti mutsakurudzi ane zvimwe zvaasina kukuburitsirai pachena maerereno nechinangwa che tsvakurudzo kana mupepa remibvunzo, Munogona kubata mutariri ari kubatsira tsvakurudzo kuti atsigire

Kana mukanzwa musina kusununguka, nemabvunzirwo emibvunzo, mutsvakurudzi achasimbisisa kuti tsvakurudzo hainei nechekuiita nekutariswa kwemashandiro enyu. Hapana kukuvadzwa kunotarisirwa kubva mutsvakurudzo.

Zvamunganowana kubva mutsvakurudzo kana mubhadharo.

Hapana mari yamuchabhadharwa kana zvimwe zvamuchawana nekuwa kwenyu mutsvakurudzo. Zvino tarisirwa kuti zvichabuda kubva mutsvakurudzo zvichazobatsira kusimudzira tsika yekunyorwa kwemishishonga navana chiremba zvienderane nezvinotarisirwa nemutemo yekunyorwa kwemishonga kubva mukhuku re EDLIZ rinotungamira nezve mishonga.

Kubuda mutsvakurudzo

Munogona kusarudza kusapinda mutsvakurudzo kana kubuda mutsvakurudzo panguva ipi zvayo pasina kuripiswa kana kumanikidzwa.

Kuchengetedza zvakavanzika

Ruzivo rune chekuita nezvenyu ruchachengetedzwa zvakavanzika nguva dzose. Ruzivo rune chekuita nezvenyu kubva mutsvakurudzo haruzo zivikanwe nezvenyu. Zvakangodaro, ruzivo ruchawanikwa ruchachengetedzwa zvakavanzika uye haruzoburitswa pasina mvumo yenyu kana zvinotenderwa nemutemo. Magwaro akapindurwa mibvunzo achachengetedzwa nekuvharirwa nguva dzose. Mutsvakudzi chete ndiye anogona kusvika pakachengetedzwa ruzivo rwabva mutsvakurudzo. Ruzivo runogona chete kugoveranwa nemutariri kana pazi rinoona nezve tsvakurudzo pa Africa University. Zita renyu harizo shambadzirwi.

Kuzvipira kupinda mutsvakurudzo

Kupinda mutsvakurudzudzo kuzvipira pachenyu. Sarudzo yenyu yekupinda kana kusapinda mutsvakurudzo haikanganisi mabatirwo amuchaitwa.

Kuzvipira kupindura mibvunzo

Musati masaina iri gwaro Ndapota Bvunzai chero mibvunzo ipi zvayo ine chekuita netsvakurudzo isina kujeka kwamuri. Munogona kutora nguva yakafanira muchifunga nezvazvo. Mutsvakurudzi ari kuita tsvakurudzo ino anonzi **Tsiko Samantha Mutsawaishe.** Munogona kubvunza mibvunzo iko zvino, kana mukava nemibvunzo munguva inotevera, munokurudzirwa kubata mutsvakurudzi pa +263777990423 kana pa imeri samanthatsiko@gmail.com.

Kana mune chero mibvunzo kana zvamungada kuziva maerereno ne tsvakurudzo ino uye muchida kutaura neumwe munhu asiri mutsvakurudzi, kusanganisira mibvunzo maerereno netsvakurudzo, mibvunzo yemu tsvakurudzo, kodzero yenyu semunhu apinda mutsvakurudzo kana kukuvadzwa kubudikidza nekuva mutsvakurudzo, kana muchinzwa kuti hamuna kubatwa zvakanaka uye muchida kutaura neumwe munhu asiri mushandi vemutsvakurudzo, ndapotai ve Africa Research Ethics Committee (AUREC pa runhare (020) 60075 kana 60026 panovedzera 1156 imeri aurec@africau.edu.

Mvumo

Muri kusarudza kupinda kana kusapinda mutsvakurudzo. Sainecha yenyu zvinoreva, kuti maverenga uye manzwisisa zvese zvakanyorwa pamusoro apo, mibvunzo yose yapindurwa uye masarudza kupinda mutsvakurudzo.

Papeji achaiswa chidhindo kuratidza humbowo hwechekwadi kubva ku Africa University Research Ethics Committee (AUREC).

Kupa mvumo

Ndaverenga zvese ziri pamusoro. Ndabvunza mibvunzo uye ndikapiwa mhinduro dzose.

Ndinopa mvumo yekupinda mutsvakurudzo.

---------------------------------------	----------------------	----------
Zita raapinda mutsvakurudzo ranhasi	Sainecha	Zuva

(Ndapota nyora nemavara makuru)

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Zita Remutsvakurudzi /Mushandi ranhasi	Sainecha	Zuva

Wemutsvakurudzo awana mvumo

Appendix 3: Data collection template from Parirenyatwa Hospital.

Record	Type of LRTIS	Type of antibiotic	EDLIZ Recommended (yes/no)	Number of days	EDLIZ recommended days
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25.					

Appendix 4: Mudziyo wekuunganidza data kubva kuzvipatara zve Parirenyatwa

Chinyorwa	**Mhando ye LRTIS**	**Mhando yemishonga unouraya hutachiona**	**Zvinotsigirwa ne EDLIZ (hongu /kwete)**	**Huwandu hwemazuva**	**Huwandu hwemazuva hunotsigirwa ne EDLIZ**
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25					

Appendix 5: Key informant Interview Guide

(For Medical Practitioners Parirenyatwa hospital in Harare)

Fill in the appropriate responses

Section A: Demographic information

1. What is your gender

☐ Male

☐ Female

2. How old are you in years?

☐ 25 to 30

☐ 31 to 35

☐ 36 to 40

☐ 40 and above

3. What is your professional qualification?

☐ Junior Medical Doctor

☐ Senior Medical Doctor

☐ Specialist Physician

☐ Other, specify……………….

4. Number of years in practice as a doctor

………………………………….. Years.

Section B: Progression of microbial resistance to antibiotics in Zimbabwe

1. Are there new strains of microbes? Yes/no

If yes, specify which ones

…………………………………………………………………………………………
…………………………………………………………………………………………

…………………………………………………………………………………………
………
2. Are existing microbes exhibiting resistance to conventional drugs? Yes/no
If yes, specify the types of microbes and the antibiotics they resist

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
………

3. Are there new diseases caused by the same microbes? Yes/no
If yes, specify

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
………

Sources of microbial resistance in Zimbabwe?
4. List the sources of antimicrobial resistance in Zimbabwe
a)
b)
c)
d)
e)

5. Is incorrect antibiotic use a cause of microbial resistance? Please explain.

…………………………………………………………………………………………
…………………………………………………………………………………………
………………
6. Is too much antibiotic use a cause of microbial resistance? Yes/no

7. Which antibiotics are commonly prescribed for LRTISs?
a)
b)
c)
d)

Awareness of EDLIZ guidelines for the prescription of antibiotics
8. What are the EDLIZ prescriptive requirements of antibiotics and over-the-counter purchases?

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
………………………
9. What is the EDLIZ recommended length of use without prescription for each antibiotic?

……………… days

10. What is the EDLIZ recommended consistence of use without prescription?

………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………
………………………

11. Are EDLIZ guidelines being followed in the prescription of antibiotics? Yes/No

12. What informs the prescription of antibiotics in practice

………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………
………………………

Recommendations on way forward

13. Is there need for new policies?

Specify the kinds of policies that may be needed

………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………
………………………

14. Is there need for new legislation?

Specify the kinds of legislation that may be needed

………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………
………………………

15. Is there need to retrain clinicians?

Specify the kinds of training programmes that may be needed

………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………
………………………

Appendix 6: Nhungamiro yakakosha inotungamira hurukuro

(Kuna vana Chiremba vepa zvipatara zvepa Parirenyatwa)

Nyorai mhinduro dzakakodzera

Chikamu **A: Demographic information**

1.Muri munhuyi?

☐ Murume

☐ Mukadzi

2.Mune makore mangani ekuzvarwa?

☐ 25 kusvika 30

☐ 31 kusvika 35

☐ 36 kusvika 40

☐ 40 zvichikwira

3.Makadzidza basa rehuChiremba zvakadiyi?

☐ Junior Medical Doctor

☐ Senior Medical Doctor

☐ Specialist Physician

☐ Zvimwewo, tsanangudza……………

4.Munemakore mangani muchishanda saChiremba?

…………………………………..

Chikamu B: Mafambiro ekusashanda kwemishonga inouraya hutachiona muZimbabwe

1. Kune mhando itsva here yehutachiona? Hongu /kwete

Kana mhinduro iri hongu tsanangurai kuti ndeipi yacho

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………

2. Iyi mhando yehutachiona yaveko zvino iri kuramba kuuraiwa nemishonga inouraya hutachiona irikushandiswa? Hongu /kwete

Kana mhinduro iri hongu tsanangurai mhando dzehutachiona uye mhando yemishonga inouraya hutachiona isichakwanisi kuuraya hutachiona ihwohwo.

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………
………………………

3. Kune zvirwere zvitsva zviri kukonzerwa nemhando yehutachiona humwe humweho? Hongu /kwete

Kana mhinduro iri hongu tsanangurai

………………………………………………………………………………………………
………………………………………………………………………………………………

Masosi ehutachiona hurikutadza kurapika muZimbabwe

4. Nyorai masosi ehutachiona huri kutadza kurapika muZimbabwe.

a)

b)

c)

d)

e)

5. Kusashandasa nemazvo mishonga inouraya hutachiona kunokonzera kusauraiwa kwehutachiona? Ndapota tsanangurai.

……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………

6. Kushandiswa zvakanyanyisa kwemishonga inouraya hutachiona zvinokonzera kusauraiwa kwehutachiona? Hongu /Kwete

7. Ndeipi mishonga inouraya hutachiona inowanzo shandiswa kurapa zvirwere zvehutachiona mumapapu?

a)

b)

c)

d)

e)

Kuziva mitemo inokurudzirwa muEDLIZ pakunyora mishonga inouraya hutachiona.

8. Ndeipi mitemo inotevedzerwa kubva mu EDLIZ inodiwa pakunyorwa kwemishonga inouraya hutachiona uye mishonga inongotengwa pachena pasina kunyorwa nachiremba?

……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………

9. Inguva yakareba sei inokurudzirwa kushandisa mishonga inouraya hutachiona pasina pakunyorwa nachiremba?

…………………… kuwanda kwemazuva

10. Ndezvipi zvinokurudzirwa muEDLIZ kuramba pachishandiswa mishonga inouraya hutachiona pasina kunyorwa nachiremba?

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

11. Mitemo inokurudzirwa muEDLIZ pakunyora mishonga inouraya hutachiona iri kutevedzerwa here? Hongu / kwete

12. Ndezvipi zvinotevedzerwa zvinodiwa pakunyorwa kwemishonga inouraya hutachiona mukushanda kwemazuva ose kwavana chiremba.

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
………………

Zvinokurudzirwa mukufambira mberi

13. Pangadiwa here kugadzirwa bumbiro remitemo mitsva?

Taurai mhando yemitemo mitsva yacho ingangodiwa kugadzirwa.

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
………………

14. .Panodiwa here kugadzirwa kwemitemo mitsva?

Taurai mhando yemitemo mitsva ingangodiwa kugadzirwa.

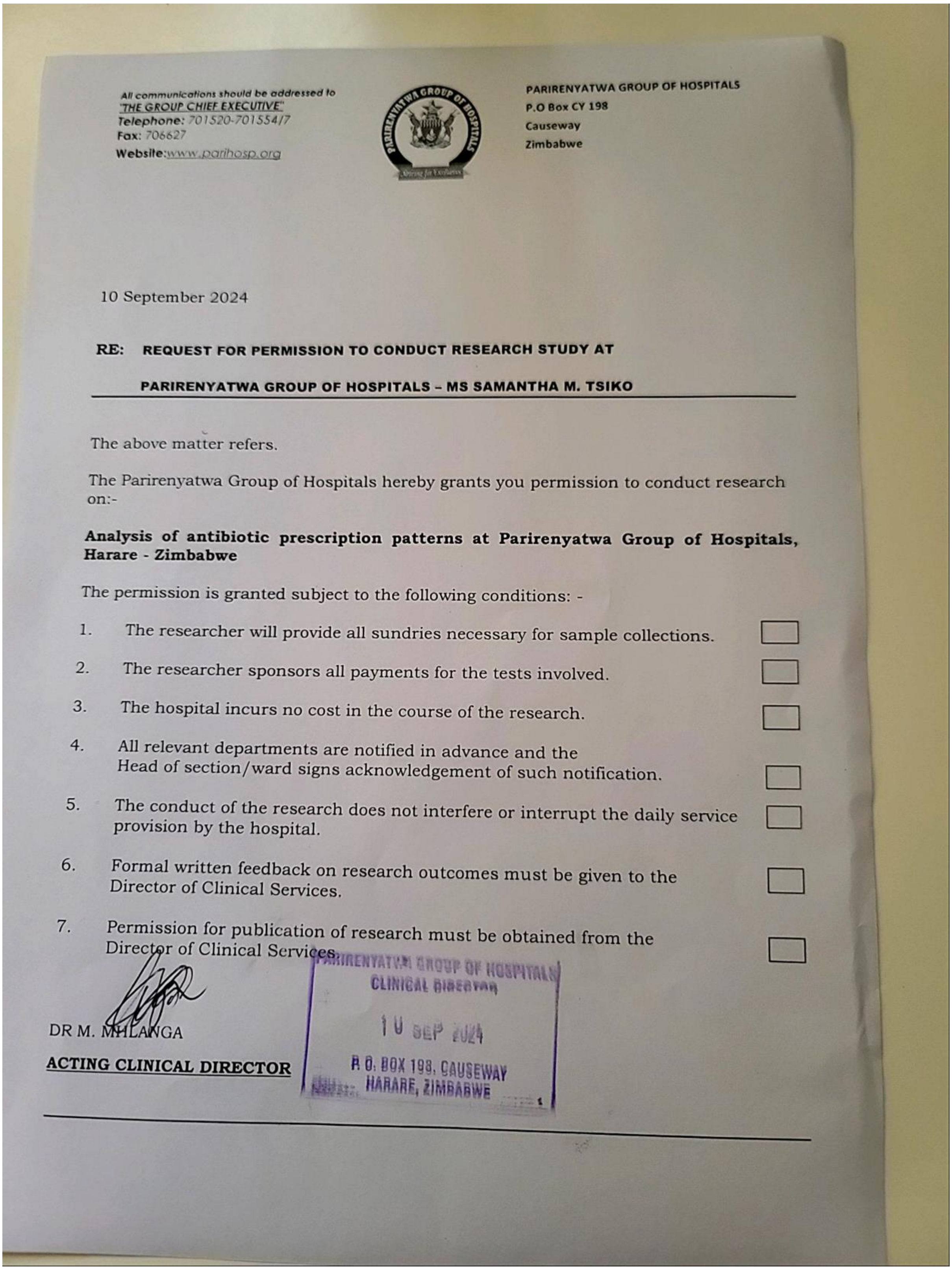
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
……………………

15. Pangadiwa here kuti vana chiremba vadzidziswezve?

Taurai mbando yezvidzidzo zvavangada kudzidziswa

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
……………………

Appendix 7: Hospital Clearance letter



All communications should be addressed to
"THE GROUP CHIEF EXECUTIVE"
Telephone: 701520-701554/7
Fax: 706627
Website: www.parihosp.org

PARIRENYATWA GROUP OF HOSPITALS
P.O Box CY 198
Causeway
Zimbabwe

10 September 2024

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH STUDY AT PARIRENYATWA GROUP OF HOSPITALS – MS SAMANTHA M. TSIKO

The above matter refers.

The Parirenyatwa Group of Hospitals hereby grants you permission to conduct research on:-

Analysis of antibiotic prescription patterns at Parirenyatwa Group of Hospitals, Harare - Zimbabwe

The permission is granted subject to the following conditions: -

1. The researcher will provide all sundries necessary for sample collections. ☐
2. The researcher sponsors all payments for the tests involved. ☐
3. The hospital incurs no cost in the course of the research. ☐
4. All relevant departments are notified in advance and the Head of section/ward signs acknowledgement of such notification. ☐
5. The conduct of the research does not interfere or interrupt the daily service provision by the hospital. ☐
6. Formal written feedback on research outcomes must be given to the Director of Clinical Services. ☐
7. Permission for publication of research must be obtained from the Director of Clinical Services. ☐

PARIRENYATWA GROUP OF HOSPITALS
CLINICAL DIRECTOR
10 SEP 2024
P. O. BOX 198, CAUSEWAY
HARARE, ZIMBABWE

DR M. MHLANGA

ACTING CLINICAL DIRECTOR