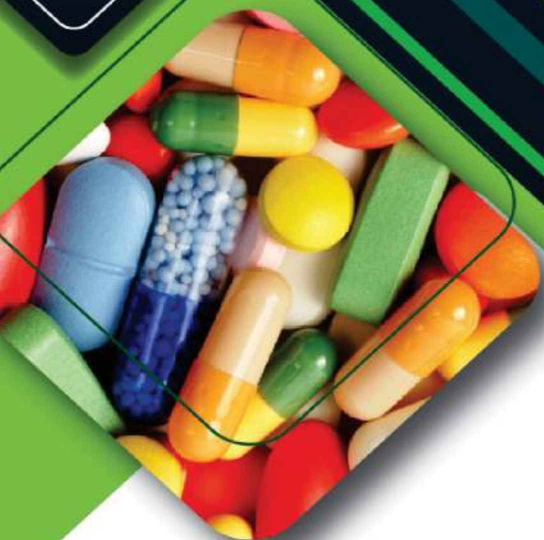
SITUATION ANALYSIS OF ANTIMICROBIAL USE AND RESISTANCE IN HUMANS AND ANIMALS IN ZIMBABWE

2017



ZIMBABWE

ReAct Action on Antibiotic Resistance
Global Antibiotic Resistance Partnership
World Health Organization
Food and Agriculture Organization of the United Nations
OIE

CDDEP THE CENTER FOR Disease Dynamics, Economics & Policy
WASHINGTON DC • NEW DELHI

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ABBREVIATIONS

ACT	Artemesinin based combination therapy
AGP	Antimicrobial growth promotants
AMC	Average Monthly Consumption
AMR	Antimicrobial resistance
AMU	Antimicrobial Use
ART	Anti-retroviral therapy
ASF	African swine fever
AU-IBAR	African Union Inter-African Bureau for Animal Resources
BCG	Bacillus Calmette-Guerin
BMGF	Bill and Melinda Gates Foundation
CDC	Centers of Disease Control and Prevention
CDDEP	Center for Disease Dynamics, Economics & Policy
CI	Confidence interval
CIET	Commission of Inquiry into Education and Training
CIRAD	Centre de Cooperation Internationale en Recherche Agronomique
Coartem	Artemether-Lumefantrite
CQ	Chloroquine
CSF	Cerebrospinal fluid
CVL	Central Veterinary Laboratories
DPT	Diptheria-Pertussis-Tetanus
DR&SS	Department of Research and Specialist Services
DTTU	Delivery Team Topping Up
DLVS	Department of Livestock and Veterinary Services
EDC	Epidemiology and Disease Control
EMA	Environmental Management Agency
EPI	Expanded Program on Immunization
EU	European Union
EWI	Early warning indicators
FAO	Food and Agriculture Organization for the United Nations
FMD	Foot and mouth disease
GAP	Good Agricultural Practices
GARP	Global Antibiotic Resistance Partnership
GAVI	Global Alliance for Vaccines and Immunization
GMP	Good Manufacturing Practices
GOZ	Government of Zimbabwe
HAI	Hospital Acquired Infections
HIVDR	Human immune-deficiency virus drug resistance
IAEA	International Atomic Energy Agency
IPPC	International Plant Protection Convention
IDSR	Integrated Disease Surveillance and Response
IPC	Infection prevention control
KAP	Knowledge attitudes and practices
Km	Kilometers
LMIC	Low and Middle Income Countries
MAMID	Ministry of Agriculture Mechanization and Irrigation Development
MCAZ	Medicines Control Authority of Zimbabwe
M&E	Monitoring and Evaluation
MASCA	Medicines and Allied Substances Control Act
MDPCZ	Medical and Dental Practitioners Council of Zimbabwe
MDR TB	Multi drug resistant tuberculosis
MEWC	Ministry of Environment, Water and Climate
MOHCC	Ministry of Health and Child Care
MRL	Maximum residue limit
MTB	Mycobacterium tuberculosis
NatPharm	National Pharmaceutical Company of Zimbabwe

NBA	**National Biotechnology Authority**
NCU	**National Coordinating Unit**
ND	**Newcastle disease**
NHIS	**National Health Information System**
NNRTI	**Non-nucleoside reverse transcriptase inhibitors**
NGO	**Non governmental organisation**
OIE	**Organization International Epizooties or World Organization for Animal Health**
OR	**Odds ratio**
PCN	**Primary Care Nurses**
PMD	**Provincial Medical Director**
PMTCT	**Prevention of Mother to Child Transmission**
POM	**Prescription only medicine**
PPS	**Point-prevalence survey**
RDN	**Rapid Disease Notification**
ReAct	**Action on Antibiotic Resistance**
RVF	**Rift Valley Fever**
SADC	**Southern African Development Community**
SDPs	**Service Delivery Points**
SP	**Sulfadoxine/Pyrimethamine**
SSI	**Surgical site infections**
STI	**Sexually Transmitted Diseases**
TAD	**Transboundary diseases**
TAHC	**Terrestrial Animal Health Code**
TBD	**Tickborne diseases**
TES	**Therapeutic Efficacy Studies**
TB	**Tuberculosis**
THP	**Traditional Health Practitioners**
TM	**Traditional Medicine**
UNDP	**United Nations Development Programme**
UNFPA	**United Nations Population Fund**
UNICEF	**United Nations International Children's Emergency Fund**
UZ	**University of Zimbabwe**
VHvet	**Veterinary household remedies**
VIAC	**Visual Inspection with Acetic Acid and Camera**
VL	**Viral load**
VMAS	**Vital Medicines and Health Services Survey**
VMDG	**Veterinary Medicines General Dealers**
VMMC	**Voluntary Medical Male Circumcision**
VPP	**Veterinary para-professional**
WHO	**World Health Organisation**
WDSS	**Weekly Disease Surveillance System**
WTO	**World Trade Organisation**
ZACH	**Zimbabwe Association of Church Related Hospitals**
ZIMASSET	**Zimbabwe Agenda for Sustainable Socio-Economic Transformation**
ZIMREF	**Zimbabwe Reconstruction Fund**
ZINWA	**Zimbabwe National Water Authority**
ZIP	**Zimbabwe Informed Push**
ZIPCOP	**Zimbabwe Infection Prevention and Control Project**
ZNFPC	**Zimbabwe National Family Planning Council**

FOREWORD

Antimicrobials have been hailed as one of the most important discoveries in medical history as they have successfully treated many diseases promoting the health and well-being of individuals. However the gains achieved through the use of antimicrobials are now being threatened by development of resistance. By 2050 it has been estimated that antimicrobial resistance (AMR) will be causing 10 million deaths annually worldwide and this will cost the world 100 trillion dollars (O'Neill, 2014). If left unattended this crisis will have worse effects as compared to the HIV and TB pandemics combined.

This situation analysis has gathered information about the current state of AMR, contributing factors and antimicrobial use in Zimbabwe from the human, animal, agricultural and environmental sectors. Data has been gathered from different sectors such as the general public, academia, the Ministry of Health and Child Care, the Ministry of Agriculture Mechanization and Irrigation Development and the Ministry of Environment, Water and Climate. It shows that AMR is a real concern in Zimbabwe and a threat to the health outcomes of humans, to the economic productivity of the livestock industry and a risk to the environment.

Specifically there is significant growing resistance to common infections such as TB, malaria, HIV, respiratory infections, sexually transmitted infections (STIs), urinary tract infections (UTIs), meningitis and diarrheal diseases. One major driver of resistance is increased antimicrobial consumption in both humans and animals. However the data on antimicrobial use in Zimbabwe is limited. Although the country's vaccination coverage rate for children under 1 year is good, more can be done to prevent infections, including general hygiene and sanitation, implementing infection prevention and control (IPC) measures in all health institutions as well as resorting to greater reliance on alternatives including preventive vaccination of livestock, biosecurity and a host of other good practices in the agriculture sector. More also needs to be done to improve incentives to appropriate antibiotic use and to create disincentives through sound legislation and policy to overuse of antibiotics. If no action is taken now, the country may not be able to treat common human primary and secondary infections with available resources and the agriculture sector will be severely undermined with consequences to public health food security and biodiversity.

Therefore, the three governmental departments whose responsibilities intersect on human, animal and environmental health outcomes, and therefore are responsible for implementing Zimbabwe's 'One Health' approach have committed themselves to investing resources in designing sound strategies and interventions to preserve the effectiveness of our antimicrobial agents, in order to ensure sustainable dependence on them. This situation analysis will assist the country in formulating a National Action Plan (NAP) on AMR that will be implemented by all sectors to significantly slow down the development of antimicrobial resistance.

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FORMATION OF THE AMR CORE GROUP AND GARP-ZIMBABWE TECHNICAL WORKING GROUP

Following the adoption of the Global Action Plan on Antimicrobial Resistance (AMR) by the 68th World Health Assembly (WHA) in May 2015, Zimbabwe took immediate steps to put a framework and systems in place in order to draft its national plan of action on antimicrobial resistance (AMR) in line with the resolution of the Assembly. On 31st July 2015, the Government held a national meeting on AMR as a prelude to the main process of drafting the National Action Plan (NAP). The one-day meeting brought together representatives from health, the veterinary and agriculture sectors, academia, civil society organizations (CSOs) including the health associations. Following this meeting the Zimbabwe Antimicrobial Resistance Core Group was formed to spearhead the process of developing AMR NAP. This 18 member core group is composed of people from the following sectors with specified terms of reference:

1. Ministry of Health & Child Care
2. Ministry of Agriculture, Mechanisation and Irrigation Development
3. Ministry of Environment, Climate & Water
4. Department of Veterinary Services
5. Medicines Control Authority of Zimbabwe
6. Food & Agricultural Organisation
7. World Health Organisation
8. World Organisation of Animal Health
9. University of Zimbabwe
10. Biomedical Research and Training Institute
11. Civil society
12. National Biotechnology Authority of Zimbabwe and the
13. Ministry of Finance and Economic Development

The group has an appointed Chairperson, the Deputy, a Coordinator and the Secretariat, while the rest are Committee members.

In addition to this group the GARP-Zimbabwe technical working group was formed in July 2016. This included the above members and experts from academia including clinicians from both the public and private sectors for human and animal health (See appendix 1). These were asked to serve on a voluntary basis in their own individual capacities with no personal gains or to institutions to which they are affiliated.

ABOUT The Global Antibiotic Resistance Partnership (GARP)

The Global Antibiotic Resistance Partnership (GARP) is a project of the Center for Disease Dynamics, Economics & Policy (CDDEP) that facilitates the development of actionable policy proposals on antibiotic resistance by and for low- and middle-income countries (LMICs). With funding from the Bill & Melinda Gates Foundation (BMGF) and other grants, GARP supports the creation of multi-sectorial national-level working groups whose mandate is to stimulate specific research and develop evidence-based proposals to encourage the introduction of measures to preserve antibiotic effectiveness, slow the spread of antibiotic resistance and improve antibiotic access.

The first phase of GARP took place from 2009 to 2011 and involved four countries: India, Kenya, South Africa and Vietnam. Phase one culminated in the 1st Global Forum on Bacterial Infections, held in October 2011 in New Delhi, India. In 2012, phase two of GARP was initiated with the addition of working groups in Mozambique, Tanzania, Nepal and Uganda. Phase three has added Bangladesh, Lao PDR, Nigeria, Pakistan and Zimbabwe to the network to date.

In Zimbabwe, GARP supports the Zimbabwe National Antimicrobial Resistance Core Group, the first multi-disciplinary, multi-sectoral group in the country to consider the problem of antibiotic resistance and to prioritize recommendations for public health policies.

ABOUT Action on Antibiotic Resistance (REACT)

Action on Antibiotic Resistance (ReAct) is an independent global network for concerted action on antibiotic resistance. It aims for profound change in awareness and action to manage the interacting social, political, ecological and technical forces that drive the rising rate of resistant human and animal infection and the rapid spread of resistance within and between communities and countries.

ReAct's vision is, a world free from fear of untreatable infections.

ReAct works across disciplines, bringing stakeholders together in developing ways forward, promoting best practices and innovative solutions, advocating and mobilizing for behavioral change. As a credible expert source for strategic policy guidance, ReAct has successfully brought evidence about the problem of antibiotic resistance outside the expert conference rooms and managed to put the issue on the agenda of various global institutions. ReAct has 5 nodes spread across the 5 continents and includes ReAct Africa Node hosted by the Ecumenical Pharmaceutical Network (EPN) in Nairobi, Kenya.

BACKGROUND, PURPOSE AND METHODOLOGY OF THE SITUATION ANALYSIS

Background

Antimicrobial resistance (AMR) refers to the ability of infection-causing microorganisms such as bacteria, viruses, fungi and parasites change in ways that render medications previously used to treat the infection, ineffective. AMR is a public health threat because it limits medication options for treatment of infections.

In Zimbabwe AMR has been identified in common infections. For instance, there is typhoid resistance to ciprofloxacilin, gonococci resistance to ceftrioxone, mycobacterium tuberculosis resistance to multi-drug regimen (MDR-TB), malaria resistance to first generation antimalarials as well as HIV resistance to some first and second line antiretroviral drugs. AMR has also been identified in some pathogens isolated from animals. For instance, the Central Veterinary Laboratory has detected some resistance in E. coli and Staphylococcus aureus to some antimicrobials such as penicillin, tetracycline, lincomycin, ampicillin, cloxacillin, erythromycin, and sulphamethoxazole.

Following the adoption of the Global Action Plan on AMR by the 68th World Health Assembly in May 2015, Zimbabwe immediately put in place a framework towards developing the AMR National Action Plan by starting with a situational analysis. The Global Action Plan urges Member States "to have in place, national action plans on antimicrobial resistance and with standards and guidelines established by relevant intergovernmental bodies."

Zimbabwe has adopted the 'One Health' concept as this is an integrated approach which considers human, animal and the environment as they interact through the spread of micro-organisms between them. This is in line with the approach taken by the WHO, the Food and Agriculture Organization (FAO) and the World Organisation for Animal Health (OIE) who now speak with one voice and take collective action to minimize the emergence and spread of AMR. The aim is to:

- Ensure that antimicrobial agents continue to be effective and useful to cure diseases in humans and animals
- Promote prudent and responsible use of antimicrobial agents
- Ensure global access to quality-assured medicines.

Purpose

The purpose of this document is to describe and analyse the situation on the ground regarding AMR in Zimbabwe to help and guide the development of a National Action Plan. A situation analysis is an important first step in the planning cycle, understanding where we are now which informs future developments of where we want to progress to and what actions need to be taken to get there. The objectives of the situation analysis are to:

1. Identify current knowledge as well as gaps or deficiencies in information available on AMR.

2. Increase awareness among practitioners, researchers, policy makers, affected communities and the public, of the national and global threat posed by AMR to human health and animal health.

3. Describe behaviours that have facilitated the spread of AMR and explore future research priorities.

4. Form the basis for development of evidence-based recommendations targeting policy-makers and in the formation of a 'One Health' approach national action plan on AMR which will be implemented by all the relevant sectors.

Methods

This situation analysis on AMR in Zimbabwe is derived from a compilation of existing data and interviews. The data included peer-reviewed articles identified through web-based literature searches, policy documents, and official reports. Knowledge, attitudes and practices (KAP) survey amongst the health professionals, veterinary professionals, and the general public, as well as a point-prevalence survey (PPS) in selected hospitals were also conducted. Key informants were interviewed in the various sectors such as the health, agriculture, environment and educational sectors. Information collected encompassed both human and animal health in line with the One Health' approach to combating AMR recommended by the World Health Organization (WHO), the World Animal Health Organization (OIE) and the Food and Agriculture Organization (FAO) of the United Nations.

In addition, consultations were held with relevant departments within the Ministry of Health and Child Care (MoHCC), the Ministry of Agriculture Mechanization and Irrigation Development (MAMID), the Ministry of Environment, Water and Climate, Universities, research and/or training institutions, and some regulatory bodies such as the Medicines Control Authority of Zimbabwe (MCAZ), the University of Zimbabwe, the Environmental Management Agency (EMA) and the National Biotechnology Authority of Zimbabwe. Input was also obtained from individuals who have a passion for AMR issues.

The Zimbabwe National Antimicrobial Resistance Core Group is responsible for the contents of this situation analysis.

1. EXECUTIVE SUMMARY

The development and spread of antimicrobial resistance (AMR) has become a global health threat. This situation analysis documents the specifics of the AMR situation in Zimbabwe. As in every country, there is cause for concern. The continued decline of antibiotic effectiveness poses a threat to human health, economic productivity in the agriculture sector, and the environment.

Because AMR extends beyond the human health sector, impacting animal health and the environment, it is considered a One Health issue that requires integrated and coordinated action between sectors for a successful response.

Zimbabwe has faced serious economic challenges over the years, which has affected all aspects of life, not least of which the health sector's ability to provide health care and resulted in a shortage of health care workers and stock outs of medicines. The agriculture sector is one of the most important pillars of the Zimbabwean economy, employing 70 percent of the population and generating 15 percent of the total Gross Domestic Product. Two thirds of the population lives in rural areas and the majority depend directly or indirectly on agriculture.

Fortunately, there are measures that can be taken to bend the AMR curve in Zimbabwe. These are laid out generally in this situation analysis and will be elaborated in detail in developing national AMR action plan.

1.1 Disease burden and AMR

Zimbabwe faces a high burden of infectious disease, including tuberculosis (TB), malaria, and human immunodeficiency virus (HIV). Life expectancy has increased in recent years, alongside reductions in maternal mortality and smaller reductions in neonatal mortality. The top causes of mortality in Zimbabwe are acute respiratory infections, TB, HIV, and meningitis.

In general, Zimbabwe has few studies on current pathogens for causes of common infections. Where recent data is available on the bacterial aetiology of a disease, susceptibility data for the bacterial pathogens remains limited.

Older studies on acute respiratory infections demonstrate that Streptococcus pneumonia was the most commonly isolated in pneumonia in children, with penicillin resistance at 50%. However, no follow up studies have been conducted. Earlier studies also identified pneumocystis pneumonia as a significant infection in HIV positive patients both in adults and children.

The national TB control programs is becoming more effective in identifying smear positive TB cases and with the advent of GeneXpert, estimates on multi drug resistant TB are improving (estimates in 2012 were of 24% MDR). Zimbabwe is considered to be at high risk for HIV drug resistance if patients do not adhere to their anti-retroviral drugs. Sentinel site prevalence for HIV drug resistance revealed that 4,3% of patients with viral load suppression at 12 months had drug resistant HIV.

Cryptococcus species are amongst the main pathogens causing meningitis in all age groups due to the link with HIV. In children under 5 years, Streptococcus pneumoniae, Streptococcus agalactiae, Haemophilus influenzae and Neisseria meningitides are the amongst the common organisms isolated however susceptibility data was not reported.

Approximately 27% of under-five diarrheal disease is estimated to be caused by rotavirus and since the introduction of rotavirus vaccine in 2014, a significant dent has been made in the occurrence of rotavirus diarrhoea. Concerning adults however the persistent challenges of poor water, sanitation and hygiene practices have kept diarrhoea cases related to typhoid and other bacteria as common occurrences. Whilst oral rehydration is the standard treatment of choice for diarrhoea, antibiotics are often used and resistance to ciprofloxacin, cotrimoxazole and ampicillin is spreading such that the recommendations are that doctors order laboratory tests as routine to determine the effectiveness of the drug.

Studies on urinary tract infections isolated Enterobacteriacee and Escherichia coli commonly with a high resistance to ampicillin (84.5%) and cotrimoxazole (68.5%) therefore norfloxacin or amoxicillin are now used as first line treatment.

Sexually transmitted diseases in Zimbabwe are treated using the syndromic treatment approach with Neisseria gonorrhoeae being the most common isolate urethral discharge in men. Antimicrobial resistance to ciprofloxacin was found in 18.6% of strains, resistance to ceftriaxone was found in 9.8%, and resistance to kanamycin was only 2% indicating that current first line treatments for these diseases are still effective.

The limited data available indicates that there is a problem of hospital-acquired infections in Zimbabwean hospitals. Isolated studies show surgical site infection rates of 26 – 29%, methicillin resistant Staphylococcus aureus (MRSA) carriage of 20% in ICU patients and 7% in outpatients and inpatients in both the private and public sectors.

Malaria remains a disease of public health importance with 50% of the population being at risk. However an assessment of artemesinin based combination therapy (Coartem) done in 2010 showed that there was 96% efficacy to the drug.

Economic losses due to bacterial infections in animals, such as brucellosis, anthrax and black leg, as well as viruses such as foot and mouth disease, are of zoonotic and economic importance. The use of vaccines to prevent notifiable and epidemic prone diseases is encouraged by the Department of Veterinary Services; however the use of antimicrobial agents has remained the major strategy for control of most bacterial infections in animals.

In animal samples, resistance has also been detected in Escherichia coli to tetracyclines, cloxacillin, erythromycin, ampicillin and ciprofloxacin. Milk samples have been reported to contain enteric bacteria and Staphylococcus aureus with high resistance to tetracycline (which is available over the counter), lincomycin, penicillin and streptomycin. Salmonella in chickens from commercial and rural free range farms showed high resistance to tetracyclines and ampicillin. Chemicals are used in the control of crop diseases caused by microbes.

1.2 Laboratory capacity for surveillance of Antimicrobial resistance

The data on AMR for humans and animals are limited. Currently only 25 percent of public health labs have the necessary staffing, equipment and reagents to do culture and susceptibility testing on human samples, which limits the diagnostic capabilities of health care professionals treating patients and the availability of antimicrobial resistance data to guide clinical practice and policymaking. However, there is an active surveillance system for notifiable diseases in the National Health Information System that could be adapted to assist with the collection of AMR and healthcare acquired infections data.

Animal health laboratories, particularly the Central Veterinary Laboratory (CVL), have the capacity to carry out some microorganism and antimicrobial residue testing, and food safety testing is currently conducted on meat and meat products for export. However, antimicrobial residues in meat products are not being monitored for local consumption and antimicrobial susceptibility testing is not currently being conducted on environmental samples. Also if farmer are unable to pay for the laboratory fees, that specimen will not proceed for laboratory testing and therefore valuable surveillance information is being lost due to lack of samples from sick animals.

1.3 Antimicrobial use

Each use of an antimicrobial, even when used appropriately for a bacterial infection, puts pressure on bacteria to select for resistance and increases the AMR burden. Reducing unnecessary antimicrobial use - against viral infections or to promote growth in animals, for instance - can slow the spread of AMR. Information on quantities and patterns of antimicrobial use in humans and animals in Zimbabwe is limited, and even if partial information exists in records, it is often incomplete and difficult to collate and analyse. The most commonly prescribed antimicrobial in animals is tetracycline followed by penicillins. Some antimicrobials are mixed into animal feeds, and the volume being applied and consumed is currently unknown. The use of antimicrobials to promote growth, particularly in in poultry and pigs, and to prevent disease is driving the use of these important antimicrobials in the animal sector.

In a recent point prevalence study in humans, antimicrobials such as ceftriaxone, benzylpenicillin, cloxacillin, amoxicillin and ciprofloxacin were found to be the most commonly used antimicrobials for inpatients in a sample of public and private hospitals in the country. Because ceftriaxone is not considered a first-line treatment for common conditions, this may indicate that treatment practices are not allied with current resistance data and treatment guidelines, emphasising the need for up-to-date AMR information.

Zimbabwe has an essential medicines list (EML) that was last updated in 2015, but stock outs of some of these, including antimicrobials, are common. The primary reason is a lack of finances at the national level and fragmented funding from donors, which are often interested in funding drugs for specific programs rather than the workhorse antimicrobials. These antimicrobials are often available in the private sector, but at a price the majority of the population cannot afford to pay. High costs and lack of access to medical care may push patients to purchase antimicrobials over the counter, where counterfeit drugs are a major concern. Although the majority of antimicrobials require a prescription, reports indicate that enforcement of this practice is weak. The Medicines Control Authority of Zimbabwe is tasked with ensuring medicines quality, but regulation and control need to be strengthened to ensure increased access to quality antimicrobials.

Widespread unregulated availability of over-the-counter (OTC) prescription-only antimicrobials for use in humans and animals has been reported despite regulations that prohibit sale without prescription and the possibility that a pharmacist may lose their license or get fined for contravening the laws.

1.4 Opportunities to reduce antimicrobial use

Preventing diseases in humans and animals reduces the need for antimicrobials and slows the growth of AMR. Disease prevention can be achieved through infection prevention and control (IPC) for humans and animals, improved biosecurity on farms and improved food hygiene practices, increased immunization, nutrition, and improved water, sanitation, and hygiene (WASH).

1.4.1 Immunization

Immunization for children as part of the Extended Programme on Immunization (EPI) is free in Zimbabwe, and coverage is 89% for all compulsory vaccines for children under 1 year. Coverage has been expanded to include pneumococcus, human papillomavirus (HPV), and rotavirus.

Immunization of animals for zoonotic diseases is supported and provided by the Department of Veterinary Services to prevent outbreaks of disease, but is underused. Coverage for vaccines preventing bacterial infections in livestock could be expanded to further reduce the need for antimicrobials

1.4.2 Infection prevention and control

There is a well-established IPC program at the national and health facility level, including national IPC guidelines, policies and strategic plans as well as a national coordinating IPC committee and committees in hospitals. The IPC curriculum has been strengthened for all medical professionals and in-service training has improved IPC practice and implementation at facility level, though resources, equipment and facilities for IPC are limited in most health facilities.

1.4.3 Biosecurity and good animal health practices

Guidelines for biosecurity – the prevention of disease transmission in livestock - are available for specific animal species targeting large- and medium-scale farms. The Department of Veterinary Services (DVS) is responsible for inspecting and certifying farms against these biosecurity guidelines and for issuing certificates that enable the farmers to access the more lucrative retailer markets with their products. Biosecurity systems for small-scale farms are not yet established, as guidelines need to be adapted for this sector. Waste disposal systems tend to be unregulated and may be implicated in releasing antimicrobial residues and antimicrobial resistant organisms into the environment.

1.4.4 Water, sanitation and hygiene

Many diseases spread in the absence of clean water, sanitation and hygiene facilities. The current diarrheal outbreaks are caused by poor sanitation systems, poor water quality and lack of hygiene facilities. In Zimbabwe, only 37 percent of the population have access to improved sanitation and 77 percent to improved water sources. Access is lowest in rural areas, where the majority of the population resides.

1.4.5 Waste disposal

Hospitals, clinics, animal health facilities and manufacturing industries have poor liquid and solid waste disposal methods and the capacity to collect and treat waste is limited. As a result, antimicrobials and antimicrobial residues are likely entering the environment, including drinking water and soil. There is currently no microbiology sensitivity testing being carried out in environmental laboratories, although chemical testing is performed on water and soil samples.

1.4.6 Improving access to and appropriate use of antimicrobials

Antimicrobials can also be conserved through improved antimicrobial stewardship in hospitals, animal health facilities and in the community. Stewardship within hospital medicines therapeutic committees must be supported by strengthened regulations and improved incentives around appropriate antimicrobial use. However, access to quality controlled antimicrobials is still limited in many areas of Zimbabwe, and should be expanded alongside efforts to curtail inappropriate use.

1.4.7 Risks to Implementation of AMR in Zimbabwe

Zimbabwe relies heavily on donor funding of its health system, especially for the medication procurement process. Should donors decrease funding at any point in time, the illegal market for antimicrobials and incentives to use unregulated antimicrobials will increase, resulting in substandard care for patients and an increase in AMR.

In addition, as the livestock industry is such a large pillar of the economy, farmers may resist the regulating of antimicrobial practices to improve responsible antimicrobial use as they may be seen as impeding productivity and profitability. Lack of regular portable water may increase infectious diseases leading to increased demand of antimicrobials.

1.5 Recommendations

A collaborative effort will be required across human, animal, and plant health and the environment to ensure that antimicrobial effectiveness is preserved and bacterial diseases are treatable in the future. Therefore, the establishment of a One Health National Action Plan for AMR, in line with the World Health Organization (WHO) Global Action Plan on AMR, implemented through the Ministry of Health and Child Care, the Ministry of Agriculture Mechanization and Irrigation Development, and the Ministry of Environment, Water and Climate, is needed to coordinate sustained action on AMR. This plan is already being developed by the Core Group on Antimicrobial Resistance in Zimbabwe.

The action plan will include activities to:

1. Raise awareness and educate the population, professionals and policymakers on AMR
2. Improve understanding of the AMR burden and use patterns through surveillance
3. Reduce the need for antimicrobials by improving IPC, biosecurity, WASH, and immunization.
4. Improve access to antimicrobials in humans and improve control of access to antimicrobials in animals
5. Improve appropriate use of antimicrobials
6. Research and sustained investment in AMR and alternatives

Implementation of a Zimbabwe's national Action Plan on AMR will occur over several years and long-term follow-up will be needed to evaluate its impact. The plan will be achieved through the One Health approach which embraces an integrated, unified effort across sectors, addressing the cross cutting nature of AMR.

2. HEALTH AND ECONOMIC CONTEXT

2.1 Geographic and Demographic Context

The 2012 census population of Zimbabwe was about 13 million and is estimated to have grown to 15.6 million as of 2015.2,3 Forty percent of the population are under the age of 15 with a median age of 20 in the country, hence the population is fairly young, a scenario typical of countries with high fertility rates.

One-third of the population live in urban areas with Harare being the most populous city. Only 37% of the population have access to improved sanitation and 77% have access to improved water sources.4

2.2 Economic Context

Zimbabwe has faced challenges economically over the years. It experienced hyperinflation and economic contraction in the years 2000 to 2008, leading to the adoption of a multicurrency regime (dollarization) in 2009. This ushered in macroeconomic stability and positive economic growth. During 2009-12, the economy rebounded, with growth rates averaging around 13% per year.6 In 2013, Zimbabwe adopted a new constitution and a new development plan, and the real GDP growth slowed from 3.8 percent in 2014 to 1.5 per cent in 2015.[7]

2.3 Health System Context

The national vision of the Government of Zimbabwe is to have the highest level of health and quality of life for all its citizens. 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 near collapse of the health sector in late 2008/09 resulted in shortages of essential medicines, commodities and infrastructure deterioration throughout the country. Additionally a high staff turnover and lack of basic lifesaving health services and equipment contributed to the deterioration of service delivery at health facilities across the country.[7]

2.4 Organization and Distribution of Health Services

The Ministry of Health and Child Care (MOHCC), is headed by the Minister appointed by the government. The public health system is centralized for policy and administrative guidance, procurement and determining funding allocation, coordinating responses to national health issues and approving of staff hires at the district and provincial levels.

In the public sector, health services are decentralized and are divided into four levels of care: primary, secondary, tertiary, and quaternary. The primary health care facilities are primarily in the rural areas and are staffed by village health care workers, community-based distributors. They consist of small clinics or health facilities which cannot handle many serious and complex medical conditions. Such health issues that are beyond the scope of these facilities are referred to the secondary care level, which are the District and Mission Hospitals run by the Zimbabwe Association of Church Related Hospitals (ZACH)8

Secondary level health facilities (district hospitals) are run by doctors and complicated cases that cannot be handled at the secondary level of care are referred to tertiary institutions, which are the Provincial Hospitals. These hospitals provide some specialist services. They also provide outreach services to complement the primary levels of care. Finally the quaternary level, are the Central Hospitals in bigger cities with the most advanced equipment, staff, and pharmaceuticals for dealing with the most severe cases.[8]

The Provincial Medical Directorate (PMD) office administers provincial hospitals and all district health offices (DHOs) within its province. Its function is to make certain that the province's health services meet the needs of the population, as well as MOHCC objectives, goals, and health policies. The PMD is also responsible for allocating the government of Zimbabwe (GOZ) funds to the provincial hospitals and DHOs. At the district level, DHOs have responsibilities similar to their provincial level-counterparts.

The number of public health facilities have been stable for a number of years with only an increase in primary health care facilities from 1331 to 1527 between 2013- 2014.[9] There are 8 provincial hospitals, 5 central hospitals, 62 district hospitals and 1527 Primary Health Facilities (government/municipal/mission).

Other health care providers include the private for profit facilities, private general practitioners and maternity homes, facilities for the military, police and prisoner service and traditional practitioners.

2.5 Health Indicators

2.5.1 Life expectancy and Millennium Development Goals (MDGs)

Life expectancy at birth for both sexes increased by 16 year(s) over the period of 2000-2012 from a low of 35 years to 58 years[1]. The cour improved mortality rates in 3 of the 5 MDG's (See table 1 below)

Table 1 – Millennium Development Goals (MDGs)

	Statistics		
Indicators	2009/2010	2014	2015
Under-5 mortality rate (per 1000 live births)	94	75	50
Maternal mortality ratio (per 100 000 live births)	960	614	651
Deaths due to HIV/AIDS (per 100 000 population)		198	191
Deaths due to malaria (per 100 000 population)		3	3
Deaths due to TB among HIV-negative people (per 100 000 population)		33	11

Zimbabwe has made some positive strides with respect to reducing HIV prevalence from a peak of 33% in the mid 1990s to the current prevalence rate of 15% amongst the 15-49 year olds. This is attributed to increased availability of ARVs, nutrition and knowledge around HIV and AIDS treatment and care.

[1] The WHO region average increased by 7 year(s) in the same period

2.6 Legislative and Policy Context

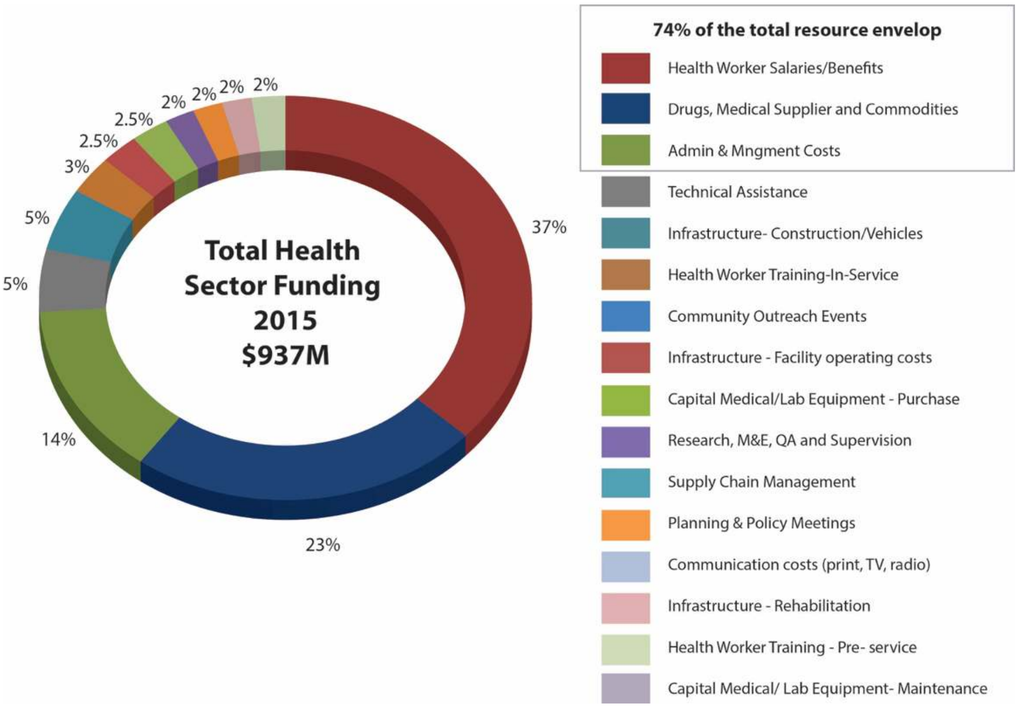
The major pieces of legislation that govern the health sector and other 'One Health' relevant sectors in Zimbabwe are the:

1. Constitution of Zimbabwe: explicitly provides for the right to health care for its citizens including the right to have access to basic health-care services, including reproductive health, chronic illness treatment and that no person may be refused emergency medical treatment in any health-care institution
2. Health Services Act (2002): provides for the creation of the health committees and community health councils that strengthen community participation in health policy development and decision-making. The Health Services Act also created the Hospital Management Boards at central and provincial hospitals; they manage the work of hospitals, in line with established minimum standards of practice in Zimbabwe.
3. Public Health Act (2002): empowers the MOHCC to protect the public health of the population through regulating sanitation standards at restaurants, schools, and hospitals. It also allows the government to quarantine people in the case of an emergency.
4. Health Professions Act (2000): regulates the registration and conduct of certain health professions. For example, the Medical and Dental Practitioners Council of Zimbabwe (MDPCZ) is responsible for overseeing the professional standards of doctors and dentists and their medical education. While all medical universities are overseen and regulated by the Ministry of Education, the MDPCZ provides supervision of curriculum standards at medical schools. As a part of its duties, it regulates the number of continuing education credits that doctors must receive in a year, and ensures that they have completed internships and verifies their qualifications. The Nursing Council of Zimbabwe fulfils similar functions for nurses, especially in terms of ensuring standards.
5. Traditional Practitioners' Act (1981): provides a framework for practice and regulation of its traditional practitioners.
6. Medical Services Act (1998): provides for the establishment and operation of both public and private hospitals and medical insurance companies, and minimum standards of practice for hospitals and medical aid societies.
7. Animal Health Act (1970) (Chapter 19:01): provides for the prevention of entry, establishment and spread of animal diseases and pests of major economic and zoonotic importance through implementation of various animal health sanitary measures among the surveillance, quarantine, test and slaughter of reactors, public education, inspection, certification and movement control.
8. Environmental Management Act (2002; amended 2006) (Chapter 20:27) aims to 'provide for the sustainable management of natural resources and protection of the environment; the prevention of pollution and environmental degradation;. Environmental management is regulated by three related agencies: the National Environmental Council, the Environmental Management Agency and the Environmental management Board.
9. Waste and Solid Waste Disposal Regulations, Statutory Instrument No. 6 (2007) regulates the disposal of effluent and solid waste. It prohibits any person from disposing waste into a public stream or ground water without a license.
10. Water Act, (20:24) (1998): regulates the planning and development of water resources, and provides a framework for allocating water permits. The Water (Waste and Effluent Disposal) Regulations (2000), associated with the Water Act, specify what quality is acceptable in terms of effluent released into rivers.
11. Food and Food Standards Act (15:04) 2001: provides for the sale, importation and manufacture for sale of food in a pure state; prohibits the sale, importation and manufacture for sale of food which is falsely described; and provides for the fixing of standards relating to food and matters incidental thereto.

2.7 Health Financing and expenditure

The major cost drivers of the health sector, making up 74% of the budget, are medicines and commodities, including laboratory commodities (23%), health worker salaries (37%) and administrative costs (14%) (Figure 1).

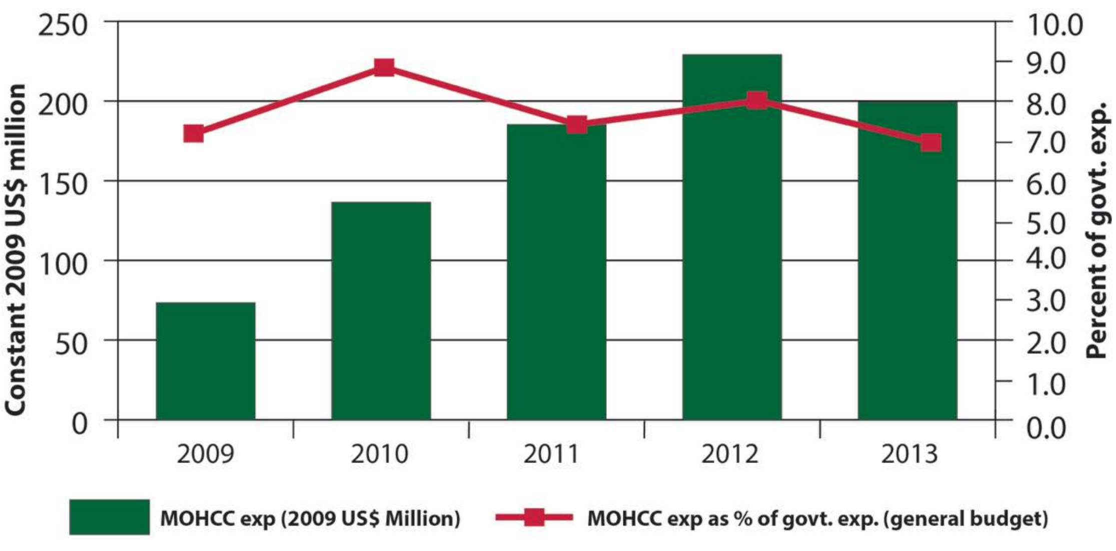
Figure 1 - Breakdown of total health sector budget by cost category 2015



Source: Authors using Ministry of Finance and Economic Development data

The period from 2005 to 2008 was highly inflationary, thereby reducing the purchasing power of funds allocated to the health sector so affecting the health system's ability to effectively provide for health commodities, equipment and payment of competitive wages. This led to a massive brain drain, professionals leaving the country at a high rate. Program activities became increasingly constrained, affecting the provision of health care services.11 Health institutions had to apply user fees to sustain operations as the government budget could not provide adequate funding. Out-of-pocket (OOP) spending was at 39% of total health expenditure in 2010, which greatly affected poor households, exposing them to catastrophic health spending. This also limited their ability to access health care services. Then the MoHCC spending increased nearly threefold in between 2009–12, from roughly US$73 million to US$229 million (2009 prices), and remained relatively stable as a share of the general budget (Figure 2).8 However the OOP in 2015, went down to 27% of the total health expenditure.

Figure 2 - MOHCC expenditure in total and as a share of general government, 2009 – 2013

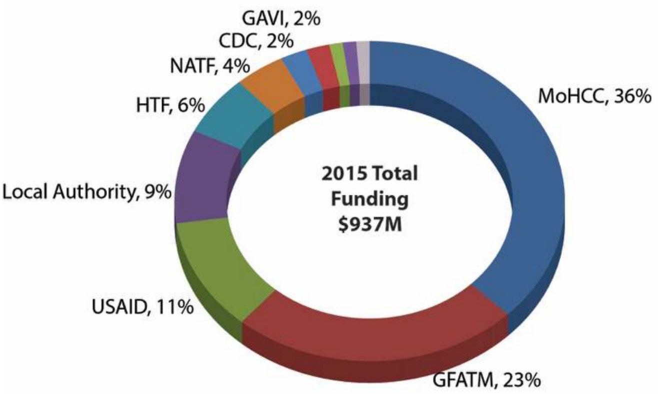


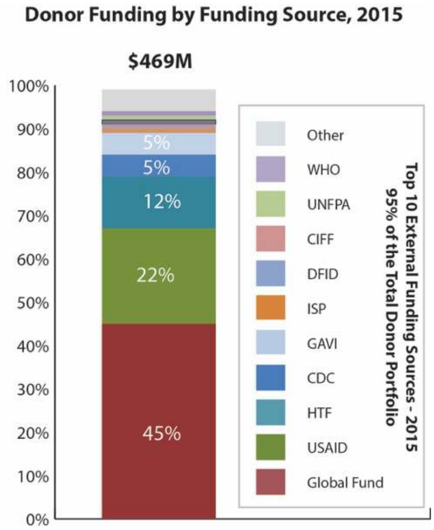
Source: Authors using MOFED data.

The health expenditure per capita of $24 (2015 estimate) is below the WHO benchmark of $86 per capita and donor funding has played a critical role in assisting the financing of the health system.

Global Fund (23%) USAID (11%) and local authorities (9%) are the largest funders of the Zimbabwe health system (Figure below) alongside the MOHCC at 30%.

Figure 3 - Funding for the Zimbabwe Health System





(WHO –World Health Organisation, UNFPA – United Nations Fund for Population Activities, CIFF – Children's Investment Fund Foundation, DFID – Department of International Development, ISP –Integrated Support Program, GAVI –Global Alliance for Vaccines and Immunisation, CDC –Centers of Disease Control, HTF – Health Transition Fund, USAID – United States Agency for International Development)

The Ministry of Health is now considering the introduction of a National Health Insurance scheme in order for the general public to be able to obtain affordable health care services.

2.8 Overview of the Agricultural Sector

The agriculture sector is one of the most important pillars of the Zimbabwean economy. Two-thirds of Zimbabweans live in rural areas and the majority depend directly or indirectly on agriculture. It is important to many Zimbabweans livelihoods, providing food, nutrition, fibre, incomes, transport, clothing and the associated employment. Agricultural products provide up to 60% of the inputs required in the manufacturing sector, where value is added, enabling trade in high value products.

The sector in total employs about 70% of the population and contributes about 15% to the GDP. The livestock industry specifically contributes 20% of the agricultural GDP, or 4% of the country's GDP. The industry contributes significantly towards foreign currency generation through exports. Export-oriented agriculture, calls for the application of sanitary rules of trade against international standards spelt out in the World Trade Organisation (WTO) Sanitary and Phytosanitary framework for plant and animal health and food safety.

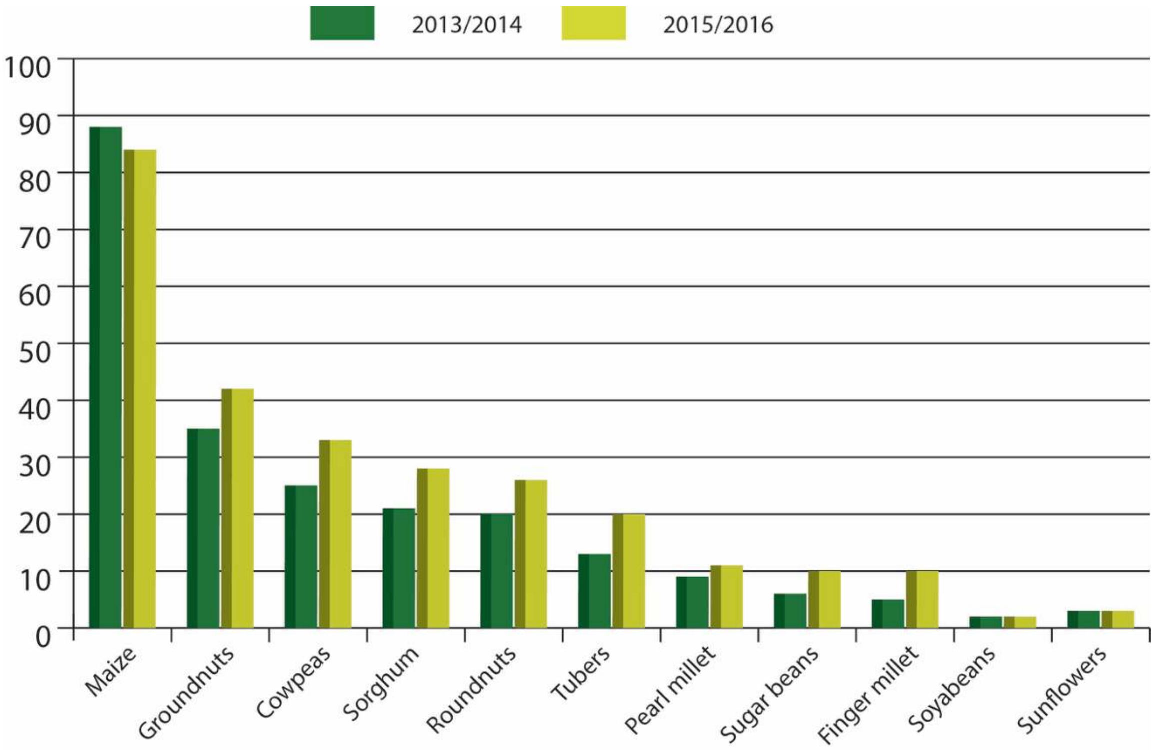
Agricultural in Zimbabwe has undergone fundamental changes following the land redistribution exercise. This has resulted in an expansion of the small-holder sector (about 300,000 newly resettled farmers) and a growing medium scale commercial farming sector engaged in crop and livestock production depending on the agro-ecological region.

The resettlement exercise has resulted in significant shifts in ownership and the use of agro-chemicals, with concomitant effects on crop and livestock management in terms of pest and disease control, biodiversity, and environmental management. At the same time, some new agricultural settlements have no health facilities, resulting in the sharing of both veterinary and human medicines generally being acceptable in the communities, posing a risk for AMR.

2.8.1 Crops

The crop sector of agriculture covers plantation and field crops staple cereals mainly maize and wheat, cash crops (tobacco, cotton), horticulture (fruit, flowers and vegetables), agroforestry, forages and seed production. Maize is the most common crop grown by rural people in Zimbabwe (See Figure 4). There is relatively widespread use of pesticides in this sector to control plant pests and diseases. In Zimbabwe, the Department of Research and Specialist Services (DR&SS) in the Ministry of Agriculture, Mechanization and Irrigation Development is the Competent Authority for plant health, plant quarantine and plant protection. Pesticide residues are often present in many fruits and vegetables found in the market for human consumption, thus posing a health risk to the consumers in Zimbabwe. Antimicrobials such as antifungals are currently being used on crops for prevention and curative purposes (See Table 2).

Figure 4 - Proportion of households that planted crops (%)



Data extracted from the Zimbabwe Vulnerability Assessment Committee (ZimVac) 2016 Rural Livelihoods Assessment

Table 2 - Crop diseases and antimicrobials used (AGRITEX, 2008)

Crop	Disease	Antimicrobial used
Cowpeas	Bacterial blight Bacterial leaf spot	Benomly Benomyl
Sorghum	Downy mildew Smut	Metalaxyl Captafol, Zineb
Pearl Millet	Downy mildew Rust	Ridomyl, Apron Zineb
Sugar beans	Bacterial blight Brown spot Rust Anthracnose	Copper oxychloride Copper oxychloride Mancozeb, Maneb Thiram, Zineb, Maneb, Mancozeb
Soyabeans	Rust	Punch Xtra, Shavit
Carrot	Powdery Mildew Leaf blight	Dithane M45, Benomyl Dithane M45, Copper oxychloride
Onion	Purple blotch Downy mildew	Dithane M45 Dithane M45, Ridomil

Okra	Leaf spot Powdery mildew	Dithane M45 Dithane M45
Potato	Late blight Early blight Fungal wilts Bacterial soft rots	Copper oxychloride, Mancozeb, Ridomil Maneb, Bravo, Captan Streptomycin
Tomato	Late blight Early blight Bacterial speck Bacterial spot	Copper oxychloride, Mancozeb, Ridomil Maneb, Bravo, Captan
Citrus	Black spot Phytophthora root rot	Dithane M45, Benomyl, Benlate Alleate, Phytex
Apple **Pear**	Bacterial blight Blossom blast Fruit spotting	Fixed Coppers, Bordeaux mixture

2.8.2 Livestock

Animal agriculture involves commercial beef and dairy production, sheep and goats, free range and commercial meat and egg poultry as well as fish and honey bee products. Livestock production plays an important role in improving the nutritional status of the population and in poverty alleviation through profitable livestock enterprises such as beef, milk, eggs, pork, poultry, hides and skins. Livestock disease control and eradication therefore remain important goals of the Government's veterinary services.

Currently there are a total of about 5.5 million head of cattle, 3.3 million goats, 975 000 sheep, 200 000 pigs, 40 million chickens and farmed crocodile. Poultry farming has increased dramatically, from about 25 million in 2001 to 40 million in 2015. There has been an increased consumption of chicken as it is cheaper than beef.

Animal production requires responsible and prudent use of quality assured medicines including antimicrobials. Antimicrobials are used for treatment of sick animals (See Tables 3 and 4). Some are, however, used for prophylaxis to prevent disease occurrence in animals produced under intensive settings particularly in poultry and pig production. In other cases antimicrobials are used for metaphylaxis by administration of the medicine to group of animals once members of the flock or herd have shown symptoms of infection.

Table 3 - Common animal diseases and antimicrobials reported used in agriculture in Zimbabwe according to results of FGD of active animal health and industry professionals

Animal species	Common Diseases in this species(FGD)	Antimicrobials commonly used in this species (FGD)
Beef	Tickborne disease Blackleg Foot and Mouth Disease Lumpy Skin Disease Trypanosomiasis	Penicillin/Streptomycin Tetracycline Penicillin Berenil Potentiated Sulphonamides Imidocarb Buparvaquone
Dairy	Mastitis Diarrhoea Coccidiosis	Penicillin Cloxacillin Tetracycline Potentiated Sulphonamides
Small ruminants	ORF	Tetracycline

Pigs	Coccidiosis Diarrhoea E.coli Streptococci spp Mange	Potentiated Sulphonamides Penicillin/Streptomycin Ivomectin
Layers/Broilers	Infectious Coryza E.coli Infectious Bursal Disease Salmonellosis Fowl Pox Respiratory illness Pasteurella	Anticoccidials Tetracyclines Sulpha drugs Tylosin Baytril
Indigenous chickens	Coccidiosis, worms Infectious Bursal Disease Fowl Typhoid Infectious Coryza Fowl Pox Pasteurella Respiratory illness	Tetracyclines Sulpha drugs Tylosin Baytril
Fish	Streptococci Columnaris Aeromonus hydrophyla, BKD, Iridovirus, KSV, EUS	Oxytetracycline Flophenicol “Salzap”
Crocodiles		Penicillin Long Acting Baytril Penicillin/Streptomycin Coccidiostats in feed
Bees	American and European foul brood Nosema Fixed/deformed wing Varroasis	Oxalic acid Formic Acid Menthanol Formalin

(Source: Situational Analysis: national baseline assessment of available information on antimicrobial use and resistance in agriculture – by the FAO)

Table 4 - Common animal diseases requiring urgent treatment according to species according to results of FGD of active animal health and industry professionals

Animal Species	Disease needing urgent treatment
Beef	Heartwater Lumpy Skin Disease Blackleg
Dairy	Mastitis Lumpy Skin Disease
Small ruminants	ORF
Pigs	Mange Coccidiosis
Layers/Broilers	Respiratory illness Coccidiosis
Roadrunners	Coccidiosis
Fish	Streptococcus

(Source: Situational Analysis: national baseline assessment of available information on antimicrobial use and resistance in agriculture – by the FAO)

2.8.3 OIE Assessment of Veterinary Services

Zimbabwe is a member state of the World Organisation for Animal Health (OIE). The country was assessed by the OIE mission in June/July 2014 to establish the performance of veterinary services. The key observations and recommendations of relevance from the assessment to AMR were that: -

1. In certain circumstances it may be necessary to authorise veterinary para professionals (VPP) and in exceptional cases, trained farmers, to use certain prescription only medicines (POM) under the supervision of a registered veterinary surgeon and capacitation. In such instances an effective means of 'supervision' needs to be established whereby the supervisor can be sanctioned as well as the supervised person in the event that the misuse of POMs or biologicals is detected.
2. Antibiotics particularly injectable oxytetracycline sold over-the-counter (OTC) at veterinary medicine general dealers created the opportunity for misuse and abuse of this antibiotic;
3. Provisions need to be made to ensure that withdrawal periods of veterinary medicines used in food producing animals are respected as well as the setting of maximum residue limits (MRLs)12
4. Medicines Control Authority of Zimbabwe (MCAZ) should enforce the inclusion of information on the withdrawal period for antibiotics used for treatment purposes on product labels advising veterinarians and farmers to allow adequate time for elimination of the medicine residues from the edible animal tissues such as meat, milk and eggs.
5. Prescribers did not reiterate the withdrawal period on the prescription and maintain records that they had counselled the farmer not to harvest edible animal tissue within the withdrawal period.
6. MCAZ, DVS and relevant stakeholders have to find ways of restricting use of veterinary medicines without veterinary supervision, advice and accountability.

From this report, MCAZ is recommended to engage in stakeholder consultations with pharmacies, licensed veterinary (general sales) dealers, private veterinary surgeons, veterinary para-professionals (VPPs) and farmers to determine a pragmatic regulatory framework for the distribution, sale and use of veterinary medicines and biologicals in order to mitigate the risks of development of antimicrobial resistance and the appearance of unhealthy levels of drug and other residues in the human and animal food chains

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3. Infectious Disease and Antimicrobial Resistance

Key points of this section :-

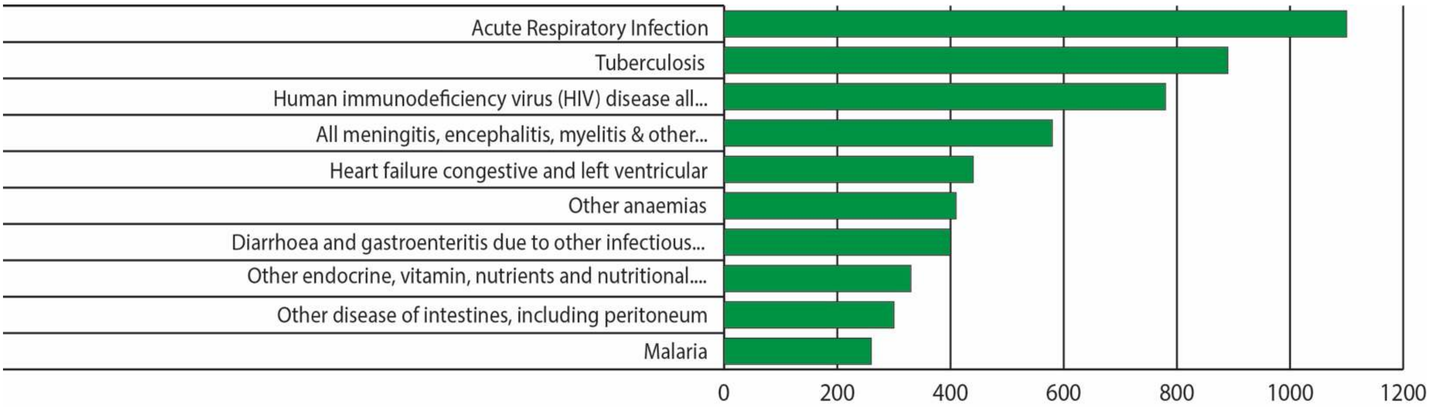
- Older studies on acute respirtory infections demonstrate that Streptococcus pneumonia was the most commonly isolated in pneumonia in children with penicillin resistance at 50%. However no follow up studies have been conducted.
- Estimates on multi drug resistant TB (MDRTB) in 2012 show 24% MDR TB
- The proportion of HIV patients with drug resistance at 12 months was 4.3%.
- The causes of meningitis are predominantly cryptococcal in HIV positive patients with high rates of mortality and in children under 5 years, the most common pathogen identified was , Streptococcus , and Nisseria meningitidis.
- Diarrhoeal disease are mainly caused by rotavirus in the winter months and bacteria in summer months where Salmonella and Shigella are common pathogens with increasing resistance to first line antibiotics
- Urinary isolates of Escherichia coli are highly resistant to ampicillin and cotrimoxazole
- 18,6% of N. gonorrhoeae sexually transmitted infections are fluoroquinolone resistant
- Artemisinin is still 96% effective for the treatment of malaria
- More than 70% of mortalities in cattle and in small ruminants (goats and sheep) are caused by Black leg, other clostridial infections and Heartwater whilst brucellosis causes 87% of the recorded abortion cases in cattle.
- ESBL genes detected in both the isolates from human urine and from chicken meat identified the same genes indicating that there might be a dissemination of resistant genes to and from humans / animals in nearby locations

3.1 Human Health Infectious Diseases and AMR

Zimbabweans continue to experience a heavy burden of disease dominated by preventable infectious diseases such as HIV and AIDS, malaria, tuberculosis, vaccine-preventable diseases, meningitis, diarrhoeal diseases, respiratory tract infections, neglected tropical diseases as well as a growing burden of non-communicable diseases (NCDs), such as cancer, diabetes mellitus and cardiovascular disease.

A paper based National Health Information System (NHIS) was developed in 1984, so that health data collected in the Provincial health systems could be transmitted to the MoHCC Head office. This system was computerised in 2010. Information from the NHIS shows that in 2015 infections such as TB, ARI, diarrhoeal and gastroenteritis, and meningitis were among the top ten cause of in-patient mortality (Figure 5). Tuberculosis is the main cause of in patient mortality in the over- five age groups and ARIs are the most common cause amongst the under –fives.

Figure 5 - Top 10 causes of mortality all ages for 2015 among in-patients



(Adopted from the National Health Information System – MOHCC)

3.1.1 Acute respiratory Infections

Acute respiratory infections (ARI's) are a major cause of morbidity and mortality in Zimbabwe in all age groups. However there is little recent published data describing the aetiology and epidemiology of these infections. The last comprehensive study on the aetiology of pneumonia in children in which the most commonly isolated organism was Streptococcus pneumoniae was done over two decades ago1. In a study to document trends in penicillin resistance (1994-2000), reduced susceptibility to penicillin was documented in 50% of S. pneumoniae isolates by the year 2000 2. However there has been no follow up study to determine whether resistance has increased even though benzyl penicillin is still used as first line in the management of pneumonia and meningitis in children 3. Earlier data also identified pneumocystis pneumonia as a significant infection in seropositive HIV patients both in adults and children [4,5.]

Studies on the use of cotrimoxazole prophylaxis in HIV positive patients in the DART trial supported the WHO recommendation for the introduction of cotrimoxazole prophylaxis in HIV infection to reduce mortality from respiratory infections 6. This is now part of the standard management of HIV patients.

Currently data on epidemiology and aetiology is available from student project reports including a study on factors associated with ARI amongst children in a mission hospital and another that focussed on lower respiratory tract infections in a central referral hospital. The latter showed that Enterobacteriaceae were most frequently isolated (11.7% of isolates) organisms and pneumonia (45.6%) and influenza (44%) were the most prevalent acute respiratory illnesses in patients of all ages [8,9].

3.1.2 Tuberculosis

Zimbabwe is among the 22 high TB burden countries and is one of fourteen countries that appear on all three high burden country lists used by WHO 2016–2020 for TB, TB/HIV, MDR-TB. Zimbabwe's national TB Prevalence Survey report, released in 2015, revealed a prevalence of 82.2 per 100,000 population for smear-positive TB cases, and 343.7 per 100,000 for bacteriologically confirmed cases. The preliminary estimated prevalence for all forms of TB in 2014 was 292 per 100,000 population. More smear negative than smear positive bacteriologically confirmed TB cases were detected, and this may reflect the effectiveness of the national TB control program (NTP) in identification and treatment of smear positive cases. It is also consistent with Zimbabwe's highly intertwined HIV and TB epidemics: given that approximately 69% of Zimbabwe's TB patients are co-infected with HIV, a relatively high proportion of smear-negative cases may be expected 10.

Metcalfe estimated the prevalence of multiple drug resistant (MDR) TB in Harare in 2012, based on microbiologic testing of AFB smear-positive sputum samples from patients previously treated for TB. Twenty (24%) of 84 specimens were consistent with MDR TB11. A national survey was recommended, in order to determine Zimbabwe's prevalence of MDR TB. This survey is being planned for implementation in 2017. The use of the rapid GenXpert MTB/RIF test has expanded substantially since 2012; there are over 120 GenXpert instruments that have been procured in the country across both public and private institutions. This has contributed significantly to the increased case-notification of drug-resistant TB, from 49 in 2010 to 412 cases in 2015. Recently, NTP adopted the use of GenXpert as the gold standard for TB diagnosis among people living with HIV (PLHIV). Given the aforementioned TB-HIV co-infection rate, the challenges in TB diagnosis among PLHIV, and concerns regarding drug-resistance in the region, rapid scale-up and optimal utilization of the GenXpert platform will be crucial for ongoing surveillance of MDR-TB. In addition further molecular characterisation of the Mycobacterium tuberculosis isolates as well as non-tuberculous mycobacteria, which has started will increase understanding of the species and strains causing the Zimbabwe epidemic,12,13.

3.1.3 Human Immunodeficiency Virus (HIV)

Zimbabwe has an estimated HIV prevalence of 14.7% among people aged 15-49, with an estimated 1,349,070 adults and 76,697 children living with HIV in 2015 (UNAIDS 2015 HIV Estimates, Zimbabwe). The national ART coverage of both adults and children has increased steadily between 2012 and 2016, with a current coverage of approximately 73% among adults and 76% in children14.

Rapid or uncontrolled emergence of drug-resistant HIV (HIVDR) is a widely feared consequence of ART scale-up which could lead to failure of ART programmes and strategies to prevent HIV transmission through pre- or post-exposure prophylaxis or topical microbicides. Thus, the worldwide effort to improve treatment outcomes and reduce transmission of HIV through the optimal delivery of ART and HIV prevention programmes must be coordinated with and enlightened by ongoing national, regional and global evaluations of HIVDR.

From 2009-2011, Zimbabwe implemented a prospective cohort study in 12 sentinel sites in which 1,728 patients were enrolled and 1,610 samples tested to measure the prevalence of viral load (VL) suppression and HIVDR at different time points in patients initiated on treatment. The study revealed that the overall proportion of participants initiating ART at the 12 sites who achieved VL suppression at 12 months (as defined by VL <1000 copies/ml) was 70.3%. The proportion classified with HIVDR at 12 months was 4.3%. The remainder, 25.4%, were classified as probably HIVDR since the outcome could not be determined [15,16].

Zimbabwe completed a pre-treatment drug resistance survey in 2016, with a sample size of 230 patients on both first and second-line regimens across 20 clinical sites. The data showed 10.3% (5.6%-18.2%) NNRTI-resistance; the main mutations noted were at K103N, K101E, and Y181C.

In an earlier study in 2013 in children less than 18 months old, newly diagnosed with HIV infection, indicated that widespread use of non-nucleoside reverse transcriptase inhibitors (NNRTI) for prevention of mother-to-child transmission (PMTCT) reduces HIV transmission but increases the risk of selecting for NNRTI-resistant mutations, thus potentially compromising the response to NNRTI-based ART regimens in young children.[17]

Zimbabwe started implementing the Early Warning Indicators (EWI) system for HIVDR in 2007 with a pilot phase after wide-scale consultations with stakeholders and feasibility assessments. The number of sites rose from 20 in 2007 to 104 in 2015. Nationally, 49% of adult ART clinics were below 80% for on-time drug pick-up; 24% of these clinics had <75% retention in care; and 51% had the recommended ART drugs in stock 100% of the time. The report therefore concluded that Zimbabwe may be at high risk of developing HIVDR given the significant number of facilities scoring poorly on these critical indicators.[18]

3.1.4 Meningitis

Recent data is available on the bacterial aetiology of meningitis but susceptibility data for the bacterial pathogens remains limited. In a study of adults and children in a central referral hospital in Harare with clinical signs of meningitis (n=296), 20.6% had laboratory confirmed meningitis, using culture/microscopy and serology The most common pathogens identified were C. neoformans, S. pneumoniae and Mycobacterium tuberculosis. The four isolates of S, pneumoniae were sensitive to ampicillin and ceftriaxone 19. In a study focussing on children aged 60 months or less, 30.2% tested positive for bacterial pathogens, using PCR in addition to culture and microscopy . Of the 53 (32.7%) confirmed meningitis cases, the most common pathogen identified was S. pneumoniae, S. agalactiae, H. influenzae and N. meningitidis. Susceptibility data was not reported [20].

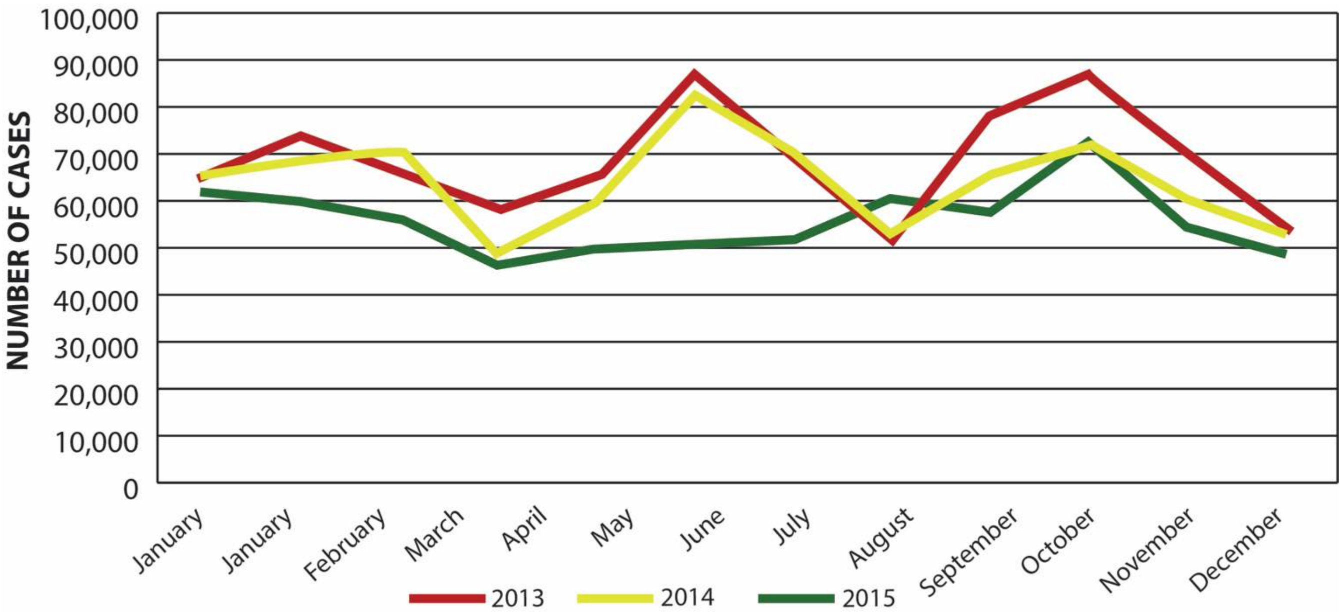
Cryptococcus species (C.neoformans, C.gattii and C. tetragattii) are amongst the main pathogens causing meningitis in Zimbabwe. 21,22, It occurs mainly in HIV positive adults, although a case series of 5 HIV-positive paediatric patients has been reported.23,24 In a recent study in patients diagnosed with cryptococcal meningitis, 54.2% were on ART and 53% had initiated ART within one year prior to the diagnosis and mortality was high25.. This suggests that cryptococcal disease burden is still significantly high despite improved access to ART and effective treatment is still an issue. Treatment of cryptococcosis is based on amphotericin B and fluconazole as these drugs are available in Zimbabwe. A study of 68 isolates from patients with meningitis showed that 97.1% had a wild-type MIC phenotype for all antifungal agents tested including amphotericin B, flucytosine and triazoles so currently anti-fungal resistance is not a problem. Data on Candida resistance to azole compounds which is an increasing problem in other parts of the world and could become a problem in Zimbabwe with the increasing availability of triazoles is not available [26].

3.1.5 Diarrheal Diseases

Diarrhoea is one of the top 10 leading causes of mortality in children under the age of 5 in Zimbabwe. The trends of diarrheal and dysentery cases in Zimbabwe for the period 2013 to 2015 as show in figures 1 and 2. These are clinical assessment data based on diarrhoea being defined as the frequent passing of loose or watery faeces and dysentery being defined as the passing of bloody or mucoid faeces.

It is estimated that 37% of all under-five diarrheal disease hospitalizations in Zimbabwe are caused by rotavirus27. Rotavirus surveillance in Zimbabwe commenced in 2008 at 3 hospital sentinel sites until December 2011. Stool specimens were collected from children <5 years of age (total of 3728 samples) with 48.5% positive for rotavirus. The highest prevalence of rotavirus diarrhoea was found during the dry, cool seasons of May - July. Rotavirus positivity peaked in children 3-17 months of age accounting for almost 80% of cases.[30]

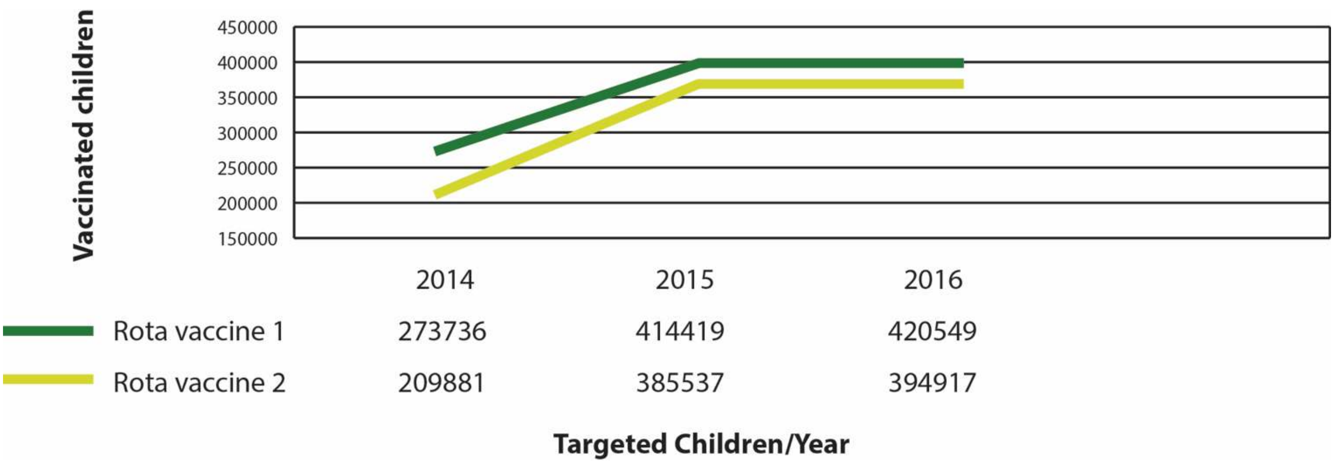
Figure 6 - Diarrhoea cases by month 2013 - 2015



(Adopted from the National Health Information System - MoHCC)

The MOHCC with support from the GAVI Alliance and partners introduced the rotavirus vaccine in Zimbabwe in May 2014, with increasing coverage in 2015 and 2016 (Figure 7), and this has seen significant decline in the common diarrhoea cases in the under fives, as shown in Fig 6 above [29,30] .

Figure 7 - Rotavirus vaccine coverage 2015 - 2016

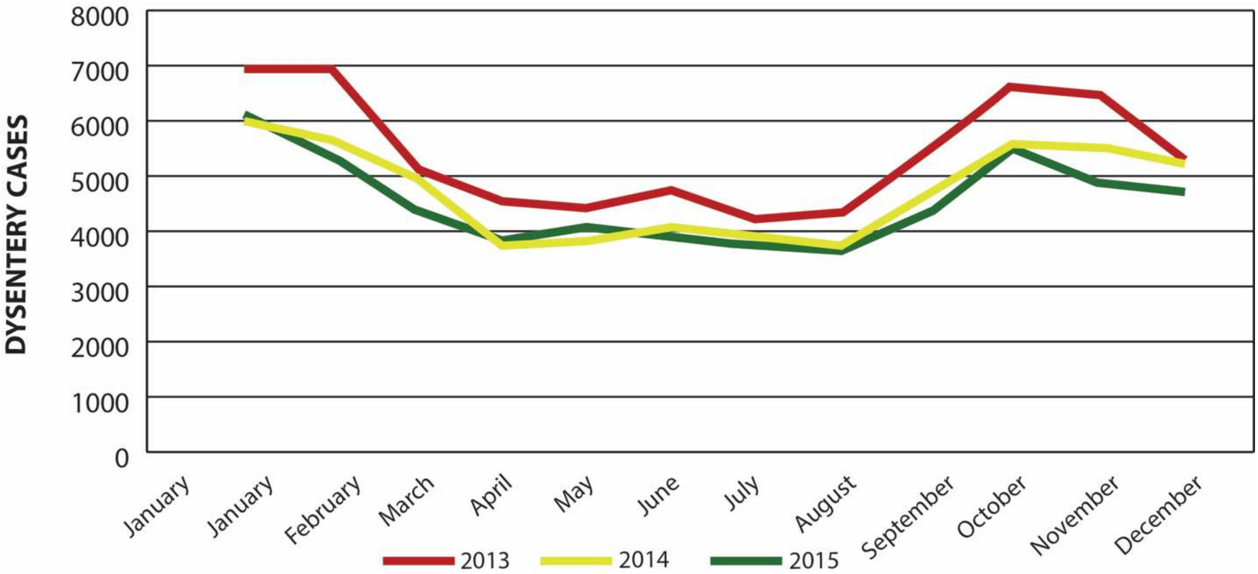


The rotavirus vaccine has made a significant dent in the wave of under fives diarrhoea; however the persisting challenges in water, sanitation and hygiene have kept diarrhoea related to typhoid as common occurrence.

The standard treatment of choice for common diarrheal cases in Zimbabwe is oral rehydration using salt and sugar solution, (SSS) or oral rehydration solution, (ORS) in light to moderate cases, but in severe cases antibiotics are indicated.

Dysentery which occurs throughout the year also appears to have seasonal peaks, Fig 3, with the first peak during the first 12 weeks of the year and the second during the last 12 weeks;The most common pathogens isolated during the past 2015/16 season are Salmonella spp and Shigella spp.

Figure 8 - Dysentery cases by month 2013 - 2015



(Adopted from the National Health Information System - MoHCC)

AMR among enteric pathogens is a critical area of public health concern. The recommended first line drugs in Zimbabwe are ciprofloxacin and nalidixic acid. Shigella isolates tested in 2004 and 2005 showed a high level of sensitivity to both of these antibiotics.29 However resistance of Salmonella and Shigella spp has been identified at the National Microbiology Reference Laboratory (2014 data) to the most commonly used antibiotics namely ampicillin, cotrimoxazole and ciprofloxacin the CDC has recommended that doctors should order laboratory tests routinely to determine effectiveness of the drug. Susceptibility data is available for other diarrhoeal pathogens including Campylobacter species but the diagnostic capacity to detect these pathogens is limited.

Zimbabwe experienced the worst outbreaks of cholera from August 2008 to July 2009 affecting 97,872 people and causing 4,270 deaths by 6 May 201028. This outbreak affected both the rural and urban communities. The predisposing factors amongst others included the multi-system breakdown in the country that caused high population mobility across borders in search of basic commodities and jobs, and internally, the dysfunctional water and sewage systems. Since this 2008/9 outbreak there has been a persistent annual occurrence of these outbreaks with reduction in overall numbers over the years such that in 2016 there were only 10 cases reported.

On the contrary typhoid fever cases have increased since 2010. In 2016, there were 2 352 cases and 9 deaths and in the first quarter of 2 017 there has already been 1 125 suspected cases with 60 confirmed cases28 (See Table 5 below). This has been caused by sewerage contamination of both municipal and borehole water in Harare and other urban areas, limited water supplies and poor solid waste management.

Table 5 - Cases of cholera and typhoid

Year	Cholera		Typhoid	
	Cases	Deaths	Cases	Deaths
2008/09	97 872	4 270		
2010	1022	22	0	0
2011	1140	45	1104	1
2012	23	1	5829	6
2013	12	0	1707	0
2014	0	0	1653	11
2015	62	0	1236	5
2016	10	1	2352	9

The medicine of choice for treatment of typhoid fever in Zimbabwe is ciprofloxacin. The laboratory culture and sensitivity tests have previously shown sensitivity of the organism to ciprofloxacin, chloramphenicol and azithromycin although there is now a current report and concern of a 23% resistance to ciprofloxacin and up to 95-100% ampicillin and chloramphenicol resistance has also been documented. The government of Zimbabwe inter-ministerial committee was activated during the last quarter of 2016 to determine a more comprehensive approach to addressing the determinants of cholera and typhoid, in view of the fact that the urban local authorities were not coping.

3.1.6 Urinary Tract Infections (UTI)

Urinary tract infections are common both as community acquired and hospital acquired infections. The current EML (2015) recommends the use of norfloxacin or amoxicillin for cystitis, and norfloxacin for mild acute pyelonephritis and ceftriaxone or gentamicin for acutely ill patients. Anecdotal information suggests that a wider range of antibiotics are used in the private sector but the pattern of prescribing has not been documented. The most recent data available on susceptibility patterns in common UTI pathogens are from two studies done in Bulawayo (2010) and Harare (2013).[31,32]

An earlier study of 62 isolates from patients with laboratory confirmed UTI infections in Bulawayo showed 61% were Enterobacteriacee of these 40.3% were Escherichia coli. Antibiotic susceptibility testing revealed a high resistance to ampicillin (84.5%) and cotrimoxazole (68.5%) among the Gram negative bacilli.32 The high level of resistance to cotrimoxazole has long been recognised and it is now rarely used in the treatment of UTIs. An investigation into extended spectrum beta lactamase resistance (ESBL) production in E.coli isolates (n=64) from urinary tract infections showed that 63% were ESBL producers33. This study together with high carriage rate of ESBL found in paediatric patients in a Harare hospital suggest Gram negative resistance could be a significant problem in the clinical environment and further studies are required to determine the prevalence of infections caused by ESBL producers and the effect on patient management.[34]

3.1.7 Sexually Transmitted Infections

In Zimbabwe, as in many African countries, sexually transmitted infections (STI) are treated and managed using syndromic treatment as diagnostic services are not sufficiently available to determine the aetiology of each of the diseases. The treatment of the urethral discharge with antibiotics over the years has shifted from use of penicillins to tetracyclines then aminoglycosides, quinolones, macrolides and now cephalosporins.

Antimicrobial resistance (AMR) in gonorrhoea is a significant challenge with untreatable gonorrhoea infections strengthening the pressing need for a global action plan to control the spread of AMR and mitigate the impact on sexual and reproductive health. WHO Global Gonococci Antimicrobial Surveillance Program (GASP) runs networks in at least 53 countries and results from Zimbabwe from a 2010-2011 study of gonococci resistance showed that Neisseria gonorrhoeae was the most frequent pathogen detected (106 cases; 82.8%), followed by Chlamydia trachomatis (15 cases; 11.7%), Mycobacteria genitalium (6 cases; 4.7%), and Trichomonas. vaginalis (2 cases; 1.6%). Only four (6.1%) of the 66 gonococci isolated were resistant to fluoroquinolones, whereas all viable isolates were susceptible to kanamycin, cefixime, and ceftriaxone.[35]

A more recent study, on consenting men aged 18 years and over with urethral discharge enrolled at 5 sentinel sites in Zimbabwe showed N. gonorrhoeae isolated in 104 men (24.5%) who presented with urethral discharge. Antimicrobial resistance to ciprofloxacin was found in 18.6% of strains, resistance to ceftriaxone was found in 9.8%, resistance to cefixime was found in 13 12.7% strains, and resistance to kanamycin was found in 2% strains tested.36 However, no resistance to cephalosporins was observed when the stored specimens were tested for resistance using genomic sequencing in Sweden. Data is being analysed to ascertain what the results mean in terms of cephalosporin resistance being reported from the culture method and none on gene sequencing. In Zimbabwe ceftriaxone and kanamycin are the first line medicines according to the recommendation of the Zimbabwean treatment guidelines of 2013.

3.1.8 Hospital Acquired Infections (HAIs)

Surveillance for hospital-acquired infections is not part of the health care delivery system in Zimbabwe. The limited data available indicates that there is a problem of hospital-acquired infections. A study to evaluate risk factors associated with abdominal surgery in 285 patients in a central Harare showed an overall surgical site infection (SSI) rate of 26%. The risk factors associated with the surgical site infection (SSIs) were high wound score, HIV status and delayed antibiotic prophylaxis.37 More recently in 2015, an infection prevention and control (IPC) interventional study at two central hospitals in Harare amongst women undergoing caesarean sections found an overall SSI rate of 29% (n=237) before intervention. A significant reduction of 12% was achieved after IPC interventions which included feedback of surveillance data, IPC training, a post-operative wound care factsheet for mothers and a standard operating procedure (SOP) for cleaning of surgical instruments.38 Microbiological data was not reported in either of these studies so the role of AMR organisms in these infections remains unknown.

Recent studies have demonstrated a high carriage rate of 20% of methicillin resistant Staphylococcus aureus (MRSA) in nasal specimens in 80 patients admitted to critical care units in 2015, in a central hospital in Harare.39 A study of 407

S.aureus isolates from swabs, blood and urine, from out-patients and in-patients and both private and government hospitals showed that 7% were MRSA.38 The impact of MRSA on patient outcomes is not known in this setting but the data suggests a potential problem for infection management that needs further investigation.

A study on MDR carriage on gram negative resistant bacteria reported 52% (86/164) extended spectrum beta lactamase resistance (ESBL) carriage and 51% (85/164) gentamicin resistance carriage in hospitalized paediatric patients at two central hospitals on admission. The acquisition of both ESBL and gentamicin resistance in those who had no carriage on admission increased with the length of hospital stay.[39]

In a linked study the hands of doctors, nurses, students and parents or guardians (n=152), were sampled before and after performing hand hygiene with a locally produced alcohol hand rub. Klebsiella and Enterobacter species were the most common microorganisms isolated in all groups. The use of alcohol hand rub significantly reduced the microbial load on the hands of all study participants.40 The MOHCC has introduced training of pharmacists to prepare alcohol hand rub using the WHO formulation, to make it readily available in the health care facilities. HAI infection caused by pathogens such as Clostridium difficile, a problem in health facilities in high income countries, has not been documented in Zimbabwe although it was identified in 8.6% of diarrhoeal stool specimen from outpatients >2 years old presenting in health care facilities in Harare. [41]

Surveillance systems for HAIs are critical in determining the prevalence of these infections, the burden of disease, the requirements for additional antibiotics and the detection of outbreaks in healthcare facilities. This information will enable appropriate interventions and HAI management.

3.1.9 Malaria

Malaria remains a disease of public health importance with 50% of the Zimbabwean population at risk. Chloroquine (CQ) was used as the first-line drug for uncomplicated malaria until several independent studies pointed to growing levels of parasite resistance from 1984 onwards. From 1999 the then Ministry of Health & Child Welfare instituted formal yearly studies at eight sentinel sites (one in each rural province) to assess malaria parasite resistance to CQ using the WHO protocol. Results from these sentinel site studies provided enough evidence to necessitate change of malaria case management from CQ to free combination of CQ and sulfadoxine/pyrimethamine (SP) from year 2000 till 2004. Further studies conducted at the same sites from 2000 to 2007 on parasite sensitivity to free combination of CQ and SP showed treatment failure rate as high as 43.2% at Lukunguni clinic in Hwange District and Hauna hospital in Mutasa District respectively. In 2004 Zimbabwe made a land mark decision to change the interim malaria case management drug policy from free combination of CQ + SP to the more effective artemesinin based combination therapy (ACTs). However due to inadequate funding, an interim policy to use a free combination of CQ and SP remained in force until 2007 when ACTs, artemether-lumefantrine (Coartem) were then made available through the Global Fund.[42]

An assessment of artemether-lumefantrine (Coartem) efficacy in Zimbabwe done in 2010 was 96%. Another therapeutic efficacy study (TES) study in 2014 showed that at 6 out of the 8 sentinel sites, the efficacy was at 96.3%. These systematic studies continue to guide appropriate malaria treatment policy [42].

3.1.10 Neglected Tropical Diseases

Zimbabwe has over the past decade developed a programme to address the high burden of eight priority parasitic and zoonotic diseases which have largely been neglected in prevention treatment and control programmes. These are schistosomiasis, (SCH), soil transmitted helminths, (STH), lymphatic filariasis (LF), blinding trachoma, leprosy, anthrax, rabies and human African trypanosomiasis.

Surveys have been done to establish the prevalence of schistosomiasis, soil transmitted helminths, lymphatic filariasis, blinding trachoma, and annual mass treatments have been conducted43,;

- albendazole (STH) and praziquantel (SCH) since 2012,
- albendazole and diethylcarbamazine, (LF) since 2016,
- azithromycin for trachoma in Binga since 2016

Furthermore, communities in anthrax prone areas know that they will get antibiotics once lesions form after consuming contaminated meat, and therefore have repeated exposure to antimicrobials which may contribute to antimicrobial resistance. There is therefore scope to factor in antimicrobial resistance in these large scale interventions with anti-parasitic and antibiotics medicines, and advocate for improved environmental and water, sanitation and hygiene improvements in order to minimize the need for continued use of antimicrobials.

3.2 Animal Health infectious diseases and AMR

3.2.1 Burden of infectious diseases in animals

A wide range of animal infectious diseases are endemic in Zimbabwe, requiring constant monitoring and remediation through treatment in order to safeguard production efficiency, product quality and safety of food commodities. Among those of relevance to AMR are bacterial infections such as clostridial infections e.g. Black leg, salmonellosis, staphylococcosis, streptococcosis, colibacillosis, brucellosis, campylocteriosis causing various disease syndromes in a variety of animal species ranging from fish to beef and dairy cattle. Vector-borne diseases including theileriosis, anaplasmosis, babesiosis and trypanosomoses are another range of microbes causing serious morbidity and mortality in farm animals.

The use of antimicrobials is very important in the control of animal diseases. Antimicrobial use (AMU) and Antimicrobial resistance (AMR) in animal health should be closely monitored to ensure effective treatment and control of bacterial diseases of economic and zoonotic importance. More than 70% of mortalities in cattle and in small ruminants (goats and sheep) are caused by Black leg and other clostridial infections (DVS Annual reports). Brucellosis which is both zoonotic and of economic importance causes 87% of recorded abortion cases in cattle. As from 1998 to 2002 the Zimbabwe cattle industry experienced 8665 cases and 939 deaths due to Anthrax, 3115 cases and 2250 deaths due to Blackleg (DVS Annual reports). The extend of the usage of antimicrobials both for prophylactic and treatment for major diseases of poultry and other small stock such as salmonellosis, coccidiosis, campylobacteriosis and collibacillosis still needs to be investigated.

The major mastitis pathogens include Staphylococcus aureus, Streptococcus agalactiae and, Streptococcus dysgalactiae and the “minor pathogens” which are coagulase negative staphylococci, and Corynebacteriumbovis. The opportunistic environmental pathogens comprise of Escherchia coli, Klebsiella spp., Pseudomonas aeruginosa, Streptococcus uberis and Actinomycespyogenes. Among all these bacteria, the most important infections are those which commonly persist in the udder. These bacteria include S. aureus and Strept. agalactiae.

Although the use of vaccines which include autogenous vaccines are being encouraged by the Department of Veterinary Services (DVS), the use of antimicrobial agents has remained the major preventive and control strategy for most bacterial infections of both economic and zoonotic importance.

A wide range of diseases have been confirmed by the Central Veterinary Laboratory (CVL) and its provincial Veterinary Laboratories however special attention is normally given to the 5 high priority notifiable diseases. Below are some of the confirmed cases in 2013 and 2014 and their comparisons:-

Table 6 - Comparison of notifiable disease diagnosis between 2013 and 2014

Disease	Total tested		Total positive	
	2013	2014	2013	2014
FMD	5423	3655	579(11%)	361(10%)
Anthrax	106	84	11(10%)	3(4%)
NCD	472	724	146(31%)	157(22%)
Brucellosis	41	1499	1(2%)	235(16%)
Rabies	416	509	261(63%)	295(58%)
Total	6458	6471	998(15%)	1051(16%)

There was a general increase in the number of tests for notifiable disease carried out by the CVL. There was an increase in the confirmed number of brucellosis outbreaks compared to 2013.

3.2.2 Antimicrobial Resistance in Animals

3.2.2.1 Cattle diseases

AMR evaluations are mostly done to assist Government Veterinary Extension officers, private veterinary clinicians and facilitate rapid treatment of high producing dairy cows for mastitis. Evaluations are also done in intensive poultry and piggeries where the problem could easily spread to affect large numbers of productive units. The Central Veterinary Laboratory (CVL) routinely carries out diagnostic bacteriology testing subjecting all disease causing bacterial isolates to antimicrobial sensitivity tests with the objective of advising veterinary clinicians and veterinary extension staff on the choice of antibiotics for treatment. In addition to this routine, the CVL also runs a Mastitis Control Scheme in which dairy farmers from both the small and large scale dairy farmers are free to join. Under this scheme, all mastitis isolates are subjected to antimicrobial sensitivity tests to assist the farmers on the choice of antibiotics. AMR evaluations are also conducted in connection with export certification of animal-source food products. For non-bacterial organisms, resistance is often estimated through epidemiological measurement in response to treatment.

Smallholder dairy farms in Zimbabwe possess a significant proportion of the overall country production of dairy commodities. Mhone et. al., found antimicrobial residues (unspecified) in raw cow milk from smallholder dairy farms from three sites in Zimbabwe. Siwela et. al., reported that Coryneforms, Escherichia coli, Enterococcus faecalis and Pseudomonas spp. isolates from the faeces of chickens and ostriches on commercial farms were generally more resistant to streptomycin, tetracycline and oxytetracycline when compared to free-range animals, possibly indicating the use of antimicrobials in commercial farms.

A study was carried out to determine the prevalence of coagulase-negative staphylococci in clinical and subclinical mastitis in commercial and small-scale farms in Zimbabwe42. Enteric bacteria, coagulase negative staphylococci and Staphylococcus aureus were found in milk samples from these cows. All the coagulase-negative staphylococci isolates were susceptible to cloxacillin and erythromycin, and more than 90% of the isolates were susceptible to neomycin, penicillin and streptomycin. The highest resistance was to tetracycline, followed by lincomycin, penicillin and streptomycin.

In the southern part of Hwange ecosystem in Zimbabwe the antimicrobial resistance of E. coli commensal populations in African buffalo and nearby cattle populations was assessed. The results confirmed the presence of tetracycline-, trimethoprim-, and amoxicillin-resistant subdominant E. coli strains, as well as the dissemination of tetracycline, trimethoprim, and amoxicillin resistance genes in E. coli strains between nearby buffalo and cattle populations.

3.2.2.2 Avian dieseases

Colibacillosis, a disease caused by avian pathogenic Escherichia coli (APEC), can lead to great economic losses in the poultry industry and many isolates exhibited resistance to more than one antimicrobial, i.e., tetracycline (100% resistance), bacitracin (100% resistance), cloxacillin (100% resistance), ampicillin (94.1% resistance), as well as ciprofloxacin (100%) and gentamycin (97.1%). Such findings indicate an emerging drug resistance in APEC associated with colibacillosis in Zimbabwe. The observed high level of multidrug resistance could hamper the treatment of colibacillosis in Zimbabwe46.
Animal-born serovars of Salmonella are causing concern due to their increasing worldwide prevalence and resistance to multiple antimicrobials. A study was carried out to determine the distribution and antimicrobial susceptibility profiles of Salmonella serovars from chickens from commercial or rural free-range farms of Zimbabwe45. Among other commonly isolated serovars, Salmonella enteritidis predominated in the urban/periurban areas, with a great proportion being resistant to one or more antimicrobial agents. Resistance to tetracycline was the most common and amongst multidrug resistant strains, resistance to ampicillin/kanamycin was predominant while no resistance was detected for furazolidone, neomycin and trimethoprim-sulfamethoxazole.

In E.coli isolates (n=120) from chicken meat, 49% were ESBL producers. The same study tested the ESBL genes detected in both the isolates from human urine and from chicken meat and identified the same genes 33 indicating that there might be a dissemination of resistance genes to and from humans / animals in nearby locations.

3.2.2.3 Other animals

A study carried out at the Veterinary School at the UZ on AMR was conducted. Bacteria isolated from dog wounds, revealed the existence of fairly high numbers of multi-drug resistant Staphylococcus aureus (65%; 13/20) and Staphylococcus pseudintermedius (50%; 8/16).

3.3 Plant Health Infectious diseases and antimicrobial diseases

No research has been done to establish the direct relationship between plant pathogens and human health. It is also important to note that, AMR pathogens can be found in irrigation water, manure and the soil but there is no data or evidence of plant pathogenic strains causing diseases in humans. E. coli and Salmonella have been detected in vegetables grown in fields treated with manure which was not properly treated. The isolated pathogens were not evaluated for AMR. It is an area which requires a lot of research. A lot of research has been done on the indirect effects of plant pathogens on humans especially related to mycotoxins.

3.4 Environmental AMR

Pathogenic bacteria with AMR may also be found in environmental samples, potentially affecting irrigation and/or drinking water, plants, food and agriculture, as well as animal farming. Clostridium difficile is a bacterium associated with diarrhoea and pseudomembranous colitis in hospitalized patients that are on long term treatment with antibiotics; if this bug is found in food animals, it may act as a source of infection to humans. The occurrence of C. difficile in broiler chickens sold at market places in an urban area in Zimbabwe was assessed42. Results demonstrated that C. difficile was found in 29 of 100 chicken faeces samples and 22 of 100 soil samples. All the isolates were susceptible to metronidazole, vancomycin, doxycycline, chloramphenicol and tetracycline and over 70% of the isolates were susceptible to erythromycin, co-trimoxazole and ampicillin. However, they were all resistant to cefotaxime, gentamicin, ciprofloxacin, norfloxacin and nalidixic acid.

In addition to the above, it has been reported that Clostridium difficile was also found in faeces of domestic animals, soil and drinking water in a rural community in Zimbabwe42. All toxigenic isolates were susceptible to metronidazole, vancomycin, doxycycline, chloramphenicol and tetracycline and all were resistant to cefotaxime, gentamicin, ciprofloxacin, norfloxacin and nalidixic acid. These results also highlighted the fact that chickens kept by villagers are an important reservoir of AMR C. difficile, which may act as a source of human infection.

3.5 Plant Health infectious diseases and AMR

No detailed situation analysis was conducted in on crops, agro-forestry and … to establish the most commonly prevailing infectious diseases. Antimicrobial use and prevalence of AMR was also not studied. However, these activities will be carried out during the first year of implementation of the NAP on AMR, to ensure that current gaps will be addressed within the five-year period of implementation of the NAP.

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4. SURVEILLANCE

Key points of this section:-

- A strong and effective surveillance program is in place for notifiable conditions which makes use of mobile technology to ensure 95% completeness of reporting monthly
- Laboratory based surveillance system has been ineffective for a long period due to lack of specialist professional staff, equipment and reagents
- Only 25 % of public health laboratories for humans have the capacity to do culture and sensitivity testing.
- The Central Veterinary Laboratory (CVL) with 3 other provincial labs and some small microbiology labs in abattoirs and slaughter houses tests animal and animal products for residues and microorgansms
- When a farmer is unable to pay for the laboratory fees, that specimen will not proceed for laboratory testing including samples that do not meet the lab requirements limiting information for surveilance
- Capacity to carry out antibiotic residue testing is available at the CVL toxicology lab, however few tests are being performed.
- The Government Analyst laboratory carries out tests of processed foods from samples sent from across the whole country.
- The Environmental Management Agency carries out chemical and microbiology tests on portable, raw and waste waters however there are no antibiotic sensitivity tests that are done.

4.1 Surveillance in humans

The Ministry of Health and Child Care adopted and adapted the WHO's Integrated Surveillance and Response framework, (IDSR) in 1998, and subsequently built a strong surveillance system which won Southern African Development Community (SADC) recognition as being the best in the region. Supported with a strong legislation to mandate reporting of certain diseases and conditions, (the Public Health Act, the Medical Services Act, etc), health care workers were trained to report through the rapid disease notification, (RDN) and weekly disease surveillance systems, (WDSS), on notifiable conditions. The private sector health workers also report using the system to local government or national health authorities.

Housed in the directorate of Epidemiology and Disease Control, (EDC) the National Health Information System (NHIS) of the MoHCC receives weekly reports of 18 epidemic prone diseases, deaths and public health events from almost 1500 of the country's 1800 health institutions. Initially only 500 clinics that had a working telephone or radio and a nurse reported using case definitions selected by the Provinicial Medical Directorate (PMD). With the advent of mobile phones, the Ministry adopted the Front Line SMS for reporting and acquired 1200 mobile phones initially and provided airtime to enable weekly reporting to the head office. Health facility staff were trained on the updated IDSR guidelines and how to use the simple reporting form. On the Mobile health platform, greater than 95% completeness and timeliness has been maintained now for 3 years, while flexibility of the system allowed the early detection of the H1N1 outbreaks in 2009. This was also helpful in aiding detection and reporting of suspected Ebola cases. With persistence of high maternal mortality the RDN system has over the past 2 years reported maternal deaths weekly [1]

A laboratory based surveillance system was put in place in 1995.2 This surveillance system made use of sentinel sites (laboratories) all over the country that would send isolates to the National Microbiology Reference Laboratory (NMRL) and complete and submit weekly surveillance forms following standardised susceptibility testing to monitor extent the of resistance. The NMRL worked in conjunction with the EDC department especially in outbreak cases of the some notifiable diseases such as cholera in 2008 and H1N1 in 2009, typhoid in 2012 and suspected Ebola cases in 2014. Confirmed results would then be reported to the EDC department. This system became ineffective in 2012 due to the failure to hire a Surveillance Officer in charge of monitoring the system. Other challenges included the lack of space to store isolates, reagents and place new equipment.

There are other laboratory based surveillance systems that have also been implemented with support from the WHO. These include the Paediatric Bacterial Meningitis (PBM) surveillance, the measles/rubella and polio surveillance and the rota virus surveillance. These surveillance systems give the country the much needed evidence for choosing the correct Rotavirus vaccine, and the PCV 13 vaccine for prevention of pneumococcal meningitis.

Specific program driven AMR surveillances have been carried out concerning malaria, HIV and TB.

4.1.1 Existing laboratory functionality to perform surveillance in humans

There is an integrated tiered government laboratory network consisting of 78 laboratories operating at five main levels within the health system organized along the referral chain as indicated below:

1. National reference Laboratories – 3
2. Central Hospital Laboratories – 5
3. Provincial Hospital laboratories – 8
4. District hospital laboratories – 62
5. Rural health clinics with rapid diagnostics tests – approx. 1500

The 3 National Reference Laboratories carry out specialized referral testing and services, namely the National Microbiology Reference Laboratory (NMRL), The National TB Reference Laboratory (NTBRL) and the National Virology Laboratory (NVL). The latter being under the University of Zimbabwe in the Department of Medical Microbiology, carries out polio, rotavirus and measles tests. The Zimbabwe National Quality Assurance Programme (ZINQAP) provides quality control and quality assurance to all the registered laboratories testing sites for rapid tests and point-of care technologies.[3]

There are 5 central laboratories, 8 provincial, 62 district laboratories and the rest are testing centers where only point-of-care technologies are available such as rapid HIV, syphilis or malaria testing. The total number of actual laboratories is 78 and out of these about 20(25%) are carrying out routine micro-culture and sensitivity mainly due to shortage of manpower, reagents and equipment.

The HIV, TB and malaria programs each support their own lab equipment for routine tests i.e.:

1. The HIV program supports CD4, full blood count, biochemistry, viral load tests
2. The TB program supports TB smear microscopy reagents, GeneXpert reagents including those for the 2 referral TB culture laboratories while
3. The malaria control program provides rapid test kits for malaria.

Active surveillance for isolates other than notifiable organisms which is mandatory is minimal. Surveillance for infant viral infections is also present for polio, measles and rota virus (the later only in Harare) due to support from the WHO.

There is a shortage of human resources, equipment and reagents across all human laboratories tiered system. More investments are needed for surveillance such as infrastructure, equipment and resources and trained human resources.

4.2 Surveillance in Animals

Both active and passive surveillance for animals are carried out by the DVS by field and laboratory personnel. The Veterinary Extension Workers (VEW) carry out planned scheduled farm inspections. These are usually done four times a year but maybe reduced to twice a year depending on the availability of resources. Important and cardinal information is relayed in this structured manner i.e. from a farmer to a VEW, to the animal health inspector who is at the animal health management centre (AHMC), where clinical presentation of animal is noted.[4]

When a post-mortem is indicated and done, samples are collected if needed are passed on to the District office who have the capacity to do further tests and determination. The results are then passed onto the chief animal health inspector. At the district office basic microscopy can be carried out including those activities that were carried out at the AHMC. This will further be passed on to the provincial level where more added technical tests are done. Then the Provincial Veterinary Officer reports to the Epidemiology and disease control unit where all records are kept.[4]

There are cases whereby a farmer reports presence of a disease at his farm and triggers an investigation requiring a farm inspection, post-mortem and/or specimen collection. Whether or not the specimen will reach a laboratory is dependent on the history and post-mortem findings. Pathognomic cases rarely proceed to laboratory confirmation. When a farmer is unable to pay for the laboratory fees, that specimen will not proceed for laboratory testing including samples that do not meet the lab requirements.4 (We need a recommendation here as key information is and will be lost – such information could be key to AMR).

The laboratory based disease surveillance infrastructure for animals includes:

Public health infrastructure:

1. A Central Veterinary Laboratory for routine diagnostics for both active and passive disease surveillance
2. Provincial Veterinary Laboratories in Masvingo, Matebeleland North and Manicaland Provinces for laboratory testing and disease confirmation.,
3. One international research and quarantine station,
4. 12 Veterinary Public Health Border Posts,
5. 140 registered abattoirs
6. More than 2 000 dip tanks and
7. The Veterinary Public Health Branch also runs small microbiology labs at their abattoirs and slaughter houses.[4]

Private laboratory infrastructure: private laboratories are accredited by Council of Veterinary Surgeons to carry out approved services and are required to report all notifiable diseases through the CVL for disease confirmation and reporting. Accredited private veterinary laboratories and their areas of specialized diagnostic services include:

1. Zimvet (Pvt) Ltd – Poultry Diseases.
2. Vetco (Pvt) Ltd – Poultry Diseases
3. Lake Harvest (PvT) Ltd – Fish Diseases
4. Agrianalysis Centre (Aglabs) – Pocine diseases and Mastitis.

Academic infrastructure: The University of Zimbabwe Veterinary Faculty is an academic institution with testing and calibration laboratories for teaching and research purposes. The faculty also runs a teaching clinic though a few cases from the public are also attended to.

4.2.1 Existing laboratory functionality to perform surveillance in animals

The Central Veterinary Laboratory (CVL) is the national reference laboratory for laboratory diagnosis of animal diseases as well as carrying out research into animal health and production. It is the national Component Authority for laboratory based disease surveillance and screening for certification of animals and animal products for imports and exports.

Being a government institution, the CVL is wholly funded by the Department of Livestock and Veterinary Services (DLVS). It is through the DVS that development partners like the International Atomic Energy Agency (IAEA), Food Agriculture Organization (FAO) and World Organisation for Animal health (OIE) provide assistance mainly in capacity building (training, equipment and reagent supply). International Research organizations like the Centre de cooperation international enrecherche agronomique pour le développement (CIRAD), the African Union Inter-African Bureau for Animal Resources (AU-IBAR) and some Italian and Germany institutions also assist in funding animal health research. To note that funding from these organizations is not always enough.

In an effort to decentralize and bring routine diagnostic services near to the farmers, 3 provincial labs were put in place to service Matebeleland North (Bulawayo Lab), Masvingo province (Masvingo lab) and Manicaland province (Mutare lab). The commonly tested antimicrobials at the provincial labs and the CVL are tetracycline, penicillin, chloramphenicol, furazolidones, gentamycin, streptomycin, sulphonamides: e.g. trimethoprim, sulphadiazine, sulphathiazole, benzimidazoles: e.g. albendazole, fenbendazole, mebendazole.

Staff shortages are severe in some professional categories placing a strain on the capacity of these laboratories to perform their functions adequately (see table of staffing in Chapter 8 – HR).

4.2.2 Existing laboratory functionality to perform residue testing.

The CVL Toxicology Laboratory, which is located within the Diagnostic & Research branch of the Division of Veterinary Technical Services (Department of Livestock and Veterinary Services, Ministry of Agriculture, Mechanisation and Irrigation Development) was set up in 1986. Its mandate then was the fulfilment of European Union (EU) directives on residue monitoring in live animals and animal products being exported to European countries. Although EU exports of animal products especially beef and ostrich meat stopped more than 10 years ago, there are still fish and crocodile meat exports requiring functions of a national residue-testing laboratory for animals and animal products.

The laboratory monitors the following residues: antibiotics and anthelmintics, heavy metals and steroid hormones. The laboratory also sub-contracts pesticide residue analysis to the Tobacco Research Board (a parastatal organization). In recent years, the country has diversified into the export of fish, ostrich meat, wild animal meat (game) and products such as crocodile meat & hides. This has resulted in numerous requests to the Central Veterinary Laboratory by farmers and other stakeholders of animals and animal products to carry out residue monitoring to facilitate the certification of their products for both the local commercial market and for exports. Coverage for the local commercial market is still very limited. There is therefore a need to include more local commercial players to increase coverage.

The table below shows results of some of the residues tested by the CVL's Toxicology Laboratory in 2014:

Table 7 - Laboratory examinations performed in 2014

Section	Test	Samples tested	Total positive
Toxicology	Antibiotic residue	74	37 (50%)
	Heavy metals	14	4 (29%)
	β lactams	4	4 (100%)
	Anthelminthics	94	94 (100%)
	Phorbol esters	3	3 (100%)
	Aflatoxin	35	7 (20%)

Although the CVL's Toxicology laboratory has now capacity to test some of the residues indicated in the 2014 results report above, there is s need to develop capacity to test most if not all of Zimbabwe's priority list of antibiotics and pesticides.[4]

4.2.3 Gaps and challenges with surveillance across all sectors

The main challenges revolve around funding for capacity to increase provincial laboratories, training of personnel in new diagnostic and research technologies, procurement of new and replacement equipment, animal health research and for carrying out disease field survey to determine disease distribution and risks. Transport for carrying out research and epidemiological surveys is also a very critical gap in Zimbabwe's disease surveillance programs.

4.3 Surveillance for processed food products

Food safety is regulated by two major laws, the Public Health Act (Chapter 15:09) and the Food and Food Standards Act (Chapter 15:04). In addition, milk is governed by the Dairy Act (Chapter 18:08). A number of statutory instruments are in place to strengthen important facets of the major laws. However most of these are outdated. The MOHCC is primarily responsible for Food Safety in Zimbabwe. (Environmental Health Services, Government Analyst laboratory), together with the Ministry of Agriculture (Veterinary Services, Plant Quarantine) and the food industry.[5]

The MOHCC also supervises over meat inspection and hygiene as stated by the Public Health Act, and has delegated this to the Ministry of Agriculture (Veterinary Services). The two Ministries are supposed to integrate and coordinate in provision of this service as stated by the laws. For export purposes international protocols require sampling, testing and certification by the Veterinary Authority for animal-source food safety and animal health sanitary safety. This is done following international standards and the produce export regulations. Meat Inspectors are registered by the Environmental Health Practitioners council and are employed by the MOHCC and Ministry of Agriculture. The two Ministries also share responsibility in the provision of Dairy Inspectors and Analysts.[5]

MOHCC provides Food Inspectors and Analysts who monitor processed food in the country ensuring that consumers eat safe food products. Food samples for domestic consumption collected by Inspectors are analysed at the Government Analysts Laboratory (GAL) against the antimicrobials in the table below. The GAL is the only central government food testing laboratory, which receives samples from all districts and provinces, local authorities, non-governmental organisations, industries and individuals. There are 2 laboratory departments namely the microbiology laboratory and the biochemistry department. The laboratory does have some equipment although some are none functional and the others like the atomic absorption spectrophotometer are out dated. Their funding for reagents comes from the government of Zimbabwe and some donors who may fund particular projects.

Result from food testing shows a number of positive isolates of bacterial pathogens in food products with meat and meat products having the most isolates.

Table 8 - Isolates from food submitted from provinces, local authorities, companies and individuals to the Government Analyst Laboratory (GAL) in 2015

Food Type	Number of Positive Isolates				
	Total samples tested.	*Salmonella* spp	*Shigella* spp	*Staphylococcus aureus*	*Escherichia coli*
Meat and Meat products	25	7(28%)	1(4%)	11(44%)	15(60%)
Milk and Milk products	33	2(6%)	0(0%)	7(21%)	9(27%)
Water	1064	3(0.3%)	0(0%)	0(0%)	32(3%)
Ready to eat food	20	5(25%)	1(5%)	11(55%)	5(25%)
Poultry and poultry product	15	3(20%)	2(13%)	4(27%)	6(40%)
Fish and fish products	7	0(0%)	0(0%)	4(57%)	0(0%)
Cereals (Cooked rice, sadza)	27	0(0%)	0(0%)	8(30%)	3(11%)
Condiments (spice and powdered soups)	33	5(15%)	0(0%)	9(27%)	11(33%)
Swabs	66	5(8%)	1(2%)	11(17%)	15(23%)
Total	1290	30(2%)	6(0.5%)	64(5%)	96(7%)

The other private laboratories that also carry out food testing include the Standards Association of Zimbabwe, the Department of Research a Specialist Services, AgriLab, Kutsaga Research Station and the National Institute of Health Research.[6]

4.4 Surveillance in Water and the environment

The Environmental Management Agency Laboratory is an ISO17025 accredited laboratory which carries out chemical and microbiological tests on portable, raw and waste waters. Chemical tests are also done on soil samples. Currently this laboratory is not carrying out any antibiotic sensitivity tests. It is a national institute built for support and advice on all aspects of environmental quality such as analysis, research, treatment studies, training and environmental information.

It has seven main laboratories: one microbiology lab, two for wet chemistry, one instrumental, two organics and one teaching laboratory. In addition there are five ancillary rooms serving these laboratories on the ground floor. Currently the laboratory is running out of space for sample storage and analysis due to an increase in the number of samples being received by the laboratory.

The laboratory has an Atomic absorption Spectrophotometer which is being used for the analysis of metals in water and soil, ultraviolet visible spectrometer used in the analysis of parameters such as cyanide, chromium hexavalent, phosphates and nitrates. A Gas Chromatograph-Mass Spectrometer (GC-MS) is also available at the laboratory for use in pesticide residue analysis. To venture into antibiotics analysis the laboratory would require an LC-MS or LC-MS-MS. Furthermore if the Environmental Management Agency Laboratory is to do antibiotics analysis, the number of analysts would need to be increased. The laboratory infrastructure may also need to be increased to cater for equipment, reagents and sample storage.

The Environmental Management Agency carries out ambient water monitoring nationwide every month. A total of 341 ambient points are monitored every month. Discharge points for industrial activities have also been established and are constantly monitored.8

There is a need to monitor levels of antimicrobials in the environment and ultimately monitor antimicrobial resistance. This can only be done once a National biosafety reference laboratory with levels BSL 1 -4 is capacitated to test levels of antimicrobials in water, soil and air. The National Biotechnology Authority (NBA) and other regulatory institutions should also develop biosafety policy guidelines dealing with the reduction of antibiotics in livestock and those that reduce the use of manure from animals that have been treated with antibiotics. Currently, the NBA Act of 2006 exists to deal with Biosafety and Biosecurity issues, but there is an urgent need to develop the laboratory capacity issues, guidelines and statutory instruments to operationalize these regulations. Although some procedure manuals are provided in the NBA Act, the observation of these guidelines by the most stakeholders is still in its infancy and a lot of public awareness and education is required. Furthermore, the need to mainstream biosafety and biosecurity threats of antimicrobial resistance as a key national priority becomes urgent.[7]

4.5 Surveillance in crops

Although there is a possibility that AMR pathogens or microbes can be isolated from food crops, water or soil, no work has been done in this area. There are a number of laboratories within Ministries, universities and private sector that can analyse samples for the presence of AMR organisms.

There is need to monitor all the value chains involved in the production of food. The biosafety guidelines need to be developed.

4.6 Gaps and challenges with surveillance across all sectors

The common gaps and challenges across all the sectors are as follows:-

1. There is a shortage of human resources skilled to perform laboratory surveillance and testing as well as training of personnel in new diagnostic tests, surveillance systems, research techniques;
2. There is a shortage of reagents and equipment as well as in space to store these items as well as isolates.
3. Some equipment do not have service contracts, therefore are not well maintained.
4. There is lack of transport for surveillance activities, research and epidemiological surveys and outbreak responses.

4.7 References

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6. MOHCC – Information from the Government Analyst Laboratory.
7. Information from the NBA.

5. ANTIMICROBIAL USE AND ANTIMICROBIAL STEWARDSHIP

Key points of this section:-

- There is no routine data collection for antimicrobial use or antimicrobial consumption.
- Various studies have been conducted to review knowledge of patients and ,healthcare professionals. There seems to be general good understanding of the impact of AMR and its importance in Zimbabwe. However prescribing and dispensing practices are not always following best practice or regulations.
- The survey conducted by MCAZ to monitor the usage patterns of antimicrobials in food producing animals indicated that oxytetracycline was the most used antimicrobial in ruminants.
- There is no information on the volume of antimicrobials used in stock feeds although these are regulated by law
- The majority of hospitals, (80%) are not implementing antimicrobial stewardship programs (ASP) and only half still have functioning Hospital Medicines Therapeutics Committees.
- Despite having access to a bacteriology laboratory, in 9 out of 10 hospitals, no antibiograms were produced.
- Pesticides are used for plant production but not antimicrobials.

5.1 Antimicrobial use and consumption in humans

In Zimbabwe, there is currently no data that is routinely collected for consumption of antimicrobials in both the human and animal health sectors. The World Health Organization has recently developed a tool that Zimbabwe can use to measure consumption.

In the year 2014 the country incurred the following costs in acquisition of medicines (See Table 8 below).

Table 8 - Total costs of medicines procured for Zimbabwe from the different sectors in 2014

Sector	US$ in millions	% Contribution
Imported medicines	123.6	50%
Donated medicines	96.8	40%
Medicines produced by local industry	24.1	10%
Total	244.5	100%

The country has a total of 9 manufacturing companies with only 1 producing veterinary medicines.

5.2 Knowledge, attitudes and practices (KAP) in relation to antimicrobial use (AMU) in humans

Understanding the "knowledge, attitudes and practices" (KAP) of health personnel and the general public about antibiotic use provides the basis for understanding AM use and AMR. A National Medicines Survey was conducted in 2015 of the public sectors medicine use. An online KAP survey was done for medical doctors, pharmacy personnel, veterinary doctors and laboratory personnel as part of this situation analysis in 2016/2017. And a point prevalence survey (PPS) of prescribing practices of doctors in hospitals in 9 provinces of Zimbabwe was also carried out.

5.2.1 National Medicines Survey Results

The National Medicines Survey (NMS) in 2015 collected data on prescribing habits that might have an effect on antimicrobial use within health facilities. The table below highlights some of the results from the surveys conducted in the public sector and show fluctuating levels of knowledge of patients over time and varying levels of compliance with appropriate treatment guidelines specifically acute respiratory infections. Patients seem to be increasing their knowledge about appropriate treatment especially for diarrhoea (See Table 9 below).

Table 9 - Findings of the National Medicines Survey on Prescription habits

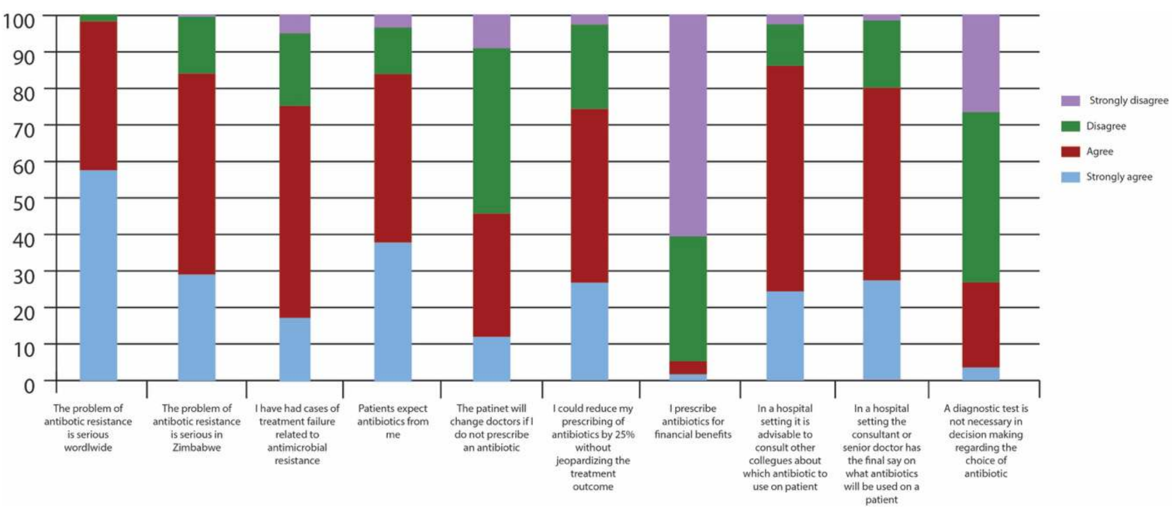
Indicator	Year		
	2011	2013	2015
Average number of medicines per prescription	2	2	2.1
Percentage of patients being prescribed antibiotics	33.8%	69%	35.47%
Percentage of patients being prescribed injections	5.1%	9.1%	6.9%
Percentage overall patient knowledge of correct medicine use	88.0%	79.3%	82%
Appropriate treatment of diarrhoea without blood in children under 5 years	27.0%	23%	45%
Appropriate treatment of Mild Acute Respiratory Infection (ARI) in children under 5 years	48.9%	22%	33%
Discrepancy between prescribed and dispensed medicines (Median value)	11.1%	9.5%	0%

5.2.2 Knowledge, attitudes and practices

Doctors

The majority of doctors, 57% strongly agreed the problem of antimicrobial resistance was serious worldwide and 53% agreed that the consultant or senior doctor has the final say on what antimicrobials will be used on a patient (See Figure 9).

Figure 9 - Knowledge, attitudes and beliefs of Medical Doctors



Most clinicians, (75%) felt that patients expected an antibiotic from them and would change doctors if they did not prescribe one (58%). Despite this > 70% felt they could reduce their prescribing of antibiotics without jeopardising treatment outcomes. About 69% reported prescribing more than one antibiotic at the same time although they did not do this for financial gain. Antibiotics were also prescribed empirically by the majority of clinicians (93%) mostly for obvious clinical diagnosis (54%). There was 1 (0.6%) doctor who empirically prescribed antibiotics for flu symptoms whilst 26 (15%) empirically prescribed for fever symptoms. The most commonly prescribed antibiotics in outpatient departments are amoxicillin and ciprofloxacin; in hospital settings ceftriaxone and penicillin; and in private settings cefuroxime and azithromycin. The majority of clinicians 161 (88%) knew that irrational use of antimicrobials would lead to resistance and 178 (97%) believed in the effectiveness of generic medications.

Pharmacists

Most pharmacists, 87% reported that they always dispensed antibiotics based on a doctor's prescription although 54% reported dispensing antibiotics on the prescription of the pharmacists which is not in line with regulations (See Table 10 below). Twenty pharmacists (10%) prescribed and dispensed injectable antibiotic. Fifty-two (26%) pharmacists said their prescribing was influenced by a patient's insistence or circumstance. Antibiotics were mostly recommended in cases of urinary discomfort with 54 (42%) having dispensed antibiotics for animal use, some without a prescription. According to the pharmacists, amoxicillin, cloxicillin and cotrimoxazole were the most commonly dispensed antibiotics without a prescription.

Table 10 - Dispensing of antibiotics by pharmacists

Dispensing of antibiotics in your pharmacy could be based on				
	Always	Sometimes	Never	N
Prescription of clinician	86.89%	13.11%	0.00%	206
Prescription of pharmacist	1.58%	44.21%	54.21%	190
Prescription of pharmacist's assistant	0.00%	4.23%	95.77%	189
Self-medication	0.00%	22.11%	77.89%	190

Nurses

As with the pharmacists and doctors, nurses were aware of the problem of AMR and knew that antibiotics were not the most appropriate treatment for mild disease or fever although 37% believed that antibiotics make a patient recover faster when they have a flu. Out of the 215 nurses that participated 22% prescribe antibiotics at their place of work to patients whilst 34% sometimes prescribed antibiotics to friends and relatives. More than 60% felt that doctors should not be the only people prescribing antibiotics to patients. The majority (77%) experienced shortages of antibiotics at their place of work. (See Table 11 below).

Table 11- Perceptions of nurses on AMR

	Question	Strongly agree	Agree	Disagree	Strongly disagree
1	The problem of antibiotic resistance is serious worldwide.	31%	54%	15%	1%
2	The problem of antibiotic resistance is serious in Zimbabwe.	20%	61%	18%	1%
3	I have seen cases of treatment failure related to antibiotic resistance	16%	67%	15%	2%
4	When I am not well I expect my Dr to prescribe an antibiotic.	13%	25%	53%	9%
5	Antibiotics are not necessary for a mild disease or fever.	19%	47%	23%	12%
6	Left over antibiotics should not be reused at a later date.	58%	28%	9%	6%
7	Doctors should be the only people that prescribe antibiotics to patients.	11%	19%	50%	21%
8	Antibiotics should only be purchased as over the counter drugs from pharmacy/chemists or obtained from the hospital only	40%	21%	17%	22%

General public
This was carried out in all the 10 Provinces of the country. There were 571 members of the public who participated in this survey the majority being 25-34 year olds 177 (32%) 46% were males and 54% were females. Table 12 below is their indication on knowledge, attitudes and beliefs concerning antibiotics.

Table 12 - Knowledge, attitudes and beliefs of the general public

QUESTION	YES	NO	DO NOT KNOW
Paracetamol is an antibiotic	111 (20%)	420 (74%)	35(6%)
Amoxicillin is an antibiotic	499 (89%)	38 (7%)	21 (4%)
Antibiotics can cure viral infections	277 (50%)	231 (41%)	52 (9.3%)
Antibiotics are used to reduce pain and swelling	252 (45%)	259 (47%)	45 (8%)

Practices
Two hundred and sixty-one (46%) took antibiotics when they had a cold and 248 (45%) would stop taking antibiotics when they start feeling better. When they visited a doctor almost half 49% would expect to be given an antibiotic. Two hundred and twenty-two (40%) kept leftover antibiotics as they might be useful in the future whilst 38% shared antibiotics with other people.

Table 13 below indicates that a pharmacy is where people obtained their antibiotic from whilst a few would buy from unregistered sites such as hair salons and the market place.

Table 13 - Antibiotic purchase sites

Site	Often	Sometimes	Never	Total
Hospital	56%	34%	10%	454
Clinic	34%	48%	18%	362
Pharmacy	60%	33%	7%	427
Doctor's rooms	20%	31%	49%	357
Market Place	3%	9%	88%	335
Hair Salon	6%	19%	75	359

Chickens were the most animals that were kept as out of the 470 people that answered this question 299 (58%) kept chickens. Out of those that kept animals, chickens were the most exposed to antibiotic see Table 14

Table 14 - Giving of antibiotics to animals

Species	Yes often	Yes seldom	No
Chickens	104 (24%)	64 (15%)	259 (61%)
Cows	68 (22%)	14 (14%)	197 (87%)
Dogs	65 (22%)	33 (11$)	204 (68%)
Pigs	13 (6%)	15 (7%)	197 (87%)
Sheep/Goats	39 (14%)	15 (5%)	222 (80%)

Out of the animals that were kept cows were the most vaccinated see Table 15 below.

Table 15 - Rate of vaccination of animals

Species	Yes often	Yes seldom	No
Cows	133 (46%)	33 (11%)	124 (43%)
Dogs	137 (45%)	42 (14%)	128 (43%)
Chickens	128 (33%)	46 (12%)	216(55%)

Sheep/Goats	66 (27%)	26 (10%)	157 (63%)
Pigs	30 (15%)	21 (10%)	151 (75%)

There was a total of 136 (29%) who used antibiotics for prevention of disease whilst 46 (14%) used them as growth promoters on their animals.

Concerning awareness issues of AMR, the majority indicated that the most effective method would be through television, followed by a poster at a clinic, then being given pamphlets respectively. Newspapers would be the least effective.

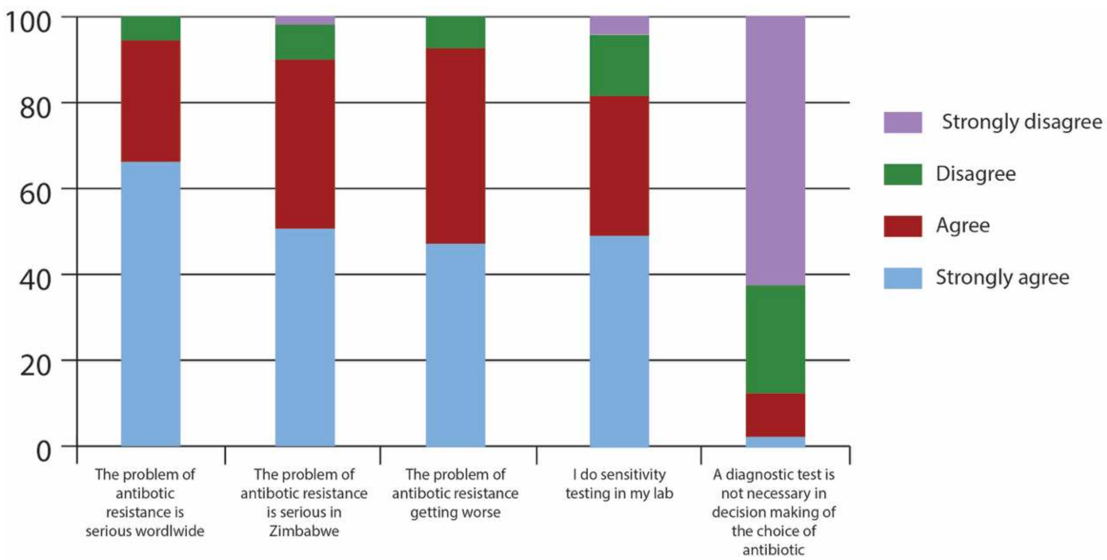
Laboratory personnel

The questionnaire was sent to 340 laboratory personnel and 52 (15%) responded, of whom one did not consent. The majority of respondents 24 (47%) were 25 to 34 years old, 35 (69%) were males, most had studied at the University of Zimbabwe, and 31 (61%) had been working for <10 years.

Forty-one (84%) had a bacteriology laboratory and 8 (16%) did not, mainly because of a lack of equipment, shortage of staff, or too small a space. For 3 respondents, bacteriology was not the core business. Forty laboratories (82%) were able to culture specimens. The quality assurance programs that were being subscribed to were the Zimbabwe National Quality Assurance Program (ZINQAP) and the National Health Laboratory Service (NHLS) from SA.

Figure 10, summarizes the laboratory personnel responses to some key questions in the survey.

Figure 10 Knowledge, attitudes and beliefs of laboratory personnel



9.5.2 Practices

The majority 20 (44%) processed >30 bacteriology samples per week. Of the respondents, 27 (57%) reported that they received urine samples "very frequently", more than any other type of sample (See Table 16 below). Overall, labs processed more urine, feces, sputum, and pus samples compared to CSF or blood. The most commonly isolated organism in urine samples was reported to be Escherichia coli.

Table 16 - xxxx

Table 16 -Point out in this table the frequency per week that you receive these samples.						
Answer Options	Never	Rarely	Frequently	Very frequently		Response Count
Blood culture	10	16	13	6	0	45

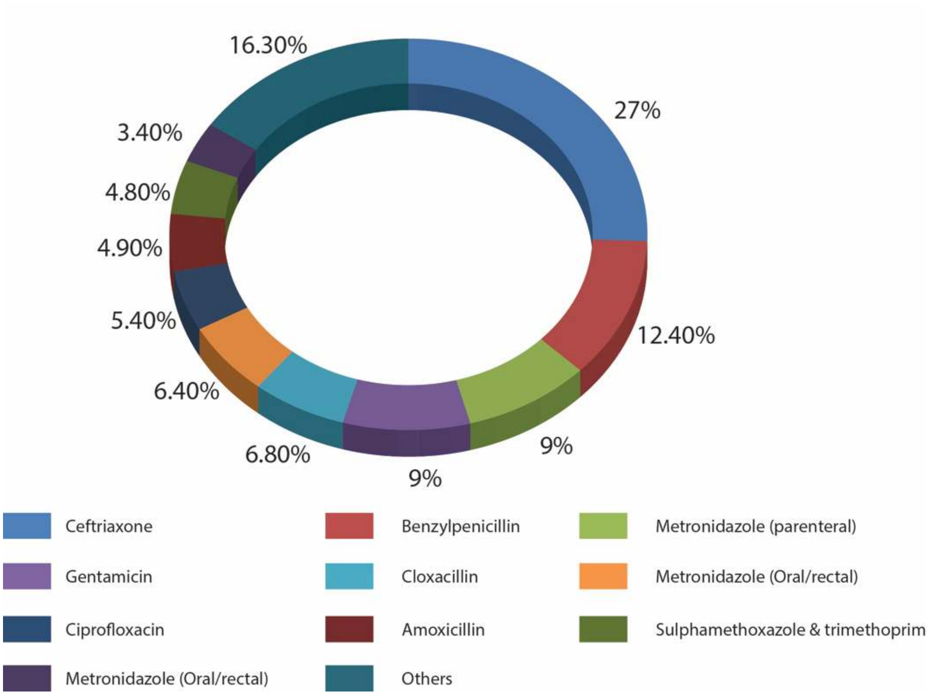
Urine	4	3	13	27	0	47
faeces/rectal swabs	5	5	22	15	0	47
Urethral and cervical swabs	9	13	16	10	0	47
Sputum	7	5	12	22	0	46
Pus swabs (wounds/burns)	5	7	19	16	0	47
CSF	5	19	17	6	0	47

Respondents reported that the most commonly isolated bacteria from chicken meat, pigs or cattle, milk and milk products was also *E. coli*, whilst from fish it was Aeromonas spp and from eggs it was *Salmonella spp*. Blood agar base was the most common media used for culture of samples. The most used sensitivity disc for Gram-positive organisms was penicillin (26; 87%), for Gram-negatives organisms, it was chloramphenicol and tetracycline (27; 87%). The majority of respondents (24; 69%) did not test for MRSA. Most (23; 74%) used the Kirby Bauer disk diffusion method for susceptibility testing and the CLSI guidelines were used by 19 (86%).

Point prevalence survey

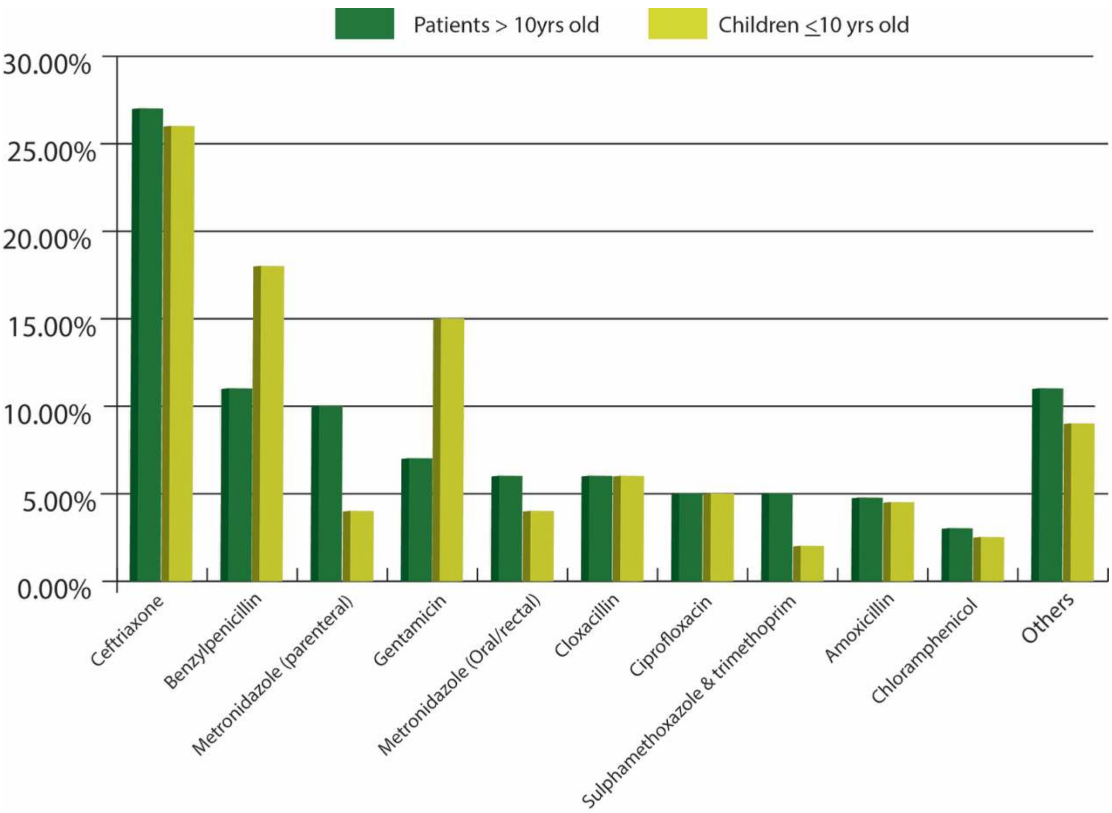
A point prevalence survey was conducted from December 2016 to January 2017 with 18 health institutions, including 5 central hospitals, 7 provincial hospitals, 2 district hospitals, 2 infectious disease hospitals, and 2 private hospitals. In-patient medical records were collected for all patients that had been admitted into a ward before 7 am on the day of the survey and had received an antibiotic prescription. Patients that did not stay overnight, outpatients, psychiatric patients, patients that received an antibiotic after 1 pm on the day of the survey, and discharged patients awaiting transport were not included. In total, 810 records were included in the analysis and 1523 antibiotics were prescribed. Those that received 1 antibiotic were 315(39%), 2 different antibiotics 313(38%), 3 antibiotics 151(18%), 4 antibiotics 24(3%) and 5 different antibiotics were 6(1%). The top 10 most commonly prescribed antibiotics were ceftriaxone 406(27%), benzylpenicillin 189(12.4%), metronidazole (parenteral) 140(9%), gentamicin 139(9%), cloxacillin 103(6.8%), metronidazole (oral/rectal) 98(6.4%), ciprofloxacin 74(4.9%), sulphamethoxazole and trimethoprim 73(4.8%) and chloramphenicol 52(3.4%) are shown in Figure 11 below with ceftriaxone being the commonest.

Figure 11 - The top 10 most prescribed antibiotics



Ceftriaxone remained the most commonly prescribed antibiotic for both pediatrics (26.18%) and adults (26.76%) (See Figure 12).

Figure 12 - The 10 most prescribed antibiotics for patients >10 years old and children less than or equal to 10 years



Concerning the Central hospitals and the private hospitals the 2 most prescribed antibiotics were similar namely ceftriaxone and metronidazole (See figures 13 and 14 below). The supply chain of medicines for Central hospitals is that, these purchase their own antibiotics whilst the lower levels such as district hospitals are supplied from the government stores which is NatPharm.

The results also differed between types of hospitals i.e. whether they were infectious disease hospitals, provincial, district, etc.

Figure 13 - Top 10 most prescribed antibiotics in the private sector

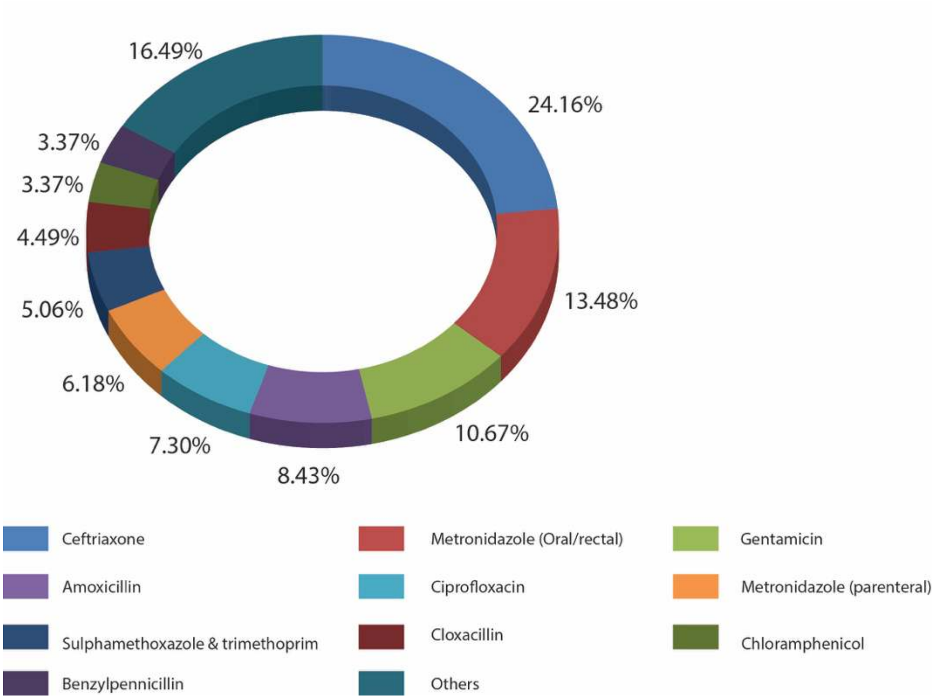
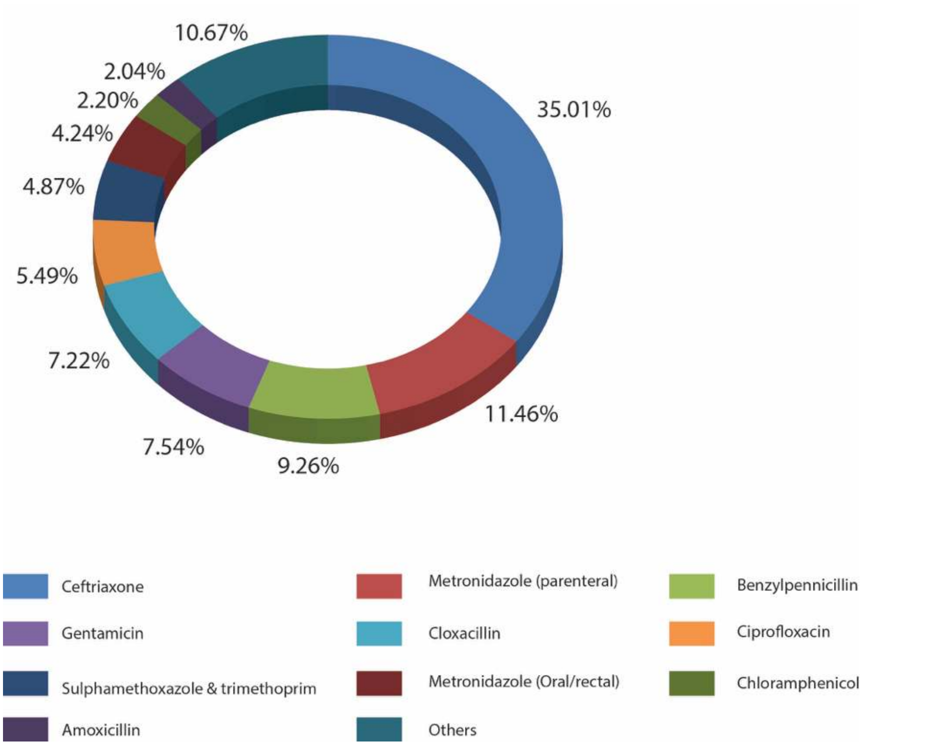


Figure 14 - The 10 most prescribed antibiotics in Central Hospitals



Concerning provincial hospitals, the pattern is almost similar to that of Private and Central hospitals. The scenario is different for District and infectious disease hospitals whereby the most common prescribed antibiotics are benzylpennicillin and gentamicin (See Figures 15 and 16 below).

Figure 15 - The top 10 most prescribed antibiotic in an infectious disease hospital

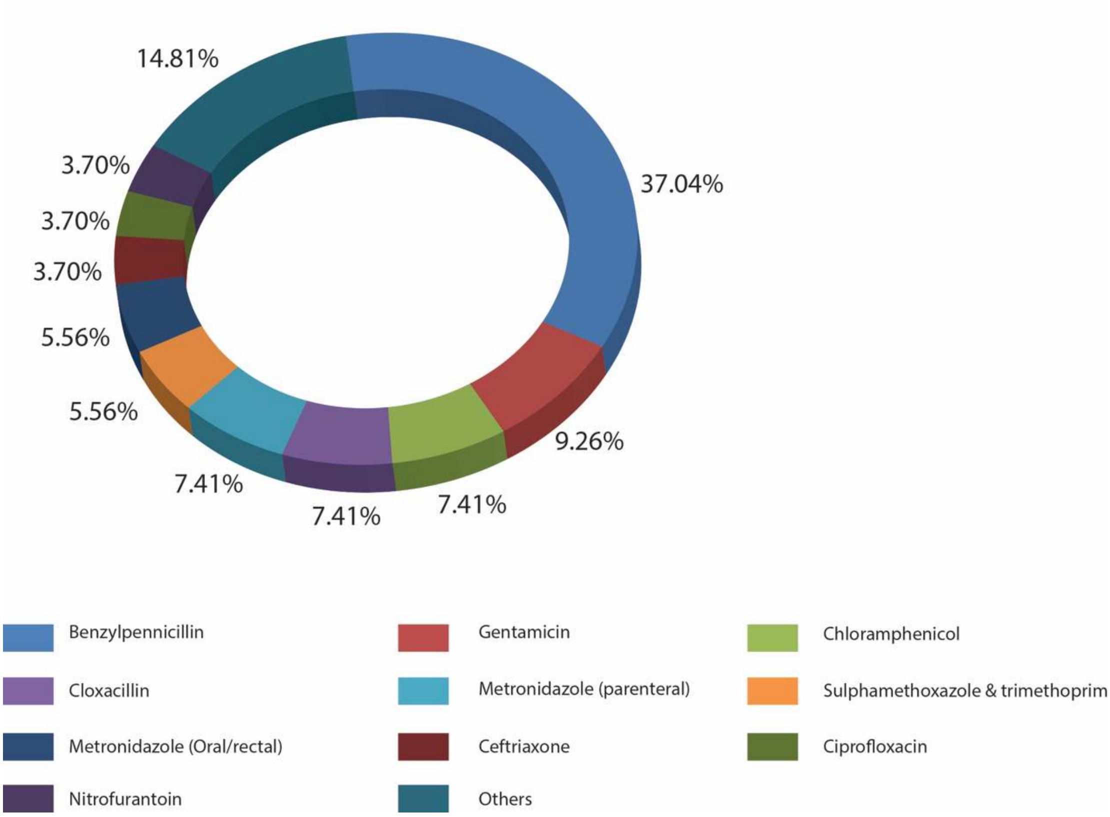
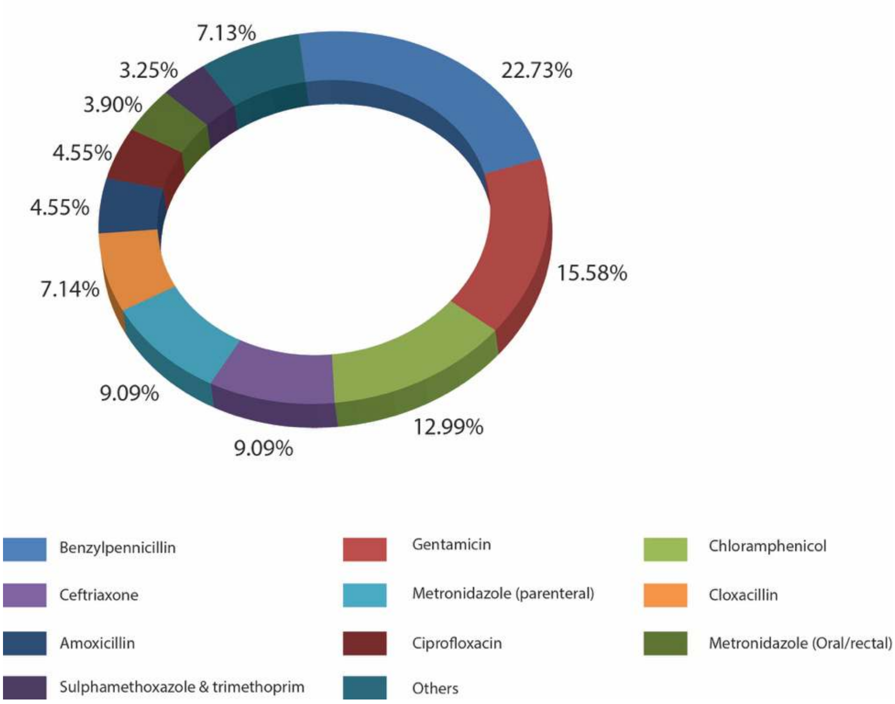


Figure 16 - The top 10 most prescribed antibiotic in the District hospitals



Ceftriaxone was mainly being used in the medical wards, whether adult medical wards (36%) or paediatric medical wards (8%). The number of patients that were given prophylaxis which lasted >24hrs were mostly from the medical ward followed by the surgical ward. Ceftriaxone was also being used for indications of all diseases (see Table 17, below) although predominantly for infections of the central nervous system (63.46%).

Table 17 - Prescribed ceftriaxone for the top 10 indications

Diagnosis	Total patients	Total prescribed ceftriaxone	% prescribed ceftriaxone
Gastrointestinal infections	109	40	36.69%
Prophylaxis	109	46	42.2%
Soft tissue infections	103	24	23.3%
Pneumonia	84	33	39.29%
Obstetric and gynecological infections	82	36	43.9%
Central nervous system	52	33	63.46%
Bone and joint infections	37	10	27.03
Undefined sites with no systemic inflammation	35	19	54.29%
Febrile neutropenia	31	11	35.48%
Systemic inflammatory response syndrome with no clear anatomical site of infection.	20	10	50%
Ear nose and throat infections	18	10	55.56%

Hospital acquired infections were considered as those infections that a patient would acquire after 3 days of being admitted. There were 125 (15%) of patients that had HAIs according to the set criteria. There were 306 patients that had some form of catheter, the most common being a peripheral catheter only 166 (54%) and 66 (22%) had urinary catheters only and the rest had other types of catheters or upto 4 different catheters on 1 patient. There were 32(10%) of these catheterized patients that had developed HAIs.

Out of the 810 records analyzed, there were only 91(11%) of samples that had been taken for culture and sensitivity. Concerning the known results 10(11%) had no growth and the most common isolated bacteria was Staphylococcus spp 10(11%), and the rest 19(21%) had growth of other different types of bacteria.

5.3 Stewardship activities in health care facilities

Hospital Medicines Therapeutic Committees (HMTC) had been established in hospitals in Zimbabwe. The main goal being to ensure high-quality medicine therapy for hospital patients, and the reduction in medicines costs by providing advice on all aspects of drug management including :-

1. Developing drug policies.
2. Evaluating and selecting drugs for the formulary list.
3. Developing (or adapting) and implementing standard treatment guidelines.
4. Assessing drug use to identify problems.
5. Conducting interventions to improve drug use.
6. Managing adverse drug reactions and medication errors.
7. Informing all staff members about drug use issues, policies and decisions.

Due to the economic situation of 2010 that led to the breakdown of health services and loss of health care workforce only a few HMTC's are still functional. According to a mini survey questionnaire that was done when the point-prevalence survey was being carried out only 5 (out of 10) had functional HMTC's with only 2 hospitals having an Antibiotic Stewardship Program (ASP), as shown in table 18.

The majority of physicians, who are the main prescribers, were not involved in an ASP, leaving mainly pharmacists responsible for ensuring appropriate antimicrobial use at a facility. Sixty per cent of hospitals have access to a microbiologist but 9(90%) did not produce an antibiogram. Only 1 hospital did reviews to check the appropriateness of antimicrobial being used and only 2 hospitals conducted audits. A positive finding is that 100% of facilities had a functioning infection prevention and control committee.

Table 18 - Antimicrobial stewardship questionnaire results

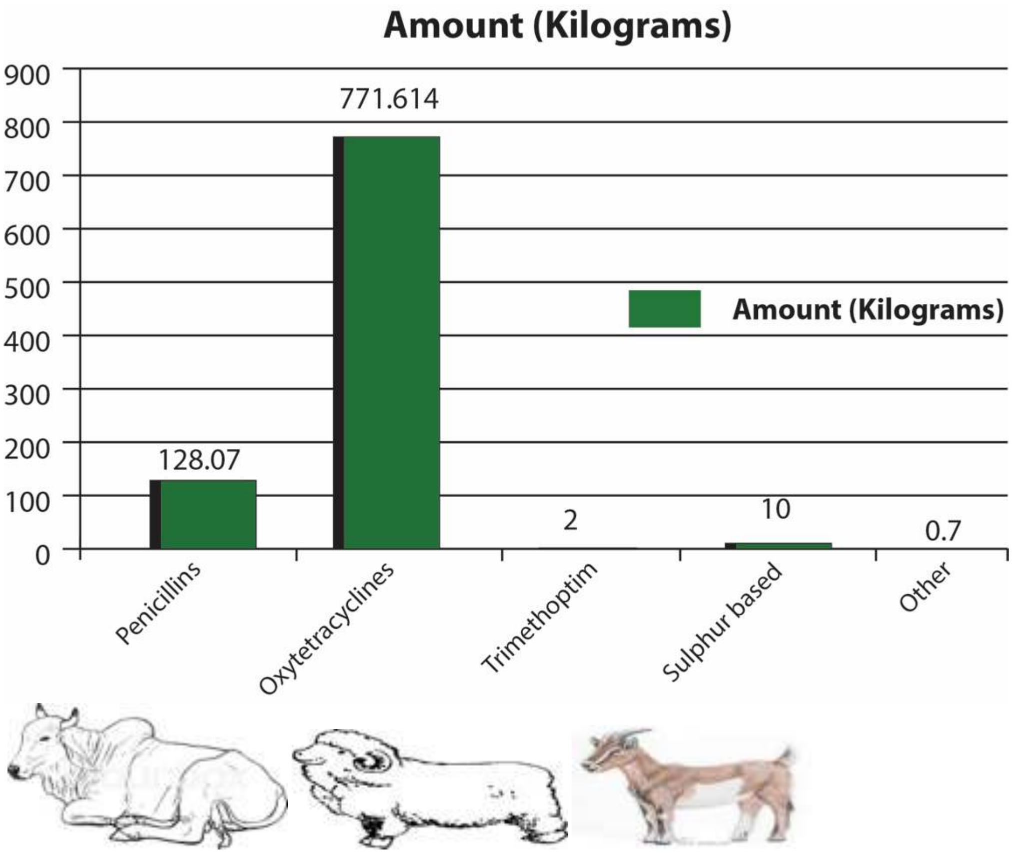
	Question	Yes	No
1	Does your hospital have a functioning antimicrobial stewardship program (ASP) accountable to ensuring appropriate antimicrobial use?	2(20%)	8(80%)
2	Does your facility have a formal organizational structure responsible for antimicrobial stewardship (*e.g*, a multidisciplinary committee focused on appropriate antimicrobial use, pharmacy committee, patient safety committee, or other relevant structure)?	5(50%)	5(50%)
3	Is there a physician identified as a leader for antimicrobial stewardship activities at your facility?	1(10%)	9(90%)
4	Is there a pharmacist responsible for ensuring appropriate antimicrobial use at your facility?	5(50%)	5(50%)
5	Is there a microbiologist accessible to your facility?	6(60%)	4(40%)
6	Does your facility provide any salary support for dedicated time for antimicrobial stewardship activities (eg, percentage of full-time equivalent [FTE] staff for ensuring appropriate antimicrobial use)?	0(0%)	10(100%)
7	Is there a functioning infection prevention control committee in the hospital?	10(100%)	0(0%)
8	Is there a formal procedure for a physician or pharmacist to review the appropriateness of the antimicrobial prescribed within 48hrs (post-authorization).	1(10%)	9(90%)
9	Has your facility produced a cumulative antimicrobial susceptibility report in the past year (antibiogram)?	1(10%)	9(90%)
10	Does your facility audit or review surgical antimicrobial prophylaxis choice and duration?	2(20%)	8(80%)

7.1 Antimicrobial use and consumption in Animals

In the livestock production sectors the usage of antimicrobials remains a challenge to accurately quantify, and large data gaps persist in documenting patterns of antimicrobial use in food producing animals. In accordance with Terrestrial Animal Health Code (TAHC), Chapter 6.8 which requires OIE member states to monitor the quantities and usage patterns of antimicrobial agents used in food-producing animals, MCAZ conducted a survey to monitor the usage patterns of antimicrobials in food producing animals and fish farming during the years 2011 and 2012. The data on antimicrobial use was obtained from the beef, dairy, poultry, pig and fisheries producers associations and farmers. Although there was significant resistance from some farmers and meat producers to share antimicrobial usage information with their medicines regulator, the survey was able to provide significant information in relation to antibiotic use in the country.

The survey revealed that oxytetracyclines, penicillins, trimethoprim and sulphur based antibiotics were the most widely used across all animal species, as shown in Figure 17 below.[2]

Figure 17 - Antibiotic usage patterns 2011 - 2012 (ruminants)



The increased use of certain animal antibiotics in Zimbabwe is due to less restrictive measures that have been put in place by the responsible authorities in assisting farmers to access medicines in emergency disease outbreaks. Most antibiotics for use in animals are available through prescription from a veterinary surgeon. An example would be the use of injectable oxytetracycline in treatment of heartwater.3Heartwater (also known as cowdriosis) is an acute, fatal, non-contagious, infectious, tick-borne rickettsial disease of ruminants caused by Ehrlichia ruminantium (formerly Cowdria ruminantium) and transmitted by Amblyomma sp. ticks (TAHC, Chapter 2.1.6).

Coccidiostats are part of the antibiotics that are used in Zimbabwe in poultry production for the treatment of coccidiosis. Zinc bacitracin, oxytetracycline and salinomycin are some of the antibiotics that are brought for registration and are handled by the MCAZ. The target animals for these antibiotics is not known. Tylosin is targeted on swine while Rumensin and Monensin are used for cattle production.4

7.2 Antimicrobial Use in stock feeds in Zimbabwe

Animal feed is a critical component of the food chain that has a direct impact on animal health and welfare and also on food safety and public health. Stock feeds are derived from the mixing of grains and other additives, and these are fed to animals to enable efficient production of milk, meat or eggs.

In Zimbabwe, the Fertilizers, Farm feeds and Remedies Act Chapter 18:12, regulates the manufacture and sale of stock feeds and it focuses on the nutritional composition of the feeds. In regard to the use of antibiotics in poultry, domestic animals, livestock or plants, for the prevention, treatment or cure of any disease, or for the maintenance of health, the mandate is with Medicine Control Authority of Zimbabwe. There is no information on the volumes of antimicrobials that are used in animal feeds and whether they are used at therapeutic or sub-therapeutic levels. The other gap is on the stage at which the antimicrobials are entering the stockfeed chain and whether withdrawal periods are being observed. There is need to track antimicrobial resistant bacteria in food animals, retail meats and humans.4

There are a number of antimicrobial growth promoters (AGPs) such as bacitracin, colistin and, virginiamycin, which are used in poultry; and avilamycin, flavomycin and zinc bacitracin, which are used in pig production. The use of antimicrobials specifically as growth promoters is minimal in poultry feeds used at all levels of production in Zimbabwe. However, coccidiostats such as monensin are still incorporated in the feed manufacturing process for poultry.

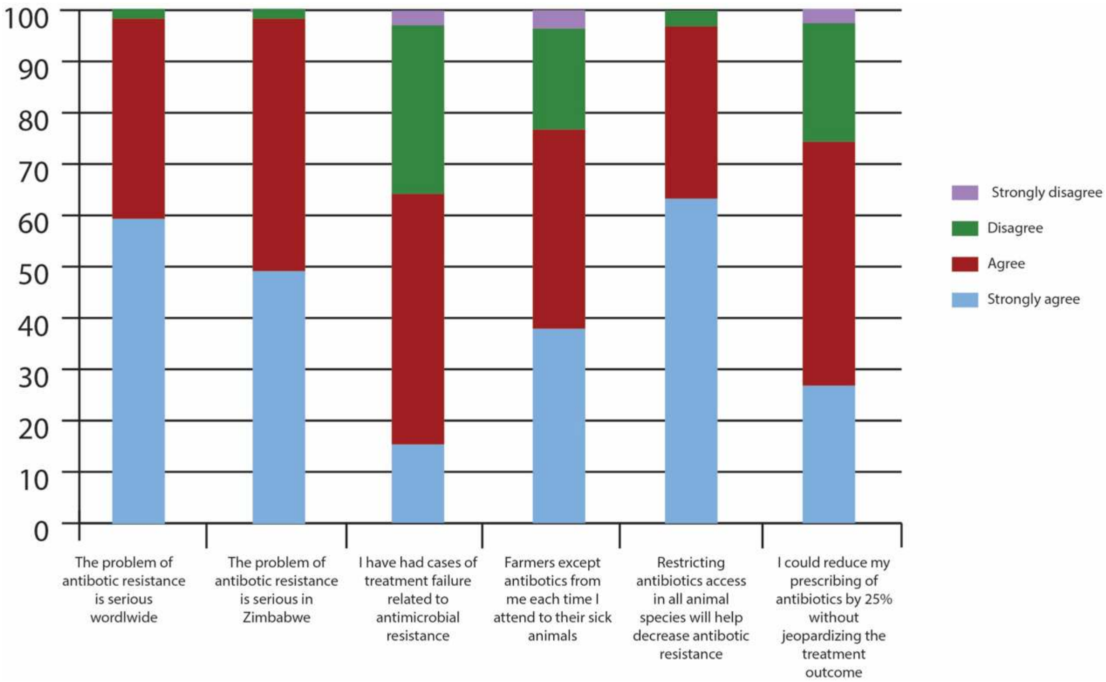
Veterinarians

7.3 Knowledge, attitudes and practices in relation to antimicrobial use

The online KAP survey which was done for health care professionals was also conducted for veterinarians as part of this situation analysis in 2016/2017.

Most respondents acknowledged the problem of AMR both globally and in Zimbabwe Most felt that restricting antibiotics access in animals with reduce AMR and felt they would be able to reduce their antibiotics prescribing by 25% without jeopardising the treatment outcomes of the animals despite farmers putting pressure on them to prescribe. (as shown in figure below).

Figure 18 - Knowledge, attitudes and beliefs of veterinary doctors



The majority of respondents (77%) did not regularly send specimens for culture and sensitivity testing. More than one antibiotic was not usually prescribed for an animal, except in cases of mixed infections or in cases of gastrointestinal or oral diseases. The most common antibiotics prescribed were oxytetracycline and penicillin. The most common route of administration was injectable.

7.4 Antimicrobial Use in plants in Zimbabwe

Zimbabwe's economy is agro-based and hence the country depends on sustainable agricultural production for its Gross Domestic Product and also for food security. There is therefore need to have high agricultural production but pests always affect this. Failure to control these pests would result in economic loses in crops at and this brings about the need to use chemical pesticides. 4 The chemicals mainly used for the control of bacterial and fungal diseases are Copper oxychloride, Sulphur, Mancozeb, Bravo, ridomill and Milraz. However bacterial diseases in crops are difficult to control and cultural methods are employed to control such as crop rotation, use of clean seed and use of resistant varieties.

Table 19 - Number of fungicides and bacteriocides used in crop production from 1992 - 2014 (FAOSTATS, 2017)

Year	1992	1993	1994	1995	1996	1997	1998	2012	2013	2014
Tonnes of active ingredients	393	1097	227	736	739	847	889	1273	776	359

7.5 References

1. MOHCC – Department of pharmacy services.
2. MCAZ – survey on antimicrobial usage in food producing animals. 2011-2012.
3. OIE - Veterinary Legislation Identification Mission report, 2015.
4. Information from the Department of Research and Specialist Services, MAMID.
5. FAOSTAT - Food and Agriculture Statistics

6. Prevention of AMR

Key points of this section:-

- There has been significant progress made by the MOHCC in improving infection prevention control in health institutions.
- Human vaccinations against preventable infectious diseases are being implemented for children in the first year of life and the coverage is at 89%.
- Commercial livestock farmers give medicated feeds to livestock for the purposes of disease prevention.
- There is no data available concerning vaccination coverages in animals.

6.1 Human National Infection Prevention and Control Programme

6.1.1 Governance of IPC

The Infection Prevention and Control (IPC) programme in Zimbabwe is based in the Nursing Directorate of the MOHCC. Stakeholders in the national IPC programme are represented in the National IPC Committee. All Central (6) and Provincial (8) Hospitals have an IPC focal person and most have a functioning IPC committee (12/14). In July 2016, eight of the ten provinces, appointed an IPC Coordinator who is responsible for monitoring and supporting IPC programmes at health facilities within each province. Zimbabwe introduced posts for IPC officers and encouraged health facilities to establish infection control committees in the 1990's.

The Infection Control Association of Zimbabwe was founded in 1993 to support IPC professionals and programmes. Economic challenges over the past few years led to an inadequately staffed and under funded health service. This led to overcrowded facilities with the ad hoc conversion of structures to clinics and waiting areas that were unsuitable for the purpose. Erratic power and inadequate water supplies added to the problem of lack of provision of a safe health care environment for patients and health workers.

In 2010 findings of a TB risk assessment in 30 Health Facilities in Zimbabwe2 showed that although the facilities had an IPC focal person in place, training was inadequate and IPC committees were not functioning.[1]

6.1.2 IPC assessment findings and IPC policy and program

In 2011 the Zimbabwe Infection Prevention and Control Project (ZIPCOP) funded through CDC-PEPFAR was established to support the MOHCC to reduce these gaps and establish a National IPC programme and strengthen IPC practices. The focus of the five year project has been to develop an IPC Policy and IPC Guidelines, develop an IPC Training Programme and strengthen IPC activities in 120 health facilities (Box 1).

Box 1: Key ZIPCOP Outputs (2012-2015)

National IPC Guidelines (2013) and National IPC Policy, strategic plan, and M&E plan and tools (2015) distributed

A National MOHCC In-service training program developed and delivered for IPC Trainers; training in Basic IPC (including TB-IC) for health care workers and Health Managers and trainers of Village Health Workers

A Core MOHCC certified Team of IPC trainers in each Province

IPC Curriculum strengthening in pre-service training programs for Nurses, Medical and Dental students, environmental health officers

Standardized PEP Workplace register to record blood and body fluid exposures, HIV and Hepatitis B screening and monitoring HIV PEP use

A National Infection Control Association with increased outreach and capacity for training participating in IPC Training programs in Africa *e.g.* Sierra Leone, Kenya

The IPC Policy which includes a strategic plan and monitoring and evaluation (M&E) tools has been "rolled out" to the senior management teams (provincial health teams) of each province, the City Health Directorate in the two major cities and senior management in the 6 Central Referral Hospitals with discussions on local strategies to strengthen IPC programmes particularly management support.

The policy includes a requirement "to collaborate with appropriate committees to monitor antibiotic use" and surveillance of AMR as well as Health Care Associated Infections (HAIs). Indicators for the National IPC monitoring framework include "the number of health facilities with standardised antimicrobial susceptibility testing to promote rational use of anitbiotics and an AMR surveillance system in place".

6.1.3 Human resources and training

The training programmes and site support visits implemented by ZIPCOP and MOHCC IPC trainers to 120 targeted sites have increased IPC program implementation and improved IPC practices. Monitoring and evaluation tools (M&E) included facility-based risk assessment and site support IPC program assessment tools (baseline and SSV tool), to monitor and support changes. The scoring system incorporated into the baseline and SSV tool allows IPC programmes to be graded into 4 levels ranging from poor to very good. The SSV tool measures progress in the development of the IPC programmes and provides suggestions to managers for corrective action that in subsequent visits resulted in improved grades. In addition indicators including a functional IPC committee, TB among health workers, have been integrated into the National Health Information System reporting framework to inform policy.

The team of National Trainers (3-6 per province) have been trained using a "Train the trainer curriculum" derived from the University of Stellenbosch Unit for Infection Control. The training curriculum includes essential components of IPC training such as standard and transmission based precautions, laundry and waste management but also includes a component of microbiology, antimicrobial resistance and HAI surveillance. This group of National IPC Trainers (approximately 70) receive annual "refresher training" which in 2016 included training in point prevalence surveys for the MOHCC antimicrobial resistance programme. They will be an invaluable group in the strategy to control AMR in the country.

6.1.4 Challenges and areas of implementation actions

The ZIPCOP Mid-term Evaluation Report 3 identified a number of challenges to the implementation of IPC including lack of material and financial resources, negative attitudes from staff, and demands placed on IPC staff by competing programmes. However they also identified significant progress by the MOHCC in improving IPC in health facilities in Zimbabwe and there is considerable support at all levels of the MOHCC for continuing implementation of the National IPC programme

6.2 Vaccination programs in Humans

The Expanded Programme of Immunisation (EPI) was introduced in Zimbabwe in 1982 with support from the World Health Organisation (WHO). The primary objective was to vaccinate all children below the age of one year against six preventable diseases: polio, diphtheria, tuberculosis, pertussis (whooping cough), measles and tetanus. Basic vaccinations for babies are done during the first year of life according to WHO guidelines. Immunizations programs are the pillar for child survival and improvement of child health. Vaccinations are done for free and each mother is given a child health card which is recorded whenever the baby receives the compulsory vaccines at the appropriate intervals (see Table 20 below).
There have been new vaccines against other severe vaccine-preventable diseases that have been developed and introduced such as the pneumococcal vaccine introduced in 2012, human papilloma virus (HPV) and the rotavirus vaccines which were both introduced in May 2014.

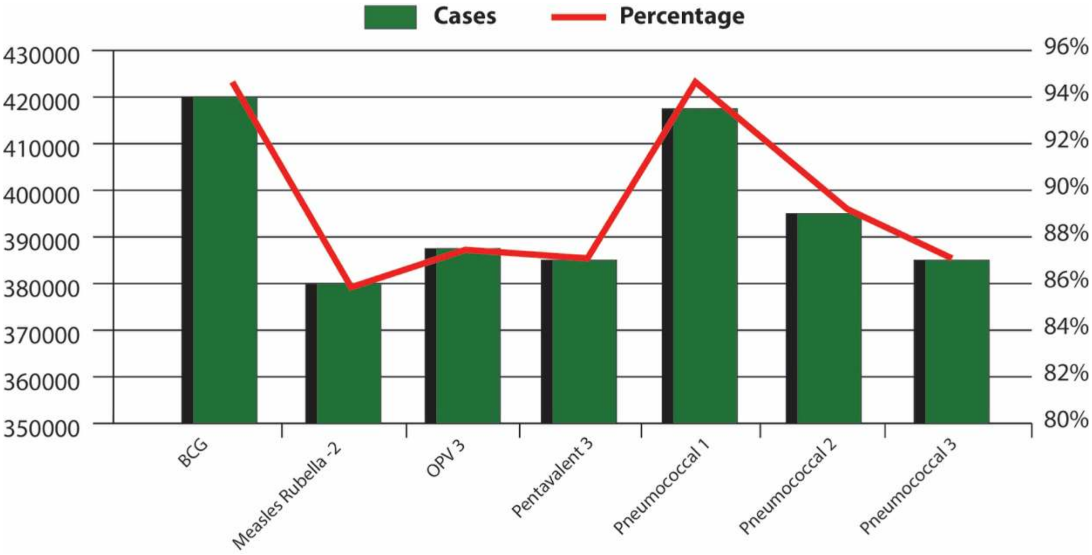
Table 20 - EPI vaccination schedule

Age	Vaccination
Birth	BCG
6 Weeks	Oral Polio Vaccine 1Pentavalent (DPT, HB, HIB) 1Pneumococcus Vaccine 1
10 Weeks	Oral Polio Vaccine 2Pentavalent (DPT, HB, HIB) 2Pneumococcus Vaccine 2
14 Weeks	Oral Polio Vaccine 3Pentavalent (DPT, HB, HIB) 3Pneumococcus Vaccine 3
9 Months	Measles
18 Months	Oral Polio Vaccine BoosterDPT Booster

* BCG- Bacillus Calmette-Guerin, DPT-Diptheria-Pertussis-Tetanus , HB-Hepatitis B, = , HIB-*Haemophilus influenza* type B ,

The EPI program has rendered immunisation services from primary health care levels where mothers go in order for their babies to be immunised. In 2015 there was an increase in BCG and pneumococcal 1 vaccinations due to effective campaigns and outreach programs (See Fig 19 below)

Figure 19 - Expanded program of Immunization (EPI) coverage for the year 2015



(Adapted from NHIS – MOHCC)

6.2.1 Nutritional Status and Infection Risk

A variety of factors determine the risk of getting infection for an individual and nutritional status is one of them. Malnutrition and infection are closely linked. The body's defense against infection is closely and intricately linked with nutritional status. Low nutrient reserves are associated with decreased immunity. For example a deficiency in vitamin A may result in progressive damage to mucosa, lowering resistance to colonization and invasion by pathogens. Thus the incidence, severity and duration of disease may be increased. Improving and maintaining nutritional status is therefore of utmost importance in prevention and control of infection.

In a survey done by the Nutrition department in the MOHCC in 2015, indicated that 21% of children 6-59 months had Vitamin A deficiency (VAD) and this was more prevalent in rural areas (25%) as compared to urban areas (11%). The prevalence of VAD amongst women of child bearing age was 24%. Woman living with HIV and AIDS (30%) were more likely to be Vitamin A deficient than women who were HIV negative (24%). Vitamin A has been recognized as a likely potential co-factor (micronutrient) in HIV progression and disease expression. HIV positive patients are at risk due to chronic and recurrent infections, chronic inflammatory conditions, poor intake and diarrhoea with or without malabsorption. Seventy-two percent of children aged 6-59 months had iron deficiency whilst in women that were 15-49 years it was 61.8%.

There has been integration of the EPI program with the nutrition program as children are given the first dose of Vitamin A at 6 months and there after at 6 months intervals until they are 5 years of age. Vitamin A deficiency increases the risks of severe illness and death from common childhood infections, particularly diarrhoea and measles. Supplementation of Vitamin A reduces child mortality by 23% with a 50% reduction of those infected with measles.

6.3 Sanitary measures for prevention and control of infectious diseases and pests

Measures of infection control are designed to limit the negative impact of plant and animal pests and diseases. These measures are instituted under the authorities responsible for plant protection in the case of the crop sector, and livestock and veterinary services in the case of the livestock sector. The scope of the interventions aim at the following:

1. Pest and vector control
2. Biosecurity (disease free compartments, zones)
3. Preventive Vaccination/ immunization
4. Test and slaughter of reactors
5. Production of safe commodities i.e. pasteurisation, cooking, fermentation, etc
6. Quarantine and movement control
7. Good agricultural practices (GAP)
8. Good manufacturing practices (GMP)
9. Therapeutic drugs, including use of antimicrobials
10. Implementation of international standards (OIE, CODEX, IPPC)

6.3.1 Role of biosecurity in reducing antimicrobial use in Agriculture

The OIE definition of biosecurity is “a set of management and physical measures designed to reduce the risk of introduction, establishment and spread of animal diseases, infections or infestations to, from and within an animal population.” With increased urbanization being experienced in Zimbabwe, there is likely to be a gradual growth in output to cope with demand and rise in expendable incomes. In order to be competitive and maximise profits from a limited land resource, commercial producers of livestock and livestock products are adopting intensive production systems. These intensive production systems are characterized by keeping high density animal populations under confinement maintained by feeding them concentrates and medicated feeds. This is resulting in high disease risk and increased exposure to prophylactic doses of antibiotics for treatment and as part of the medicated feeds. These intensive farming practices are encouraging the abuse of antimicrobials which may result in build up of resistance.3

Use of antimicrobials is increasing as farmers try to cope with the increased demand for their products and minimise disease risk to their animals. Increased use of antimicrobials in Zimbabwe is being driven by the following factors:

1. Managing increased disease outbreaks associated with intensification of production systems.
2. Managing increased build up of disease agents in the environment associated with poor sanitation and hygiene in intensive production systems;
3. Need to improve production efficiency by managing subclinical infections in animals. This is usually done through mass treatment with broad-spectrum antibiotics.
4. Dealing with consequences of selecting for high productivity at the expense of disease resistance;

In order to minimise reliance on antimicrobials to manage animal disease problems the country is promoting management systems that emphasise biosecurity measures at various levels of the animal production value chain as a pro-active and cost effective approach to management of animal diseases and build up of anti-microbial resistance. The aim is to reduce chances of disease entry, disease establishment and disease spread in an animal sub population.

Biosecurity measures are being implemented at different levels in the livestock sector as follows:

6.3.1.1 National level Biosecurity

All animal diseases of economic and zoonotic diseases are listed as notifiable diseases under the Animal Health Act in line with international best practice standards.
All Imports of animals and animal products from outside the country require a DVS import permit involving prior risk analysis of application of international standards entailing certification by the Veterinary Authority of the exporting country. Such goods may only be permitted into the country through designated entry points where there is presence of veterinary personnel to inspect and ensure compliance with import requirements.
Efforts are underway to equip all designated border entry points with recommended biosecurity infrastructure such as foot and wheel baths and incinerators.
All import consignments are released by a DVS official at destination point.
Efforts are under underway to put in place an acquittal system of all in transit consignments at point of exit within a stipulated time period.3

The country’s livestock population is divided into distinct subpopulations with a defined health status as determined by the veterinary authority for purposes of:

1. Designing disease surveillance programs for early detection and control of specific diseases,
2. Designing area specific extension and awareness

programmes for farmers and other stakeholders.
3. Managing animal movements through a movement permit system to prevent disease spread from one area to another
4. Designing and implementing animal disease eradication programs where appropriate.

6.3.1.2 Regional Level Biosecurity

Sub-populations of livestock in the communal and commercial sectors of the country are subdivided into regions using appropriate physical and geographical boundaries depending on species. DVS is in the process of improving the current animal identification and traceability system which will ensure major livestock species and individual animals are identified to epidemiological units of origin (dip tank, farm, ward or village depending in species). A mandatory animal movement permit and recording system is in place to manage and monitor movements of animals, including wildlife translocations, between epidemiological units and across disease zones for disease prevention and control purposes. The DVS is lobbying for sufficiently deterrent penalties to be imposed on all individuals who move animals illegally.

6.3.1.3 Farm level biosecurity

Efforts are underway to put in place legislation that make installation of farm boundary fences mandatory for all self-contained farms to prevent mixing of animals of different health status from different farms. The DVS maintains a register of all self contained farms and prescribe minimum standards on farm sanitation systems that each farm should comply with. Standards are being developed to promote implementation of additional on-farm biosecurity measures e.g. specific disease free compartment certificates that can assist enterprises access lucrative markets within and outside the country. Maintenance of farm stock registers giving details of antimicrobial usage and evidence of adherence to withdrawal periods will be made mandatory for all self contained farms

The DVS in conjunction with other stakeholders run and manage an extension, advisory and regulatory system that promotes implementation and enforcement of biosecurity measures. The DVS again in conjunction with other government departments will be implementing a data collection system that will facilitate effective monitoring and evaluation of the impact of biosecurity measures on the reduction of antimicrobial use.

6.3.1.4 Gaps concerning biosecurity:-

The following gaps have been identified in biosecurity:

1. The need to review guidelines for registration of compartments and accredited sub-populations will enable implementation of basic biosecurity measures.
2. Mainstreaming biosecurity concepts in training of curriculum of veterinarians and veterinary paraprofessionals.
3. In service training of veterinary extension staff.
4. Production of information leaflets on biosecurity for use by extension staff.
5. Information management system to capture and analyze data on antimicrobial usage.
6. Stakeholder training

6.3.2 Vaccination in animal health

Vaccination if available is a lower cost and more effective preventive measure than treatment of disease. There are 'government mandated' vaccines that the DVS offers for free or some at a negligible fee to farmers, for diseases which are of either economic or zoonotic importance e.g. Foot & Mouth Disease, Anthrax, Rabies. With these 'government mandated' vaccines, the state aims to prevent outbreaks of these diseases from having an impact on people's livelihoods and human health. There are also ‘farmer obligated’ vaccines which the farmer has to purchase on their own e.g. Vaccines against Bovine Respiratory Diseases. These are equally important in animal production however as they are dependent on farmers to purchase the coverage is therefore poor.

Zimbabwe requires more animal vaccines per year as compared to other SADC countries. Concerning poultry, the country would require 10 million doses of Newcastle vaccines compared to 8 million for Mozambique and 3 million doses for Namibia. One million doses of the anthrax vaccine is required for cattle whilst 0.5 million is required by Mozambique and 0.25 million is required by Namibia, etc.[4]

6.3.3 Environmental infectious pathogens and residues

The Environmental Management Act CAP (20:27) and the National Biotechnology Act Chapter 14 (31) requires all persons whose activities generate waste, to employ measures essential to minimize the waste through treatment, reclamation, recycling and proper disposal to a lined landfill.
Improper effluent and solid waste management have become topical issues in Zimbabwe. Waste management strategies are being employed by local authorities, industries and hospitals but there is still a long way to go before Zimbabwe can embrace the benefits of these strategies. Currently Zimbabwe has seen a proliferation of illegal dumps, non-functional sewage treatment plants, dilapidated sewer trunk lines, disposal of untreated sewer waste in water courses, dumping of expired antibiotics and other medicines and harbouring of waste at institutional and industrial complexes. The frequency of waste collection is not in line with generation levels and consumption patterns. The spread and contamination of the environment, mainly through the so called “hot spots” like hospital wastewaters or incompletely treated urban wastewaters is considered a serious environmental public health problem in Zimbabwe.

Under the Ministry of Environment, Water and Climate change namely the Zimbabwe National Water Authority (ZINWA) has the mandate to manage the country's water resources and the Environmental Management Agency (EMA), is responsible for ensuring the sustainable management of natural resources and the protection of the environment, the prevention of pollution and environmental degradation, the preparation of Environmental Plans for the management and protection of the environment.[45,6]

Poor liquid and solid waste disposal methods by hospitals, clinics and manufacturing industries increase the amounts of antibiotics in the environment. Most of the antibiotics consumed by animals and humans are excreted unmetabolised and enter into sewage and water sources. The agricultural sector where chemical fertilizers, herbicides and pesticides are used is also implicated. Once in the environment it becomes very difficult to predict how quickly these chemicals and antimicrobials will degrade. Some degrade easily whilst others bind to organic matter and can persist in their active states for long periods of time, further threatening the genetics and ecology of endogenous microorganisms which catalyst the entire biogeochemical nutrient cycles. This to a greater extent violates the effort of the National Biotechnology Authority of Zimbabwe (NBA to conserve the biodiversity, given that Zimbabwe is a signatory to the Catargena protocol on biosafety. The government's major concern so far has been that antibiotics found in aquatic environment may cause increased resistance among natural bacterial populations. Sewage sludge recycled onto agricultural land may contain significant amounts of various antibiotics, and antibiotic resistant bacteria. Some of the resistance is a result of genetic transformation, which arises as microorganisms try to adapt to these stressful environments. Therefore, antibiotics and their ingredients in the aquatic environment are warning signals for current and future public health as well as ecological problems.[7]

The NBA is an autonomous research and development institution with a mandate to promote the use and adoption of new and emerging technologies such as biotechnology, nanotechnology, synthetic biology. Part of the waste profile contains a lot of e-biowaste, spent microbial waste and nano-waste which originate from the use of state of art equipment and technologies currently used in high technology processing and analysis. E-waste (which is modern waste) refers to waste which is generated as a result of individuals or industry applying using new and emerging technologies such as biotechnology, nanotechnology, synthetic biology. This waste may contain new forms of micrograms which are either resistance to antibiotics and may be virulent - thus posing new bio threats/biosecurity threats to humans, plants and the environment. The current waste management and treatment methods are not adopted to detect or to handle such type of waste and such new strains of microorganisms. A laboratory infrastructure of Biosafety levels 1-4 is thus a requirement to handle biomaterials whose potential threats are not yet known.

As enunciated in the e-waste draft policy, e-waste presents a major environmental problem. Not only is it difficult to dispose but also contains harmful materials and components like mercury, lead, cadmium, chromium and flame retardants. The draft e-waste policy mentions the importance of establishing e-waste management infrastructure and the recycling of e-waste. As indicated above biological methods can be employed to manage and to bioremediate e-waste. In accordance with the NBA Act of 2006, the e-waste has to be profiled and categorized and then appropriate regulatory approval from the NBA should be sought before biological methods are employed in the management of e-waste.[7]

The role of the NBA will be to ensure that biotechnology guidelines and standards are adhered to.

6.4 The Department of Water and Sanitation Health (WASH) in the MOHCC

The Department of Environmental Health within the MOHCC, houses the water and sanitation services. In the 20 years from Zimbabwe's Independence in 1980, overall water coverage increased from 32% to 56% and overall sanitation access from 28% to 55%. Urban services had achieved well over 90% coverage by the late 1990s. Since then there has been a decline, the exact extent of which is estimated at 37% for sanitation coverage and 77% for safe water supply by December 2016. The consequence of neglecting sanitation and hygiene is that there will be premature illnesses and deaths due to cholera and typhoid as has been indicated earlier.

Zimbabweans continue to succumb to waterborne and water washed diseases such as scabies, trachoma, schistosomiasis and intestinal worms. Attention to hygiene and sanitation could go a long way in reducing these illnesses.

The water and sanitation department in the Ministry holds annual hand washing days as they try to implement hygienic practices to ensure reduced diseases that are caused by water and sanitation. Coordination of WASH resources is done by the National Coordination Unit (NCU) whose mandate is to mobilise resources for WASH activities. Currently NCU is housed in Ministry of Environment, Water and Climate.

4

6.5 The Harare City Council

In order to keep the environment clean, the City of Harare is guided by the following statutory instruments in ensuring that the environment is kept clean: EMA Act 20:27 , Public Health Act 15:01 , Harare (Waste Management) By-laws 2005, Harare (Anti-litter) By-laws 2016.

The City of Harare has an Environment and Amenities Division which is mandated to collect, transport and dispose of waste at the designated disposal sites, septic tank emptying into designated manholes, provision and cleaning of public conveniences, mobilisation of stakeholder participation. Through the City Health and Harare Water Departments, the City carries out regular and quarterly tests and analysis of water and food samples. The City's astronomical growth has put a major strain on service provision by the local authority to maintain a clean environment. Financial and material resource gaps are the biggest challenges facing most departments including the laboratory.

6.6 Prevention of AMR in Crops

1. Inappropriate use of antimicrobials can result in the development of AMR organisms and this can be prevented by adopting an integrated disease management strategy which can minimise the use of chemicals in controlling plant pathogens. The disease management strategies can include:-
2. Uses of non chemical antimicrobial agents such as biopesticides, these agents are easily degraded and do not accumulate in the environment and do not lead to the development AMR.
3. Encourage use of tolerant/resistant cultivars whenever they are available, this reduces or eliminates the use of antimicrobials
4. Site selection is another option, crops are grown in areas not suitable for pathogen multiplication or in areas where there are no vectors of the pathogen
5. Use of proper forecasting tools for timely fungicide application
6. Planting certified disease free planting material

6.7 References

1. Report of TB Risk assessment conducted on 30 Health Facilities in Zimbabwe August 2010 (CDC Zimbabwe 2010)
2. Zimbabwe Infection Prevention and Control Project Midterm Review Report 2016.
3. MAMID – Information from the DVS.
4. MAMID – Information from the CVL.
5. OIE Veterinary Legislation Identification Mission report, 2015
6. MEWCC – Information from EMA. 2016.
7. National Biotechnology Authority of Zimbabwe. 2016.

7. Supply Chain and Implications for Antibiotic Access

Key points of this section:-

- There is a fragmented supply chain system in Zimbabwe.
- Medicines for the public sector are procured through NatPharm, NGOs or individual health institutions.
- Funding for essential medicines is limited.
- There is need for computerization of all the public sector pharmacies in order for the eL-MIS system to be effective.
- Few animal health centres are functional mainly due to the reduced numbers of Veterinary Extension Assistants.
- The herb Moringa oleifera is among the top 10 herbs most commonly used by HIV-positive people in Zimbabwe.

7.1 Overview of the Pharmaceutical Supply Chain system

The pharmaceutical supply chain in Zimbabwe for the public sector is coordinated by the Ministry of Health and Child Care through the Directorate of Pharmacy Services. The functions of the supply chain such as pharmaceutical product selection, forecasting, and quantification are under the guidance and responsibility of the Ministry of Health and Child Care and all partners respond to request coming from the Ministry. Procurement, storage and distribution functions on the other hand are also performed by the government through the National Pharmaceutical Company of Zimbabwe (NatPharm) whilst quality assurance is mandated to the Medicines Control Authority of Zimbabwe (MCAZ).

The countries limited fiscus has led to donors procuring the bulk of medicines for use in the public sector. Once the needs are determined, they are shared with donors who select their preferences and quantities to procure. In addition, the country benefits from the Health Development Fund (HDF) which is a multi-donor pooled fund, managed by UNICEF and UNFPA, to support the Ministry of Health and Child Care. It supports the procurement of reproductive and maternal and child health commodities in addition to program implementation. Additionally UNICEF procures some essential medicines used and prescribed at the primary health care level. The Global Fund procures the bulk of antiretrovirals, antimalarials and antituberculosis medicines. The obvious challenge with this system is that medicines that the donors do not fund are left out even though they are essential.

1. Medicine supply and use in Zimbabwe, is guided by the National Medicines Policy under the MOHCC. This policy provides for the following;

2. The National Pharmaceutical Company which is mandated to procure medicines, store and distribute health commodities to mainly public health facilities.
3. The Medicines Control Authority of Zimbabwe (MCAZ) which is mandated to ensure circulation of quality products in the market as well as pharmacovigilance.
4. The National Medicines and Therapeutics Advisory Committee which develops the Essential Medicines List (EML).[1]

The MOHCC commissioned the Euro Health Group to conduct a “Comprehensive Assessment of the Supply Chain for Health Commodities in the Public Sector in Zimbabwe” in 2014. The Ministry in 2014, with support from the Global Fund also conducted an “Assessment of Storage Capacity and Conditions of health Commodities” at 158 health facilities across the country. The highlights of these reports as regards the supply chain of all commodities have been used to develop strategies to strengthen systems in the country. The current situation of the supply chain in the country is detailed below.2

7.2 Pharmaceutical Management Framework

7.2.1 Selection of medicines – The Essential Medicines List

Zimbabwe has an Essential Medicines List (EML) that is developed by the National Medicines and Therapeutics Advisory Committee (NMTPAC) and is reviewed every four years; the last review was done in 2015. An essential medicine is only replaced on the list when there is sufficient evidence that the new medicine produces better therapeutic outcomes than the current one and comes at a cost that the country and individual can afford. The committee also spearheads the development and adoption of standard treatment guidelines (STGs), which are still in development. Contributions to the development of the EML are provided by all levels of health care system including the:

1. Public sector - Primary care level, Secondary, tertiary and quaternary levels
2. Academia - Medical Schools
3. Research institutions
4. Private sector - Zimbabwe Medical Society, Pharmaceutical Society of Zimbabwe, Pharmaceutical Manufacturers' Association

Though development of the EML is all inclusive, the private sector does not use the EML to a greater extent as the public sector. Compliance of the EML in the public sector is almost 100% as procurement of medicines and their availability is largely guided by the EML. The EML is used in all training colleges for doctors, pharmacists, pharmacy technicians and nurses. Distribution of medicines to the different levels is guided by the EML as follows;

1. S items – available only to those facilities where the relevant specialist is present
2. A – items that are available at Provincial and Central Hospitals provided the prerequisite specialists are available
3. B – items available only at central, provincial, district and mission hospitals
4. C – available at primary care level as well as the other levels.

The EML further categorizes medicines according to the VEN system, V (Vital), E (Essential) and N (Necessary) which guides procurement with priority being given to V items when resources are limited.
Changes may occur to the list in between regular reviews and these are sent out to facilities as an addendum to the latest official list. Currently the EML is a draft version.

7.2.2 Forecasting

The EML and STGs coupled with data on disease burden is used for forecasting requirements where applicable which occurs twice a year in February and August. The outputs from the two exercises are used to mobilise resources and guide subsequent procurements.

7.2.3 Procurement

Procurement of medicines in Zimbabwe is conducted by different entities depending on the funding sources. All procurements for funding provided by the government and the National AIDS Council is conducted by the National Pharmaceutical Company (NatPharm). These items include but not limited to ARVs, essential medicines including antimicrobial agents, rapid tests kits for HIV and syphilis as well as anti-cancer medicines. The private sector procures from wholesalers both local and international.

Other organizations carrying out procurements include the following;

1. UNDP – ARVs using funding from the Global Fund
2. Chemonics Global Health Supply Chain Procurement and Supply Management Project – ARVs, HIV Rapid tests kits, medicines used during and after Voluntary Medical Male Circumcision procedures, condoms (male and female) and antimalarial medicines
3. Global Fund Pooled Procurement Mechanism – Antimalarial medicines, Rapid test kits for malaria, and anti TB medicines
4. UNICEF – essential medicines including antimicrobial agents.
5. Crown Agents – contraceptives
6. UNFPA – Contraceptives, VIAC commodities, selected reproductive health medicines and rapid test kits for HIV

All the above use outputs from the quantification activities mentioned earlier to guide them on quantities and delivery dates. Individual health facilities also procure medicines from the private sector when they are not available from NatPharm using user fees or funds from the Results Based Financing mechanism.

The major challenge facing the country in the supply of medicines especially those not covered under the vertical programs such as HIV, TB or Malaria due to inadequate funding. This leads to the failure in procuring all essential medicine needs and the right quantities as mentioned earlier. The economic challenges have also resulted in a number of patients not being able to afford to pay for their medicines leading to limited access to vital medicines.

7.2.4 Ordering & Distribution

Storage and distribution of medicines in the public sector is through NatPharm for virtually all commodities that are procured through national funds or commodities bought by different partners for the MOHCC.

Since 20014, the MOHCC has had a well-functioning distribution system for contraceptives, called the Delivery Team Topping Up (DTTU). This programme was and still is managed by the Zimbabwe National Family Planning Council (ZNFPC) together with USAID | DELIVER PROJECT. In 2008, TB and malaria medicines were also distributed in this manner.

The Zimbabwe Informed Push (ZIP) system which is used to distribute essential medicines was modelled after the DTTU distribution network. A total of six distribution systems (excluding that for vaccines) have been in operation and efforts are being made to consolidate them. Primary care level distribution will remain as one distribution system.

The ZIP delivery system works as follows:

1. Commodities are distributed from a regional warehouse, using trucks that supply multiple service delivery points (SDPs). Distribution to individual health facilities depends on level of care provided and specialization. The EML S, A, B, C categorization is thus followed during distribution.
2. Trained district pharmacy managers from the district hospitals serve as team leaders, travelling with the delivery trucks at least once every quarter.
3. At each SDP, the team leader physically counts the commodities, calculates losses and adjustments, analyses consumption since last delivery, and determines the average monthly consumption (AMC) using AutoDRV software. The emergency order point for facilities is one month of stock, and preventing stock-outs is critical, especially for seasonal products such as malaria.

Following the introduction of the Zimbabwe Informed Push delivery system it was noted that medicine and medical commodities stock levels improved at health facilities throughout the country. [3]

7.2.5 Warehousing and Storage

The warehouses used for the storage of commodities require infrastructure upgrades in order to provide sufficient storage areas for the products as well as comply with Good Warehousing Practices in terms of storage, cold chain, inventory management, expired stock management and distribution systems. Much storage space is occupied in the warehouses by antiretroviral medicines making management of stock of all commodities challenging.

Health facilities themselves experience stock management issues relating to insufficient storage space in pharmacies, lack of qualified staff to manage medicines and inventory, burdensome reporting requirements and poor stock management practices impacting on availability of medicines to the patient. Power supply challenges further complicate the good management of quality medicines in the health facilities.

7.2.6 Dispensing

There are 2- categories of medicines stipulated by the law prescription medicines and non-prescription medicines. Prescription medicines can only be dispensed from a licensed outlet upon providing a prescription from a qualified medical or dental practitioner, while over the counter medicines can be dispensed without a prescription. Antibiotics fall under the category of prescription medicines.

It is suspected that antimicrobials, and antibiotics are being sold without a prescription from registered pharmacies and unregistered outlets. Enforcement of the law is a challenge despite having inspectors who do routine inspections. Pharmacy technicians and pharmacists found contravening the law are called before the Pharmacists Council and MCAZ for disciplinary actions and receive a requisite penalty. Results from recent surveys show the increasing willingness of pharmacists to sell antibiotics without a prescription (see table below)

Table 21 - Percentage of pharmacists willing to sell antibiotics without a prescription

	Year		
	2011	2013	2015
% of pharmacists willing to sell antibiotics without a prescription	19%	50.0%	57.1%

Knowledge, Attitudes and Practices survey, 2016 (unpublished data)

<u>Role of the Human Resource Factor in the Procurement Cycle</u>
Part of the challenge of good stock management is that there are insufficient trained pharmacists and pharmacy technicians serving in the public sector, leading to untrained pharmacy personnel performing these duties. In most cases nurses are the ones that fill-in, but such functions as quantification, procurement and distribution require a trained pharmacist or pharmacy technician to perform optimally. This lack of dedicated staff has contributed to the mis-management of medicines in public health facilities. The table below shows levels of staff as at May 2015.

Table 22 - Pharmacy professionals in Zimbabwe

Professional Qualification	Public Sector	Private Sector	Total
Degree in Pharmacy (Pharmacist)	87	787	874
Diploma in Pharmacy (Pharmacy	225	260	485

Technician)	

Source: Pharmacists Council of Zimbabwe, May, 2015

Trained pharmacy personnel with a pharmacy degree or diploma are only found at hospital level with management of medicines stocks at primary care level being done by the nurses who also conduct clinical and preventive activities.

In the private sector on the other hand, distribution of medicines is through a chain of wholesalers, retail pharmacies, industrial clinics, private hospitals and certified dispensing doctors. All formal private distribution channels are licensed by the Medicines Control Authority of Zimbabwe (MCAZ)

Table 23 - Number of private sector facilities licenced to distribute human medicines

Retail pharmacies	**583**
Dispensing Doctors	**39**
Wholesalers	**80**
Veterinary Surgeons	**15**
Private hospitals	**16**
Industrial clinics	**191**

Source: MCAZ August 2016

7.3 Quality

Quality of medicines is one of the key areas highlighted in the National Medicines Policy document. The manufacturing of medicines both in-country and otherwise are supposed to meet the standards of Good Manufacturing Practice (GMP) or WHO Prequalification. The MCAZ registers all products on the market in the country and collects samples from the field as part of post marketing surveillance. The authority further conducts batch by batch testing for ARVs, TB and anti-malarial medicines.

However, due to a lucrative market for medicines, substandard, spurious, falsely labelled, falsified counterfeits (SSFFC) do exist. Although the degree to which this is a problem has not ascertained in Zimbabwe, there is however anecdotal evidence of medicines being smuggled into the country through undesignated ports of entry. This exposes the country to high risk of poor qualities medicines coming into the country.

7.4 Antimicrobial use information and stock visibility system

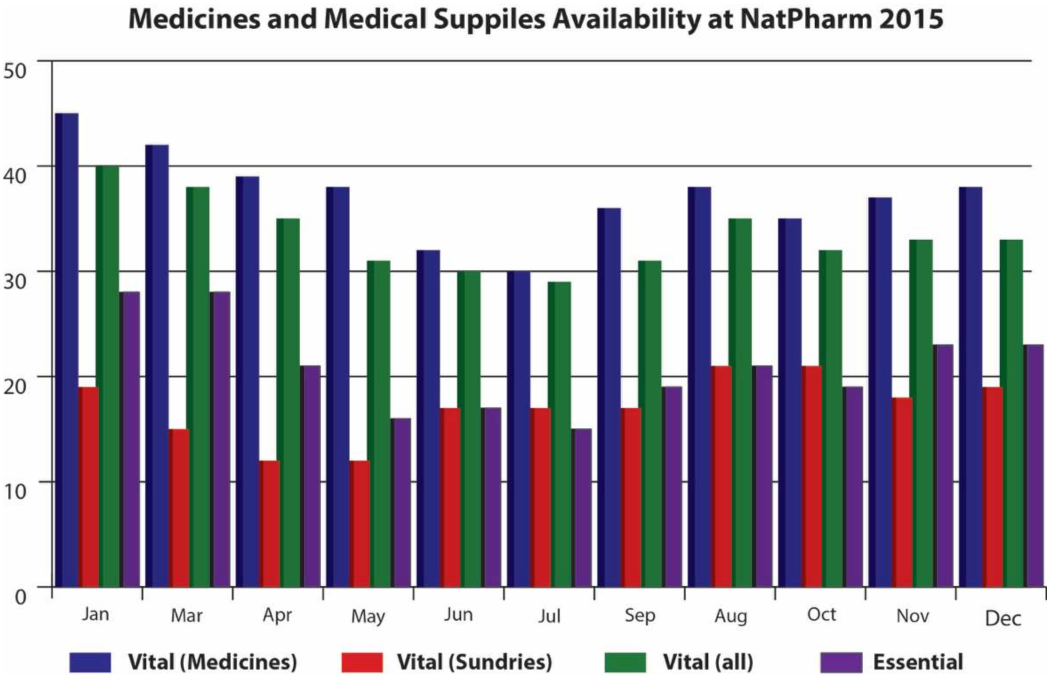
Currently most systems for reporting on stock are manual at health facility level; the completed reports are sent to the central level for entry into a centralized system called the Zimbabwe HIV and AIDS Information System (ZADS) for ARVs, laboratory commodities Zimbabwe Laboratory Commodities Distribution System (ZiLACODS) and Voluntary Medical Male Circumcision (VMMC) commodities. For TB, malaria, condoms, contraceptives and selected other essential medicines, data is captured onto laptops at facility level and then uploaded into a software called TopUp at central level. A few central and provincial hospitals have bought software using their own funds to aid in stock management as well as billing of patients.

Reporting of logistics data is through different distribution systems which unfortunately, do not cover all commodities. The Medicine Information System within the DHIS2 is supposed to report on all commodities but faces challenges of reporting rates and timeliness of reporting. This lack of a good information management system further limits the "visibility" of the warehouse as to the stock issues at health facility level. The country intends to start rolling out an electronic logistics management information system as well as dispensing software in 2017.

7.5 Access

Access to medicines in the public sector is mainly affected by the lack of funds to procure the full spectrum of required medicines. The figure below gives the general availability of medicines and medical supplies at the NatPharm warehouse during the year 2015. Though this might not reflect the exact situation at health facility level, it is a good indicator as most of the supplies are from NatPharm.

Figure 20 - Availability of supplies (%) at NatPharm 2015



Because of the availability situation shown in Figure 20 above, stock outs are experienced in the public sector as most antimicrobials are not donor funded (except for ARVs, TB and malaria medicines) and only a few in the primary health care package.

A survey conducted by the Ministry on selected medicines in 2011, 2013 and 2015 shows that the situation is better than portrayed by the availability study at NatPharm due to the procurement by health facilities using local funds, as shown in table 24.

Table 24 - Availability of health facility for selected medicines and medical supplies

Category	Availability in Year		
	2011	2013	2015
Vital Items	76.6%	65.7%	71.1%
Essential Items	81.0%	75.3%	81.0%

A significant number of pharmacies do not accept payments for medicines through medical aid, forcing patients to use their own financial resources. This is a major obstacle to access especially for the poor.

Availability in the private sector is better, however prices are above what most people can afford. The National Medicines Survey conducted by the Directorate of Pharmacy Services in 2013 showed that prices in Zimbabwe were generally higher than the international benchmark prices and that some prices in the private sector were more than 4 times the price in the public sector.4

7.6 Donations

The country has guidelines that stipulate the conditions for donations of medicines to Zimbabwe5. All donations need to be approved by the Ministry or Provincial Medical Director responsible for that province before acceptance in the public sector. All medicines imported into the country through regular means have to be cleared by the MCAZ before they can be released by the Zimbabwe Revenue Authority's Customs division. Compliance is however a bit lower at mission hospital facilities.

7.7 Importation and Local Production of Medicines

Importation of medicines is mainly done by The National Pharmaceutical Company (NatPharm) and registered wholesalers. Retail pharmacies do import at a very small scale for individual patients whose medications are not readily available in the country or whose volumes are small as to discourage regular wholesalers from importing. NatPharm imports medicines, including antimicrobials, mostly for the public sector but in some cases for the private sector as well. Importation of medicines is through designated ports of entry namely, Harare International Airport, Beitbridge, Plumtree, Forbes Border posts and Bulawayo airport. There are however reports of medicines being smuggled through undesignated border posts like Chirundu, the border between Zimbabwe and Zambia.

The products manufactured locally are: amoxicillin preparations, doxycycline, metronidazole tablets and cotrimoxazole preparations.

7.8 Veterinary Medicines Supply chain.

The pharmaceutical supply chain system in the distribution of veterinary medicines in Zimbabwe is also fragmented and not coordinated. Veterinary medicines are procured mainly by the private sector through registered wholesale dealers. There is no government or central funding for importation of veterinary medicines and vaccines. There is also limited funding from development partners such as FAO in importation of some vaccines in livestock for prevention and treatment of diseases of veterinary importance such as Foot and Mouth Disease in cattle. Government source other medicines for treatment of animals from the registered private wholesalers locally. Forecasting is done based on animal census as well as disease burden.

There are only six local manufacturers of veterinary medicines in Zimbabwe and as a result most veterinary medicines are imported. Only registered wholesalers and registered vet surgeries are authorised to import medicines according to law. These registered wholesalers and surgeries belong to the private sector. All the wholesalers are situated in Harare, the capital city and as a result the distribution of veterinary medicines to remotes parts of the country is limited. There are only 15 veterinary surgeries in Zimbabwe and the bulk of them situated in Harare, cities and towns.

Table 25 - Number of private sector facilities licenced to distribute veterinarian medicines

Retail pharmacies	2
Vet General dealer	**256**
Wholesalers	**7**
Dispensing Vets	**15**

Similar to human medicines, veterinary prescription preparations are accessible from pharmacies throughout the country. There are no vet wholesalers outside Harare and veterinary prescription preparations can only be filled from Harare limiting access significantly.

In the public sector, the distribution of veterinary medicines by the Division of Veterinary Services in the communal and small scale livestock farming sector was mainly carried out through animal health centres. The animal health centres served a critical role by ensuring that all veterinary medicines including cold chain products were kept under appropriate conditions. They also monitor the distribution and use in their respective wards. Currently not all animal health centres are functional mainly due to the reduced numbers of Veterinary Extension Assistants (VEAs) who should run the centres. This poor coverage as a result of limited numbers of extension officers could have resulted in uncontrolled use of antimicrobials. However, these centres no longer keep any medicines and the infrastructure is dysfunctional. In addition, there is limited skilled veterinarian oversight since government has only filled 25% of the district and provincial veterinary officers positions due to limited fiscal space. This has compromised veterinary services in Zimbabwe and is a threat to animal health issues including prudent use of veterinary medicines and AMR. There is no regulation prohibiting government veterinarians from consulting, prescribing and dispensing medicines, but there is a general understanding that it presents a conflict of interest and is not permissible, thus limiting access to prescription veterinary products to the animal health sector.

There are no STGs and EML for use in the veterinary sector. Although, Zimbabwe has a competent Authority, which ensures veterinary antimicrobials are available on the market, are of good quality, safety and efficacy, there is a weak pharmacovigilance system for monitoring the quality of veterinary medicines in the distribution channel. There is need for regulatory capacitation of MCAZ in order to effectively monitor quality of veterinary medicines in distribution through establishment of good post market surveillance systems and effective pharmacovigilance systems.

7.9 Pharmaceutical Registration, Licensing, Inspection

The Medicines and Allied Substances Control Act (MASCA) (1969) identifies the Medicines and Control Authority of Zimbabwe (MCAZ) as the competent authority with powers and authority to regulate the importation, manufacture, distribution, sale, and use of both human and veterinary medicines, vaccines, blood and blood components, medical devices, in-vitro diagnostics and certain biological reagents (OIE Veterinary Legislation Identification Mission report, 2015). MCAZ was established in 1997 as the successor to the Drugs Control Council and the Zimbabwe Regional Medicines Control Laboratory. The legislated responsibilities of MCAZ include:

1. Processing of applications for registration of medicines and subsequent amendments healthcare products
2. Licensing of premises and persons responsible for the manufacture, supply, distribution, and storage of medicines,

3. Approval and monitoring of clinical trials of the medicinal products
4. Collection and evaluation of reports of adverse reactions/events to medicinal products.
5. Official testing and release of batches of medicinal products within the scope of products under the act.

The Authority's role is to protect the public and animal health through the effective regulation of medicines and medical devices (MCAZ annual report, 2013). The Authority does not receive any funding from the government budget. It charges statutory fees for services provided to applicants for registration of medicines, processing any variations to registered products, licensing of persons and premises, approval and monitoring of clinical trials, quality testing of medicines samples and annual retention fees for registered products.

Veterinary Medicines are assessed and are approved for use in animals based on the national registration guidelines for veterinary medicines which were adapted from SADC Harmonisation of Technical Requirements for Registration of Veterinary Medicines Guidelines, the World Organisation for Animal Health (OIE) and the International Cooperation on Harmonisation of Technical Requirements for Registration of Veterinary Medicinal Products (VICH). 1 The regulation of biologicals and dips is done in conjunction with the Ministry of Agriculture under the Animal Health Act, and feed additives in conjunction with the Ministry of Agriculture.

Access to medicines for animals is controlled by allocation of products to specific distribution categories based on the need for expertise in disease diagnoses and treatment, safety of the substance to human and animals, compliance with Department of Veterinary Services Animal Health and Disease Control Policies. The categories for distribution are as follows:

1. Veterinary Prescription Preparation (PPvet): these medicines can be accessed only with a valid prescription from a licensed veterinary practitioner. Examples are penicillin injection, injectable sulphonamide preparations, and streptomycin.
2. Veterinary Medicines General Dealers (VMGD): these are medicines that do not require a prescription from a veterinarian, which can be accessed by farmers from agrochemical shops called VMGDS. Examples are dewormers (albendazole, levamisole, triclabendazole), livestock vaccines for cattle, pigs, poultry excluding vaccines for notifiable diseases for which vaccination is done by Division of Veterinary Services, hot strains for poultry diseases which are restricted to access on prescription. Other VMGD medicines include tetracycline powder, sulfaclozine (sulfachlopyrazine) sodium powder and cattle dips. An anomalous member of the VMGD category is oxytetracycline injection which should be PP(vet) was left as VMGD due to Heartwater (formerly Cowdria rumenantium, now Ehrlichia ruminantium), an acute and high mortality tickborne disease of cattle and small ruminants.
3. Veterinary Household Remedies (HR(vet)): these are very low toxicity products for treatment of conditions that can be easily diagnosed by an untrained person. These medicines may be sold from supermarkets. Examples include fly repellents and some wound remedies.

7.10 Access of crop antimicrobials

There are close to 40 companies involved in formulation and marketing up to 450 agro-chemical products. They all belong to the Agricultural Chemical Industry Association (ACIA) which is affiliated to the International Group of National Association of Pesticide Manufacturers/Distributors. The ACIA and its members have subscribed to observe the International Code of Conduct on Distribution and Use of Pesticides

It is mandatory to register all pesticides for use in agriculture with the Pesticide Registration Office within the Ministry of Agriculture, Mechanization and Irrigation Development. This body enforces the provisions of the fertilizer, farm feeds and remedies Act (18:12) and pesticide regulations. The core functions of the Pesticide Registration Office are:-

1. Registration of all pesticides
2. Issuing pesticides import and export permits
3. Discharging advisory services on various pertaining to pesticides
4. Regulating the pesticides trade in Zimbabwe

The Registering Officer assigns a colour code to each commercially available pesticide based on the mammalian toxicity as indicated by: • Acute oral LD50 of the technical material - this data will be taken from the Pesticide Manual published by the Crop Protection Council. The oral LD50 is that single dose expressed in mg/kg of body weight which when given by mouth kills 50% of the animals under test. • The strength of the formulation. • The persistence of the material after application. • Other relevant data.

Green label pesticides

These are formulations with an acute oral LD50 of over 2001 mg/kg of body weight. These can be used without danger in the homes or where stated as admixture to grain or other stored produce for human or animal consumption. They can be sold by any shop or store and the word "Caution" appears within a green triangle and the words "Harmful if Swallowed" beneath the base of the triangle.

Amber label pesticides

This is for formulations with an acute oral LD50 of between 501 and 2000 which could be used without danger in home gardens and for external use about the home. The word "Danger" with a symbol of one skull and crossbones appear within the amber triangle and the word "Poison" beneath the base of the triangle.

Red label pesticides
This is assigned to formulations with an acute oral LD50 of between 100 and 500. Their use should be generally restricted to horticultural, agricultural, health or industrial pest control operations. These may be sold by a licensed dealer, with a special part of premises set aside for the storage and sale of dangerous substances. The word "Danger" with one skull and crossbones symbols appears within the red triangle with the words "Dangerous Poison" beneath the base of the triangle.

Purple label pesticides
These are formulations with acute oral LD50 of up to 100. These may only be sold to persons whose business, profession or trade require them. They may only be offered for sale by licensed dealers where part of the premises is set aside for the sale of dangerous substances. The dealer must keep a person register of all sales of this group of pesticide, each sale being countersigned by the purchaser or his nominee and the firm's license number noted. The word "Danger" with one skull and crossbones symbol appears within purple triangle and "Very Dangerous Poison" beneath the base of the triangle.

7.11 Traditional Medicine Department in the MOHCC

The Ministry of Health and Child Care has a department of Traditional Medicine (TM) whose vision is to integrate traditional medicine into the country's health care system. Its mandate is to ensure equitable and proper use of safe, efficacious and quality traditional medicines, while contributing to economic and social development of Zimbabweans7.

Before the introduction of Western medicine, Traditional Medicine was the sole source of healthcare for the entire populace. Many of the traditional medical practices produced effective therapeutic results. In 2000, the World Health Organization estimated that about 80% of the African population and other developing countries still use traditional medicine for their health care need8. Recent surveys conducted in Zimbabwe report sustained wide spread herbal medicine use for the management of various acute and chronic conditions.9,10,11

Many legitimate traditional practitioners that live within rural communities in Zimbabwe, have a long standing relationship with the community based on trust. They often only require token payments for consultations. Their prescriptions, which usually consist of crude traditional herbal medicines, are obtained from the surrounding local environment and are not charged to the patient. Many of the practitioners view their expertise as a gift and have a sense of social responsibility towards their communities.12 As a result patients in such areas often turn to and undoubtedly benefit immensely from traditional complementary and alternative practitioners and their treatments. In some cases, particularly among urban populations, both traditional medicine recipes and biomedical medicines are used concurrently.

The use of herbal supplements is widespread in Africa, particularly for the management of HIV and AIDS. In Zimbabwe, the prevalence of herbal medicine use in HIV-infected people is as high as 79%.13 Several studies have shown that the herb Moringa oleifera is among the top 10 herbs most commonly used by HIV-positive people in Zimbabwe14. Another review also cited Moringa as one of the 53 most important African medicinal plants presently traded.15. Concomitant use of herbs with conventional drugs may lead to herb-drug interactions in the same way that two or more co-administered drugs may interact. Herbal constituents that are substrates for the same enzymes or transporters of conventional drugs may induce or inhibit the enzymes and/or transporter activity.

Traditional Medicine and THPs were officially recognized by the Alma-Ata Declaration of September, 1978 as important resources for achieving Health for all.16 In view of this and the sustained prevalence of traditional medicine use, the Department of Traditional Medicine embarked on many programmes aimed at sensitizing THPs on the prevention and care of both communicable and Non-communicable diseases. This include implementation of the following projects:

1. Building the Capacity of Traditional Health Practitioners in HIV and AIDS Prevention and Care (ZIM, BOTS and RSA): End of Term Report
2. Malaria National Control Programme: Sensitization of THPs on malaria prevention & care

The gaps that exist in relation to AMR include lack of collaboration between the traditional and western medicine systems. Although a framework for collaboration has been proffered by WHO it needs to be adopted and implemented. Due to lack of this collaboration the referral system is weak such that one system does not have knowledge of what the other system is doing. There is also no database on what traditional medicines are being used and the contraindications. Training of health workers must integrate TM so that practitioners understand what is happening in the other system.5

7.12 References

1. MOHCC – Information from the Department of Pharmacy.
2. USAID. 2010 Zimbabwe Health Systems Assessment report. January 2011.
3. Euro Health Group Report 2014. Comprehensive Assessment of the Supply Chain for Health Commodities in the Public Sector in Zimbabwe.
4. Assessment of Storage Capacity and Conditions of health Commodities
5. MOHCC – DPS – National Medicines Survey.
6. Guidelines for medicines donations to the republic of

Zimbabwe
7. MOHCC – Department of Traditional Medicine
8. WHO 2000. Traditional Medicine – WHO Fact Sheet. http://www.who.int/mediacentre/factsheets/2003/fs134/en/
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13. Tsitsi G Monera. Research Focused on Traditional Health Systems and its Integration into Conventional Health Systems has Great Potential to Improve Health Coverage in Developing Countries. Institute of Tropical Medicine 52nd Annual Colloquium, November, 8-10, 2010 Antwerp, Belgium.
14. Sebit MB, Chandiwana SK, Latif AS, et.al. 2000. Quality of life evaluation in patients with HIV-1 infection: the impact of traditional medicine in Zimbabwe. Central Afr. J. Med 46(8):208-13.
15. Monera TG, Wolfe A, et.al., Moringa oleifera leaf extracts inhibit 6-hydroxylation of testosterone by CYP3A4. J. Infect. Dev. Ctries. 2(5):379-83.
16. Van den Bout-van den Beukel CJ, Koopmans PP, Van der Ven AJ, De Smet PA, Burger DM. Possible drug-metabolism interactions of medicinal herbs with antiretroviral agents. Drug Metab Rev. 2006;38(3):477-514. Review.
17. WHO 1978. Declaration of Alma-Ata. http://www.who.int/publications/almaata_declaration_en.pdf?ua=1

8. HUMAN RESOURCES IN ZIMBABWE

Key points to this section:-

- There is a shortage of staff in in both the health sector and the agriculture sector.
- Medical doctors and veterinary doctors are supposed to be the main prescribers of antimicrobials however other cadres are prescribing due to shortage of staff to improve access to medicines
- Shortages of laboratory staff limit the capacity to perform surveillance activities

8.1 The human resources situation in the human and animal health sector

Human resources are key to managing, prescribing, dispensing and providing diagnostic support to any country wide antimicrobial programme. Many health improvements achieved during Zimbabwe's first 10 years of independence have been declining, due to the shortage of skilled and experienced health workers. Unfortunately, this has also come at a time when demand for services is increasing due to the HIV and TB pandemics that are prevalent in the country. The public sector provides 65% of health care services in the country, and so a shortage of public sector workers affects the majority of the population.1 This shortage can be attributed to four dominant factors namely outmigration, low salaries, difficult conditions of service, and HIV/AIDS risks among health staff.2

The prescribers of antimicrobials are any health care professionals, technicians, non health care professionals, animal health professionals and technicians, who may prescribe or use antimicrobials in either humans, animals or the environment. It is not only important to identify who they are but also it is important to understand the numbers and capacity of these professionals to function effectively in order to control the prescription and use of antimicrobials in Zimbabwe in line with their scope of practice and legal obligations.

8.2 Human Health staff

In human health the key professionals involved in the management of antimicrobials are the following:-Doctors, nurses, pharmacy personnel and laboratory personnel.

Table 26 - Scope of practice of health professionals

Health professional	Scope of practice			Concerns/ comments around the current scope of these professionals
	Prescribing	**Dispensing**	**Administration**	
Doctors	**Primary prescribers of all antimicrobials**	√	√	**Consultants in most cases have the final say concerning which antimicrobial will be prescribed.**
Pharmacists	**Primary prescribers of some antimicrobials**	√	√	**They do prescribe if patients come straight to a pharmacy without first seeing a Doctor.**
Nurses	**Primary prescribers of some antimicrobials**	√	√	**As they run rural health clinics, they do prescribe antimicrobials for non-complicated cases. ARVs have also been task shifted to Nurses.**

As of January 2009, there was a shortage of 6,940 health care staff, meaning Zimbabwe's health system is just 57% staffed to capacity. In the public and private sectors, health workers are lost more rapidly than training institutions are able to replace them.3 As of December 2015 there was a shortage of 7 700 health professionals in the human health sector (See Table 27 below) :-

Table 27 - shortfall of human health staff per selected cadre for the public sector - 2015

Cadre	# of Staff for Full Health System Operations	# of Staff in Place as at Dec 2015	Shortfall	% in post
Doctor	**1887**	**1209**	**678**	**64%**
Nurse	**19477**	**17242**	**2235**	**89%**
Primary care nurse	**1277**	**1277**	**0**	**100%**
Pharmacists	**119**	**77**	**42**	**65%**
Pharmacy technician	**187**	**163**	**24**	**87%**
Laboratory scientist	**357**	**189**	**168**	**53%**
State-certified medical laboratory technician	**103**	**75**	**28**	**73%**
Environmental Health Officers	**122**	**82**	**40**	**67%**
Health services administrator	**56**	**37**	**19**	**66%**
Total for all cadres nationally	**37602**	**29902**	**7700**	**80%**

Source: Health services board.

In order to improve staffing levels at District levels, there has been the introduction of the Primary Care Nurses (PCN), a donor funded health staff retention scheme and Results Based Funding has provided some relief. However, with the resettlement of some people, not all areas have access even to community health workers (CHWs) and environmental health technicians. The infrastructure is not only inadequate but also inequitably distributed with population growth and dispersion patterns not being matched by establishment of new facilities. Consequently, over all outpatient utilization is 0.35 outpatient visits per person per year, which also falls below the target of 5 outpatient visits per person per year in all provinces.4

There are insufficient numbers of trained pharmacists and pharmacy technicians serving the public sector in the country therefore some health facilities do not have an experienced individual to manage their medicines placing additional pressure on none-pharmaceutical clinical staff to fulfil this function. The lack of dedicated staff has resulted in management of medicines being below expectations. The table below shows levels of staff as at May 2015.

Table 28 - Pharmacy professionals in Zimbabwe across all sectors

Professional Qualification	Public Sector	Private Sector	Total
Degree in Pharmacy (Pharmacist)	**87**	**787**	**874**
Diploma in Pharmacy (Pharmacy Technician)	**225**	**260**	**485**

Source: Pharmacists Council of Zimbabwe, May 2015

The cadres mentioned in table above are only found at hospital level with management of medicines stocks at primary care level being done by the nurse who also conducts clinical and preventive activities.

Laboratory diagnostic staff are another critical category of staff required to manage the AMR program in Zimbabwe. Below is a table of laboratory staff that are registered with the Medical Laboratory and Clinical Scientists Council (See Table 29 below).

Table 29 - Laboratory staff that are registered with medical laboratory and clinical scientist council in 2014 and 2015

Registers	2014	2015	Country Needs	Shortage
Clinical scientists (MSc, Doctrates, Post doctoral)	**85**	**94**	**380**	**286**

Specialists medical Laboratory Scientists	**125**	**125**	**Phased out**	**0**
General Medical laboratory Scientists	**500**	**546**	**1600**	**1053**
Med Lab Scientists (Cytologists)	**1**	**3**	**60**	**57**
State Certified Blood Transfusion Technicians	**20**	**20**	**120**	**100**
State Certified Medical Lab Technicians	**475**	**480**	**600**	**120**
Total	**1206**	**1268**	**2885**	**1617**

As mentioned under Chapter 4 Surveillance, Laboratory based surveillance at the NMRL has ceased due to the lack of a surveillance officer responsible for the monitoring system and other sufficiently skilled laboratory technicians to perform the diagnostics tests required for surveillance (vacancy rate of lab technicians 23 - 47%).

8.3 Animal health staff

Veterinarians are the primarily responsible for the management of antimicrobials in veterinary medicines however, in order to improve emergency access for farmers to live saving medicines, veterinary technicians are able to provide and dispense antimicrobials to animals and famers themselves are able to purchase these medicines from their local agricultural product store and administer these medicines to their livestock without the oversight of a veterinarian or veterinary technician.

In terms of being able to manage the public health, surveillance epidemiological sides of livestock in the country, the various government departments are also short staffed in critical posts as can be seen from the tables below[5]:

Table 30 - Summary of establishment and vacancies: division of veterinary services as at 30 Oct 2016

Technical staff				
CATEGORY	**Number of Staff for full Operations**	**Staff in Post as at October 2016**	**Shortfall**	**% In Post**
Principal Director	**1**	**1**	**0**	**100%**
Veterinary Officer Snr/Pri/Chief	**1**	**1**	**0**	**100%**
Station Superintendant	**1**	**1**	**0**	**100%**
TOTAL	**3**	**3**	**0**	**100%**
Table 30 above clearly shows that the senior staff positions are well staffed.				
Table 31 Veterinary services division				
HEAD OFFICE				
Director	**1**	**1**	**0**	**100%**
Epidemiologist/Snr/Prin/Chief	**2**	**0**	**2**	**0**
Sub Total	**3**	**1**	**2**	**33%**
EPIDEMIOLOGY SECTION	**ESTAB**	**IN POST**	**VAC**	
Deputy Director Epidemiology	**1**	**1**	**0**	**100%**
Chief Epidemiology (Training and Advisory)	**2**	**1**	**1**	**50%**

Veterinary Officer Snr/Pri/Chief	4	2	2	50%
Veterinary Technical Superitentent	1	1	0	100%
Veterinary Officer Snr/Pri/Chief(Wildlife)	3	2	1	67%
Animal Health Inspector/Snr.	1	1	0	100%
SUB TOTAL	12	8	4	67%
PROVINCIAL OFFICES				
Provincial Veterinary Officer	8	6	2	75%
Epidemiologist/Snr. Principal	16	2	14	13%
Chief Animal Health Inspector	8	6	2	75%
Veterinary Public Health Officer/Snr/Pri/Chief	8	2	6	25%
Chief Food Inspector	8	0	8	0
SubTotal	48	16	32	67%
DISTRICT OFFICES				
District Veterinary Officer	60	17	43	28%
Government Veterinary Officer/Snr./Principal	120	15	105	13%
Animal Health Inspector/Snr.	223	89	134	40%
Food Inspector	71	49	22	69%
Veterinary Extension Worker	1340	850	490	63%
SUB TOTAL	1814	1020	794	56%

Table 31 Above indicates that there is a shortage of epidemiologists, public health officers and district officers.

Table 32 - Diagnostics and Research Section

Deputy Director,Diagnostics	1	1	0	100%
Quality Manager	1	1	0	100%
Station Superitendent	1	0	1	0
Veterinary Laboratory Technologist/Snr/Pri/Chief	37	30	7	81%
Quality and Safety Officer/Snr/Prin/Chief	2	2	0	100%
Vet Diagnostic Officer/Snr/Pri/Chief	32	8	24	25%
Instrument Technician	1	0	1	0

Veterinary Laboratory Techn/Higher/Snr/Pri	**21**	**12**	**9**	**57%**
Artisan Higher/ Snr/Pri	**1**	**1**	**0**	**100%**
Agricultural Assistant	**1**	**1**	**0**	**100%**
Subtotal	**98**	**56**	**42**	**57%**

Concerning the diagnostic and research section (see Table 32 above) there is need to fill in posts of the station superintendant and the instrument technician.

Table 33 - Veterinary Public Health Section

Deputy Director	**1**	**1**	**0**	**100%**
Chief Food Inspector	**1**	**0**	**1**	**0**
Veterinary Public Health Officers	**12**	**2**	**10**	**17%**
Veterinary Laboratory Technologist/Snr/Pri/Chief	**1**	**0**	**1**	**0**
Learner/Food Inspector/Snr/Prin (Harare)	**25**	**15**	**10**	**60%**
Subtotal	**40**	**18**	**22**	**45%**

In the Veterinary public health section there is need to fill in post Chief food inspector lab personnel.

Table 34 - Dairy Service Unit

Chief Dairy Officer	**1**	**1**	**0**	**100%**
Dairy Officer/Snr/Pri	**6**	**4**	**2**	**67%**
Research Technician/Higher/Snr/Prin	**10**	**9**	**1**	**90%**
Dairy Technician/ Higher/Snr/Prin	**9**	**2**	**7**	**22**
Sub Totals	**26**	**16**	**10**	**62%**
National Total	2004	1120	884	56%

In the dairy services unit (See Table 30 above) there is need for more dairy technicians. The CVL and provincial Laboratories are also short of staff in the technical areas limiting their ability
to perform laboratory based surveillance on animal health pathogens.

Table 31 - Establishment of technical staff for the CVL and Provincial laboratories as per 31 Dec 2014

Professional Category	Approved Establishment	Number of Officers in Post	Vacant post not Filled	Staffing Levels as a % of the Establishment
Veterinary Research Officer	**23**	**9**	**14**	**39%**
Technologist	**36**	**23**	**13**	**64%**
Technician	**21**	**12**	**9**	**57%**

Similar staffing constraints are experienced at the Government Analyst Laboratory where food product residue sampling in performed (See Table 32 below).

Table 32 - Human resources at the Government Analyst Lab

Staff	Number
Director	**1**
Deputy Directors	**2**
Chief	**1**
Quality Manager	**1**
Heads of departments	**9**
Analysts / Technicians trained in vitamins and minerals testing	**8**
Analysts / Technicians trained in microbiology	**7**
Analysts / Technicians trained in nutritional content	**14**
Analysts / Technicians trained in contaminants	**14**
Total number of technicians	**32**
Total lab staff	**43**

8.4 References

1. MOHCC report of 2005.
2. USAID. 2010 Zimbabwe Health Systems Assessment report. January 2011.
3. Chikanda A. 2007. "Medical migration from Zimbabwe: magnitude, causes and impact on the poor." Development Southern Africa 24 (1, March).
4. SARA 2015.
5. Information from MAMID

9. Education and Awareness

Key points on this section :-

- There is no AMR module in both the College of Health Sciences and the Veterinary School.
- Very little research is being carried by schools of higher learning.
- Awareness activities are still limited and they need to embrace the 'One Health' approach

9.1 The education structure

According to the multiple indicator cluster survey done in 2014, it showed that girls start school at an earlier age than boys, although at age 14, more girls drop out as compared to boys. More children from rich families progressed to A-level.1 Zimbabwe has been ranked number one in Africa with the highest literacy rate of 90.7.2 In 2015 the total school enrolment was 3 120 000.

9.2 Education activities at tertiary institutions

There are 20 universities in Zimbabwe and the University of Zimbabwe which was established in 1955 is ranked number one in the country. It is involved in teaching and research and offers degrees, diplomas and certificates in various disciplines which include arts, agriculture, law, medicine, social studies, science, engineering, education, commerce and veterinary sciences. There are about 12 000 undergraduates and about 1500 post graduates.3

9.2.1 College of Health Sciences – University of Zimbabwe

The use of antibiotics is taught at undergraduate level to medical and pharmacy students, in the department of Clinical Pharmacology under the topics :-

1. Antimicrobials and infection
2. Antibiotics
3. Classes of antibiotics
4. Use of antibiotics
5. Rational use of antibiotics
6. Irrational use of antibiotics
7. Antibiotic resistance[4]

Medical laboratory scientist are trained within the department and they do cover the same areas mentioned above. Practical work in antibiotic susceptibilities are run for all levels of trainingi.e. from 1st year to 4th year.[4]

At postgraduate level i.e. Masters in Medicine antibiotic use is taught under the following topics,

1. Rational use of antibiotics in organ failure, e.g. in renal failure
2. Antibiotic use in surgery
3. Prophylactic use of antibiotics
4. Correct use of antibiotics and mechanisms of antibacterial resistance
5. Molecular mechanisms of resistance
6. Molecular diagnosis of resistances.

9.3 Research in AMR being done at the College of Health Sciences

Not much research into antibiotic resistance has been carried out in Zimbabwe at tertiary institutions. In fact in 2014 the WHO noted that national surveillance of antibiotic resistance in the WHO Africa region was as low as 1%.

In 2015 a study titled "Antibiotic use in an Urban setting" was carried out by Tagwira, in the department of Clinical Pharmacology, College of Health Sciences, University of Zimbabwe. The objective of the study was to determine the pattern of antimicrobial resistance of Staphyloccocus aurens, Staphyloccocus pneumonia, Salmonella, Escherichia Coli, and Pseudomonas among other microorganisms. The study was a retrospective review of records from the laboratories spanning over a period of five years. The records were from a private laboratory and a central hospital public laboratory.[4]

Overall the study showed a high rate of resistance in both the private and public sector, of up to 60 to 100% in the public sector, especially resistance to penicillins, cephallosporins (showing an incremental trend), aminoglycosides (with very little resistance to amikacin). In conclusion this study indicates that there is an incremental rise in resistance to antibiotics and more research to accumulate more data is required. This research is yet to be published.[4]

9.4 Veterinary School, University of Zimbabwe

In the veterinary medicine training, antimicrobial agents and the concepts of AMR in terms of their mechanisms and factors that contribute to their emergence are emphasized in various disciplines including pharmacology, microbiology, veterinary public health and regulation of veterinary medicinal products. Given that the misuse and inappropriate use of antimicrobial agents may promote the emergence AMR education and awareness focuses on prudent use of antimicrobial agents by recommending the adoption of the following codes of practice as suggested by Carter, 19955:

1. Avoiding the use of antimicrobial agents whenever possible especially for mild and inconsequential infections
2. Prescribing prophylactic treatment only where a real risk of serious disease exists
3. Observing principles of aseptic surgery to avoid use of prophylactic antimicrobials
4. Encouraging treatment of clinical cases using drugs that have been selected appropriately based on the laboratory results
5. When antimicrobial agents are administered, measures should be taken to ensure full therapeutic doses are given for an adequate period.[5]

However, there may be several factors that may contribute to misuse of antimicrobials, including misconceptions about AMR and lack of awareness, especially among farmers as some of the drugs are easily accessible on the market.

No research has been carried out in the area of antimicrobial resistance in plants, but the general trend observed in the field is that some of the recommended antimicrobials are failing to control the microbes. The use of antimicrobial agents and the concepts of AMR are covered in plant pathology as well as factors which result in the emergence of AMR are also discussed. Since inappropriate and overuse of antimicrobials can lead to AMR in plant pathogens, education and awareness campaigns encourage the use of integrated microbial control strategies which include:-

1. Uses of non chemical antimicrobial agents such as biopesticides, these agents are easily degraded and do not accumulate in the environment and do not lead to the development AMR.
2. Encourage use of tolerant/resistant cultivars whenever they are available, this reduces or eliminates the use of antimicrobials
3. Site selection is another option, crops are grown in areas not suitable for pathogen multiplication or in areas where there are no vectors of the pathogen
4. Use of proper forecasting tools for timely fungicide application
5. Planting certified disease free planting material

9.5 Awareness

There are many deep-rooted, inappropriate behaviours when it comes to antimicrobial use, and many misconceptions about antimicrobial resistance regarding when and how antimicrobials should be used. For example, patients may self-medicate and demand antimicrobials when they are not needed, health care providers may prescribe or recommend antimicrobials unnecessarily, and antimicrobials are used in vast amounts for non-medical applications such as promoting growth of food animals. There are many reasons for this inappropriate behaviour, including lack of understanding of the issue and intensive marketing campaigns promoting use.

The goal of raising awareness is to change behaviours and social norms that have an influence on the problem of antimicrobial resistance. Efforts can be aimed at the general public, healthcare professionals, educators, civil society organizations, or policy makers amongst others. As antimicrobial resistance is a complex phenomenon influenced by many biologic and socioeconomic factors, and is an issue that has an impact on human health, animal health and the environment, it is important to address the problem from a holistic ecosystems perspective.
Additional awareness activities are described in appendix 2.

9.5.1 Journalist Awareness Campaign (workshop held on 14 June 2016)

The Ministry of Health and child care (MOHCC) in collaboration with the Zimbabwe Association of Church related Hospitals (ZACH), National Microbiology Reference Laboratory(NMRL), World Health organization (WHO), Department of Veterinary Services, National Food safety, PortHealth Services and Medicines Control Authority of Zimbabwe(MCAZ) held an awareness workshop targeting journalists from various media houses in Harare on how journalists can use effective communication, education and training to change behaviours and social norms within the area of AMR. This was supported by the Ecumenical Pharmaceutical Network (EPN) based in Kenya. The journalists felt really empowered and ready to disseminate accurate information on AMR producing over 20 publications on AMR. ZACH clearly highlighted the need for Journalists to release articles to the public through their respective media platforms in an effort to pass knowledge gained about AMR and ZACH later organized ceremony to honor exceptional journalists.7

Besides the above mentioned awareness campaign there has been no other campaigns that have been carried out on AMR of this magnitude. A respondent in the doctors KAP survey recommended that it is important that IEC materials such as pamphlets on AMR are distributed in physicians offices. There is need to develop home grown 'One Health' approach awareness materials for the Zimbabwean population that resonates with them. Such efforts would contribute increasing, promoting behavioural and social norms in tackling AMR.

9.6 References

1. Zimbabwe National Statistical Agency. Extended analysis of Multiple Indicator Cluster Survey (MICS) 2014. Education. June 2016. No. 2.
2. African Economist. July 2013. http://theafricaneconomist.com/ranking-of-african-countries-by-literacy-rate-zimbabwe-no-1/
3. University of Zimbabwe http://www.uz.ac.zw/
4. UZ. College of Health Sciences – Department of Clinical Pharmacology and the Department of Medical Laboratory Sciences.
5. Information from the Veterinary School. UZ.
6. Dhliwayo S, Makonese TA, Whittall B, Makonese TA, Whittall B, et. al. 2016. A study on the prevalence of dog erythrocyte antigen 1.1 and detection of canine Babesia by polymerase chain reaction from apparently healthy dogs in a selected rural community in Zimbabwe. Journal of South African Veterinary Association. 87(1).
7. Information obtained from Zimbabwe Association of Church related Hospitals (ZACH).

10. Investment requirements and support for Research & Development

Key points on this section :-

- Currently very little research is taking place concerning AMR due to lack of funding.
- There is the Medical Research Council of Zimbabwe (MRCZ) (for human research) and the Agriculture Research Council of Zimbabwe (ARC) (for crop research) are all managed and regulated by the Research Council of Zimbabwe (RCZ).
- There is need for short, medium and long term researches to be carried out using the 'One health' concept.

10.1 Overview of research and development

All research and development in Zimbabwe is managed and regulated by the Research Council of Zimbabwe (RCZ). Under the RCZ are two main councils, the Medical Research Council of Zimbabwe (MRCZ) and the Agriculture Research Council of Zimbabwe (ARC). The MRCZ concentrates on human medical problems and the ARC concentrates on crop and animal health research, hence there is no collaborative research. Fields covered under "One Health" which include AMR/AMU, "neglected" zoonotic diseases and food safety issues remain without a 'home'.

Main government research institutions include for animal and crop health – the Department of Research and Specialist Services (DR&SS) and for human health is the National Institute for Health Research (NIHR). The major mandate of the DR&SS is to provide for the country research based technologies, technical information for advisory services and products for supporting enhanced agricultural productivity and the production of various crops and livestock (including tea, tobacco, sugarcane, pigs and forestry). These technologies, knowledge and information are designed to :-

1. Deliver specialist services that promote sustainable agricultural and economic growth.
2. Facilitate improved or increased productivity per unit area or per resource quantum.
3. Protect Zimbabwe's agriculture through the provision of dependable, effective, efficient and competitive regulatory service that prevents the introduction of pests and diseases and ensures the availability of quality agricultural inputs and products.
4. Remove drudgery for farmers, speed up activities and save on time, physical and financial resources.
5. Facilitate the development of agriculture by commercializing research based technologies.[1]

The mandate of the NIHR is to carry out human scientific research that promotes evidence based decision-making and policy development to improve the health of the people of Zimbabwe through effective control of disease and solving problems associated with health care delivery.

Other Institutions that carry out research in Zimbabwe are :-

1. All the 20 universities in Zimbabwe.
2. The Biomedical Research and Training Institute
3. The Central Veterinary Laboratory
4. The National Microbiology Reference Laboratory
5. The Government Analyst Laboratory
6. African Institute of Biomedical Science and Technology

10.2 Current Research activities

There is very limited research being done separately on AMR/AMU and on infectious zoonotic diseases by Universities and Research institutions under Ministries of Health, Agriculture and Environment without any coordination.

Some of the current researches that NIHR is conducting are on malaria with special emphasis on antimalarial drug efficacy monitoring at sentinel sites (using both in vivo and molecular techniques), insecticide resistance monitoring at sentinel sites (using WHO standard tests as well as molecular techniques), malaria vector mapping (using both morphological and molecular techniques) and in schistosomiasis and soil transmitted helminthes focusing mainly on mass drug administration (MDA) and its impact in school children. They have currently mapped the prevalence of schistosomiasis and soil transmitted helminthes, which has informed our current efforts in MDA. The main gaps are in research funding including some specialized equipment, reagents, technical assistance, training at postgraduate level and vehicles for sample collection.[2]

10.3 Research and funding needs

There is a need to conduct short and medium term research (3-5 years) to include baseline studies for antibiotic resistance and use in humans and animals, animal products and the environment. Baseline work on indicator organisms such as Salmonella spp or E. Coli in animal products, humans and the environment (soil, water), plants and animal feeds needs to be carried out including transmission of resistant strains in different reservoirs (human-animal-environment). Molecular technique methods also need to be undertaken. The content of the available traditional medicines needs to be looked at including the beneficial and negative impacts of usage of these types of medications.

New diagnostic tools tools are required as current culture results take 2 to 4 days for results to come out and hence doctors cannot that long and therefore treat the patients empirically.

Currently there has been no investment plans nor has there been funding that has been secured for Research and Development (R&D) under the "One Health" concept to address research and development in AMR/AMU, food safety of crop and animal origin and "neglected" zoonotic diseases infecting both humans and animals in Zimbabwe. It is recommended that a government financing mechanism be put in place for research into AMR/AMU including other public health disciplines covered under "One Health" concept. Industry is also being encouraged to fund AMR/AMU research. One of the suggestions for industry participation is by charging a 0.5% research levy on all imports of antimicrobials or their components for research funding.

There is need to introduce another arm under the RCZ which addresses research and development under the "One Health" concept. This arm is to include Ministries of Health, Agriculture and Environment are part of a committee under the RCZ to enable it to impartially access, approve, regulate and coordinate research projects under "One Health" and avoid bias and potential duplication under different "silos" of Ministries of Health, Agriculture and Environment.

10.4 References

1. Information from the department of research and specialist services.
2. Information from the National Institute of Health Research.

11. Conclusions And Recommendations

11.1 Summary of key findings

Surveillance and AMR

1. In Zimbabwe, multiple infectious disease create a large burden on the country's economy and health status with resistance high to first line antibiotics;
2. Very little up to date data on current pathogens causing infections in human health making
3. it difficult to inform the EML and STG's;
4. Lack of HAI or AMR surveillance system in health care facilities to understand the burden and support treatment guidelines. This is due to a weak National Microbiology Reference Lab;
5. Interventions used to control nonbacterial diseases such as Foot and Mouth Disease in animals involves the use of antimicrobials in the treatment protocol or as first line choice;
6. Strong and effective surveillance system for notifiable diseases exists using mobile technology ensuring 95% completeness of reporting (The National Health Information System) this could be used to assist with the collection of AMR and Hospital Acquired infections;
7. Human health lab based surveillance system has been ineffective for a while and only 25% of public health labs have capacity to do culture and susceptibility testing which limits diagnostic capabilities of health care professionals treating patients. The profile of important resistant organisms are required in order to support STG's and appropriate prescribing by healthcare professionals in the facilities;
8. Animal health laboratories have capacity to carry out some microorganism and antibiotic residue testing and Government Analyst Lab and CVL does food safety testing for the country. Residues in meat and meat products not being monitored in local food. However, when a farmer is unable to pay for the laboratory fees, that specimen will not proceed for laboratory testing and therefore valuable surveillance information will be lost.
9. Water quality testing is performed by Environment Management Agency and Government Analyst lab including chemical and microbiological tests however no AMR testing is done. DVS and MOHCC oversee food safety with good coordination between them;
10. Legislation exists that ensures that antibiotics for use in animals and humans are available through prescription only from a veterinarian or doctor however it is not always enforced;
11. Regulations are in place for categorisation, prescription and distribution channels for antimicrobials however distribution system constraints result in challenges with availability;
12. Antimicrobial use data for humans and animals is difficult to collect or collate from existing sources. Zimbabwe is unable to determine whether the existing antimicrobial use is considered rational and in compliance to STG's ;
13. Animal health injectable antibiotics such as oxytetracycline and oral preparations are available over the counter and therefore potential for abuse by farmers exists.
14. There is need for surveillance of antimicrobials in the crop sector.

Prevention

1. Very strong, well-coordinated IPC program at national and health facility level this includes good national IPC guidelines, policies and strategic plan as well as a coordinating IPC committee however funding is lacking for implementation of the program. IPC curricula has been strengthened for all medical professionals and in service training has improved IPC practice and implementation at facility level. Though resources, equipment and facilities for IPC are still deficient in the health facilities ;
2. Biosecurity guidelines are available in animal health for specific species and are mainly targeting larger and medium farmers. These are used by the DVS to inspect farms and provide them with compliance certificates which allows the farmers to sell their products with the more lucrative formal retailers. BS need to be contextualised for smaller scale farmers in order to be appropriate;
3. Vaccination have reduced incidence of bacterial/viral infections in humans and animals and should be funded and coverage improved
4. Vaccination in humans as part of the EPI program is free and coverage has been expanded to include pneumococcal vaccine and HPV and rotovirus (impact undetermined)
5. Nutrition program and EPI are integrated with Vit A doses included therefore reducing mortality for those infected with measles;
6. Vaccination of animals for zoonotic diseases is supported and provided by Department of Veterinary services to prevent outbreaks of disease. However not all animal health vaccines available that would reduce the need for antimicrobials i.e. coverage for vaccines needs to be improved especially for vaccines preventing bacterial infections;
7. Activities such as such as crop rotation, use of clean seed and use of resistant varieties should be done in order to prevent bacterial crop diseases.

Supply chain and regulatory control of medicines

1. Supply of medicines and vaccines is from donors

and they choose what they want to supply therefore resulting in poor availability. There is no coordination of donors to get the EML completely covered. Patients pay for medicines and this results in high economic burden for them, poor access or poor quality unlicensed medication;
2. Mixture of high quality and counterfeit drugs on markets despite regulations that should enhance quality
3. EML and STG's are regularly reviewed and updated to inform procurement processes
4. Well-functioning distribution system for medicines exists for some programs which can be expanded to support antimicrobial distribution
5. Single regulatory body licenses animal and human medicines however medicated feeds falls within the DRSS
6. Use of herbal/traditional medicines may help alleviate pressure on antimicrobial use and should be researched

Education and training and awareness

1. Strong professional associations and accreditation systems for each cadre of healthcare professionals;
2. Need to strengthen the modules in the current undergraduate curriculum for College of Health Sciences and the veterinary school for specific AMS practices;
3. Limited awareness of public of the risks of AMR.

11.2 Key Recommendations

A collaborative effort will be required across human and animal health and the environment to ensure that antimicrobial effectiveness is preserved and bacterial diseases are treatable in the future. Therefore, the establishment of a One Health National Action Plan for AMR, in line with the World Health Organization (WHO) Global Action Plan, implemented through the Ministry of Health and Child Care, the Ministry of Agriculture Mechanization and Irrigation Development, and the Ministry of Environment, Water and Climate, is needed to coordinate sustained action on AMR.

The action plan will include activities to:

1. Raise awareness and educate the population, professionals, and policymakers on AMR. There is need for targeted education and awareness raising campaigns for patients, general public, prescribers and dispensers in human and animal health care on issues of antimicrobial resistance. There is also need to highlight hand hygiene, food safety and appropriate antimicrobial use;
2. Improve understanding of the AMR burden and use patterns through surveillance. A 'One health' integrated laboratory based surveillance system will need to be in place to monitor disease burden in humans, animals and the presence of resistant strains in the environment. This national surveillance system is critical to monitor not only antimicrobial resistance but also antimicrobial usage in hospitals, farms, the environment and communities. The data will guide the appropriate policy changes to STG and EML, treatment protocols in animals and humans and extending vaccination programs.
3. Reduce the need for antimicrobials by improving IPC, biosecurity, WASH, and immunization. Guidelines for infection prevention control (IPCs) in hospitals and biosecurity for animals are recommended to be put in place including ensuring their implementation. Continuous enforcement of a clean environment and the provision of improved water sources and sanitation measures are needed in order to prevent infectious diseases spread in the community.
4. Improve access to antimicrobials in humans and improve control of access to antimicrobials in animals. Funding for antimicrobial use and vaccines to be considered a key priority for all donors to ensure sustainable access in the country and to strengthen the procurement and distribution system to ensure their availability in health facilities. Enforcement mechanisms need to be enhanced to ensure that only good quality, approved medicines are being prescribed and dispensed appropriately to patients and animals.
5. Improve appropriate use of antimicrobials. The presence of standard treatment guidelines which align with the burden of disease and resistance patterns of organisms, coupled with the essential drugs lists for both humans and animals will help guide appropriate use by prescribers and users. These should be communicated and assessed by the Hospital Therapeutics Committees to strengthen compliance with best practice and monitor antimicrobial use. Antimicrobial Stewardship (AMS) programs, providing audit and feedback to appropriate antimicrobial use and prescribing need to be implemented in both human and animal health practices. Veterinarians and para veterinarians should be capacitated to guide and support appropriate antimicrobial us by farmers.
6. Research in AMR and alternatives to antimicrobials. There is need for research to be carried out on AMR patterns and behaviours in order to guide policy as well as for the development of alternatives to antimicrobials.

This plan is already being developed by the AMR Core Group in Zimbabwe and will be approved by the tripartite ministeries.

The problem of AMR is real in Zimbabwe and calls for a proportionate One Health to address the gaps identified in this situational analysis response. There is need for the formation of a 'One health' antimicrobial resistance control program along the lines of those for HIV, TB and malaria to curb

AMR. A national action plan that encompasses issues of education and awareness, infection prevention control measures, biosecurity, antimicrobial use, surveillance and research and development needs to be put in place and will need to be implemented in order to curb this critical health threat.

APPENDIX 1 – The GARP, ReAct TECHNICAL WORKING GROUP

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APPENDIX 2 - AWARENESS CAMPAIGNS THAT HAVE BEEN DONE IN ZIMBABWE.

A number of publications that promote AMR awareness, rational use of antimicrobials or antimicrobial adherence were published in various media houses in the past. Some of the publications are as follows;

1. Internet Based Publications -June 2015 to August 2016.
2. BussinessConnect published a story were it was said that Zimbabwe commemorated the World.
3. Consumer Day: The of 2016 World Consumer Day celebrations, ”Antibiotics Off The Menu” is in tandem with the country’s drive to develop anti-microbial resistance action plan. Director of Epidemiology and Disease Control in the Ministry of Health and Child Care Dr Portia Manangazira who spoke during the World Consumer Day celebrations in Harare, said the importation of meat reared using antibiotics and the over prescription of antibiotics to patients by doctors is now a health hazard and a cause for concern. Dr Manangazira said too much uptake of anti-microbial agents affects patients’ recovery processes even if the right treatment is administered, adding that the national anti-microbial resistance group is working on the national plan as a response to this challenge. The Consumer Council of Zimbabwe deputy executive director Rose Mpofu says there is need to ensure people do not take anti-microbial agents, adding that antibiotics should not be used in livestock production as they affect the human body’s resistance to diseases.
4. Clinical, Virologic, Immunologic Outcomes and Emerging HIV Drug Resistance Patterns in Children and Adolescents in Public ART Care in Zimbabwehttp://journals.plos.org/plosone/article?id=10.1371/journal.pone.0144057
5. New threats to food safety are constantly emerging. Major challenges to national food safety systems are as a result of changes in food production, distribution and consumption, changes to the environment, new and emerging pathogens and antimicrobial resistance. Increases in travel and trade enhance the likelihood that contamination can spread internationally. As the World celebrates World Health Day, the Zimbabwe Human Rights Commission, would like to urge the Government to ensure that measures are put in place to ensure food safety. Consumers should also ensure that they do not compromise on their own health by consuming unsafe food stuffs that create a vicious cycle of diseases as this impacts badly on the socio economic development of the country.http://www.zhrc.org.zw/index.php/2014-07-02-07-41-38/press-releases/97-press-statement-by-the-zimbabwe-human-rights-commission-zhrc-on-world-health-day-7-april-2015
6. Antimicrobial Resistance of Escherichia coli Isolated from Chickens with Colibacillosis in and Around Harare, Zimbabwehttps://www.researchgate.net/publication/236913320_Antimicrobial_Resistance_of_Escherichia_coli_Isolated_from_Chickens_with_Colibacillosis_in_and_Around_Harare_Zimbabwe
7. Antibacterial Effects of Cissuswelwitschii and Triumfettawelwitschii Extracts against Escherichia coli and Bacillus cereus http://www.hindawi.com/journals/ijb/2015/162028/
8. BussinessConect also published a story were the Minister of Health and Child Care, David Parirenyatwa said, Antimicrobial resistance is soon going to be causing more deaths than the HIV pandemic and TB infections in sub Saharan Africa if left unattended. Addressing a media and stakeholders meeting on the development of an antimicrobial resistance “one health’ national action plan for Zimbabwe, Parirenyatwa said Europe and America had recorded at least 50 000 antimicrobial deaths per year and is estimated that by 2050, antimicrobial resistance will be causing 10 million deaths annually worldwide and this will cost the world US$10 trillion dollars. “Antimicrobial resistance affects all infectious diseases that are caused by microbes which are bacteria, viruses, fungi or parasites. Therefore antimicrobials refer to any pharmaceutical agents that are used to treat/kill all these, while resistance means these microbes will not die thus in other words a patient is treated with the correct medicine, but the microbes will not respond to the agent such that the signs and symptoms of the illness such as fever may not improve and in fact this may lead to complications while on treatment.”
9. 263Chat.com published a story entitled “Zim to develop antimicrobial resistance plan” and said the Government through the Ministry of Health and Child Care has joined forces with Medicines Control of Zimbabwe, African Treatment Access Movement and the Veterinary Public Health in an effort to develop an antimicrobial resistance “one health” national action plan for the country. http://263chat.com/2016/06/zim-to-develop-antimicrobial-resistance-plan/
10. NewsdzeZimbabwe published the following story were they said ANTIBIOTICS are important medicines for treating bacterial infections in both humans and animals. They are prescribed for a variety of ailments, from a chest infection to infected in-growing toenail. But overuse of antibiotics may be bad for your health so I urge you to think carefully before seeking an antibiotic from your doctor. The worrying thing is that antibiotics are losing their effectiveness at an increasing rate. Antibiotic resistance is one of the biggest threats to patients' safety. Overusing antibiotics can affect the body’s natural ability to fight infection and make people more likely to develop infections, including more serious ones. http://www.newzimbabwe.com/news/printVersion.aspx?newsID=20094
11. FAO published a story entitled “Zimbabwe Readies War on Drug-Resistant İnfections”. Zimbabwe's government has declared war on antimicrobial resistance in both humans and animals, with the help of powerful international partners.

12. The Southern African country's One Health Antimicrobial Resistance National Action Plan, t0 be developed in cooperation with the World Health Organization (WHO), United Nations Food and Agriculture Organization (FAO), and World Organization for Animal Health (OIE), represents an international first. "Only four countries in the world – namely Kenya, Ghana, Cambodia, and Zimbabwe – are currently developing their antimicrobial resistance action plans, courtesy of funding from the Fleming Fund [a UK government fund to fight drug-resistant infection] and FAO," Dr. Pamela Woods, national project coordinator for antimicrobial resistance in agriculture, livestock production, food and fisheries, told the workshop in Harare. http://en.haberler.com/zimbabwe-readies-war-on-drug-resistant-infections-928058/
13. The Consumer Council of Zimbabwe also published an article on how it is driving at ensuring consumers are aware of antimicrobial resistance issues www.facebook.com › Places › Harare, Zimbabwe
14. We come across an article entitled “Zimbabwe: Unsafe Food - a Major Health Threat” Consuming unsafe foods poses a significant public health threat in the African region. Infants, young children, pregnant women, the elderly and those with underlying illnesses are particularly vulnerable. http://allafrica.com/stories/201504110121.html
15. Zimbabwe News Now published an article entitled “Antibiotics: A pillar of medical treatment is under threat”. http://www.zimnewsnow.com/node/524
16. SABC Antimicrobial resistance of Escherichia coli isolated from chickens with colibacillosis in and around Harare, Zimbabwe. http://www.ncbi.nlm.nih.gov/pubmed/23678746
17. Print Media Publications May -2015 to August 2016
18. Newsday published a story on 2nd May 2015 saying that several people afflicted with gonorrhoea, tuberculosis, malaria and HIV-related infections have been caught in sixes and sevens, with the diseases developing drug resistance that have left medical experts with headaches. https://www.newsday.co.zw/2016/07/02/antibiotic-resistance-rises-diseases-develop-virulent-trends/
19. New day published a story on 3rd May 2015 saying can people not turn to pharmacies for cheap treatment than going to doctors and be charged huge amounts of money. https://www.newsday.co.zw/2016/07/02/antibiotic-resistance-rises-diseases-develop-virulent-trends/
20. Newsday also published a story saying that the sale of antibiotics and other antimicrobial medicines without prescription remains widespread in Zimbabwe, increasing the potential for overuse of the medicines by the public and medical professionals, research has shown. https://www.newsday.co.zw/2015/05/02/antibiotic-overuse-makes-bacteria-resistant/
21. The Herald published the following story entitled “Fear Mounts over drug resistant HIV”. http://www.herald.co.zw/fears-mount-over-drug-resistant-hiv/
22. The Herald published the following story entitled “Thanks God for antibiotics’. http://www.herald.co.zw/thank-god-for-antibiotics/
23. Harare Metro published an article on “Respite for TB patients” hmetro.co.zw/category/health/
24. Sunday mail published a feature story titled “Resistant infections plague” on 14 August 2016 http://www.sundaymail.co.zw/resistant-infections-plague-the-globe/
25. Sunday mail published a feature story titled “ARVs, antibiotics are the latest vendors’ gold” on 24 August 2016http://www.sundaymail.co.zw/arvs-antibiotics-are-the-latest-vendors-gold/