THE REPUBLIC OF UGANDA

MINISTRY OF HEALTH

ANTIMICROBIAL RESISTANCE SURVEILLANCE PLAN FOR HUMAN HEALTH

2019 – 2023

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ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
AMR	Antimicrobial resistance
AST	Antimicrobial Susceptibility Testing
ATCC	American Type Culture Collection
BSAC	British Society for Antimicrobial Agents and Chemotherapy
CDC	Centers for Disease Control
CLSI	Clinical and Laboratory Standards Institute
DHIS-2	District Health Information System version 2
DSR	Disease Surveillance and Response Program Area
ESD	Epidemiology and Surveillance Division
GLASS	Global Antimicrobial Resistance Surveillance System
EAPHLNP	East Africa Public Health Laboratory Networking Project
EQC	External Quality Control
e-HLIMS	electronic Health Laboratory Information Management Systems
ESBL	Extended Spectrum Beta Lactamases
EUCAST	European Committee on Antimicrobial Susceptibility Testing
HIV	Human Immunodeficiency Virus
HIV-DR	HIV Drug Resistance
HLIMS	Health Laboratory Information Management Systems
IQC	Internal Quality Control
IDSR	Integrated Disease Surveillance and Response
LTC	Laboratory Technical Committee
MDR-TB	Multidrug-resistant TB
MIC	Minimum Inhibitory Concentration
MRSA	Methicillin Resistant Staphylococcus Aureus
NAP	National Action Plan
NIC	National Influenza Centre
NHLDS	National Health Laboratory and Diagnostic Services
NICD	National Institute for Communicable Diseases
NTRL	National Tuberculosis Reference Laboratory
PCR	Polymerase Chain Reaction
RDT	Rapid Diagnostic Tests
STD	Sexually transmitted diseases
TWG	Technical Working Group
XDR-TB	Extensively Drug-resistant TB

FOREWORD

In Uganda, infectious diseases notably HIV, malaria, tuberculosis, respiratory tract infections, meningitis, neonatal sepsis and diarrhea account for 8 of the top 10 causes of premature death. Infections also contribute significantly to death due to non-communicable causes like malnutrition, cancer and injuries. The rising problem of antimicrobial resistance is therefore of grave concern to us as country.

Nearly, 5 - 15% of the people on Antiretroviral therapy in Uganda carry strains that are resistant to first-line agents Efavirenz and Nevirapine. An estimated 300 patients require costly and relatively toxic second line anti-tuberculosis drugs for their multidrug resistant (MDR) mycobacterial strains annually. Uganda abandoned chloroquine and most sulfadoxine-pyremethamine based regimens for treatment of malaria due to the high burden of resistance to these agents. This alarming picture pales in comparison to that of the antibiotics used for numerous bacterial infections. Despite being prescription only agents, they are readily accessible over the counter in pharmacies and community drug shops. Even in health care facilities, they are used liberally and empirically due to the remarkably constrained microbiology diagnostic services in the country as well as the virtual absence of antimicrobial stewardship. The national treatment guidelines on which empirical therapy depends based mainly on expert opinion as there is no surveillance system to generate resistance data. The limited research data available suggests alarmingly high rates of resistance to commonly used agents like penicillins and fluoroquinolones as well as a worrying prevalence of methicillin resistant *S.aureus* and extended spectrum beta-lactamase E. coli. Inadequate infection prevention and control practices and crowding in many health facilities provides the potential for amplifying the problem. Widespread misuse and resistance in animal husbandry also creates a reservoir of resistant strains that not only threatens human health but also animal production.

It is therefore of great relief to note that the world has started taking action against this problem that has been snowballing since the first antibiotic was used in the 1930s. Uganda was keen to endorse the Global Action Plan on AMR that was presented at the 158th World Health Assembly in 2015. Its goal is; 'to ensure, for as long as possible, continuity of successful treatment and prevention of infectious diseases with effective and safe medicines that are quality assured, used responsibly and accessible to all that need them'. Key among the GAP's 5 objectives is strengthening the knowledge and evidence base through surveillance and research. This surveillance plan is therefore a timely response to the GAP and shall generate data critical for guiding the attainment of the rest of GAP's objectives.

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ACKNOWLEDGEMENTS

The Ministry of Health would like to acknowledge its sincere appreciation and gratitude to all individuals and institutions that supported and contributed to the development of the AMR Surveillance plan. Special thanks go to the One Health Platform, AMR Coordination Center and the National Health Laboratory Diagnostic Services for coordinating the development and review of this document.

We extend our utmost appreciation to the Department of Medical Microbiology, Makerere University, Department of Medical Microbiology, Mbarara University of Science and Technology, and the Infectious Diseases Institute, Makerere University, College of Health Sciences for providing invaluable technical expertise during the development and review of the human health AMR surveillance plan.

In particular, the Ministry of Health would like to thank Dr. Henry Kajumbula (DMM-MUK), Dr Joel Bazira (DMM-MUST), Dr. Florence Najjuka (DMM-MUST), Richard Walwema (IDI, Makerere University, College of Health Sciences), Musa Ssekamatte (One Health Platform, Mugerwa Ibrahim (NHLDS), Dr Aniku Gilbert (Arua RRH). Dr. Keneema Olive (Mbarara RRH), Dr. Kalyesubula Simeon (EAPHLNP/MoH), Dr. Reuben Kiggundu, Dr. Ivan Lumu, Peter Mukiibi, Sheila Agaba, Rodney Mugasha, Richard Walwema and Dr. Mohammed Lamorde (IDI, Makerere University, College of Health Sciences), for the technical expertise provided in the development of this AMR surveillance plan.

Special appreciation is extended to the Centers for Disease Control and Prevention (CDC) and the Fleming Fund Country Grant through the Infectious Disease Institute (IDI), for funding the development and review process of this plan respectively

CHAPTER ONE: BACKGROUND AND INTRODUCTION

1.1 Background

Public health surveillance is important in the prevention and control of infectious diseases and their medical management. AMR surveillance involves a systematic collection, analysis and timely dissemination of AMR information to facilitate an effective public health response. Surveillance data are used to determine the magnitude of health problems, document the natural history of a disease, detect and predict epidemics, describe the distribution and spread of disease, evaluate prevention and control interventions, and aid in public health planning (McDonald, 2012)

The discovery of antibiotics and their introduction into medical practice in the early 1940s was a major milestone in health-care delivery. Antibiotics not only provided a lifesaving solution to bacterial infections like pneumonia and meningitis but also enhanced the safety of complex surgery, cancer chemotherapy and organ transplantation. It is projected that the use of effective antibiotics would avert 75% of under-five year old deaths due to community acquired pneumonia, the leading global killer in this age group (Laximinarayan et al.,2015).

Antibiotics together with anti-viral, anti-fungal and anti-parasitic drugs which kill or inhibit various groups of microorganisms (microbes) constitute the antimicrobial agents. Unfortunately, microbes have a natural tendency to develop resistance to the antimicrobial agents they are exposed to. While alternative 'second or third line' agents are available in case of resistance, they tend to be more toxic, costlier and may require elaborate investigative procedures and prolonged hospitalization. As such, resistance complicates treatment and drives up health-care costs (WHO, 2018a). Additionally, some microbes carry genes that render them resistant to numerous classes of antimicrobial agents leaving virtually no treatment options. Multiple-resistant organisms like methicillin-resistant *Staphylococcus aureus* (MRSA), extended-spectrum beta-lactamase-(ESBL)-producing Gram-negative rods, carbapenem-resistant gram-negative rods, vancomycin-resistant enterococci and colistin-resistant *Enterobacteriaceae* have been associated with significantly higher mortality than non-resistant strains (WHO, 2018a).

It was estimated that in 2014 alone, about 700,000 deaths were directly attributable to antimicrobial resistance. In absence of robust interventions, this figure is projected to rise

to 10 million per year by 2050, outstripping all deaths due to other major causes (O'Neil, 2017). In addition to the clinical burden, antibiotic resistant bacterial infections drastically impact economies and livelihoods. Estimates of annual direct and indirect costs have ranged from $ 1.4 billion in Thailand, through € 1.6 billion for the European Union, to nearly $ 55 billion for the United States (Smith and Coast, 2013).

While the attention paid to the burden of antimicrobial resistance has been grossly inadequate, the world now recognizes that AMR is not a prediction for the future but an urgent problem that requires global intervention. In 2015, at the 68th World Health Assembly, the World Health Organization (WHO) published a global action plan (GAP) for AMR that called on member states to develop national action plans (NAPs) centred on five strategic objectives:

1. Improve awareness and understanding of antimicrobial resistance through effective communication, education and training.
2. Strengthen the knowledge and evidence base for AMR through surveillance and research.
3. Reduce the incidence of microbial infection through effective sanitation, hygiene and infection-prevention measures.
4. Optimize the use of antimicrobial medicines in human and animal health.
5. Develop the economic case for sustainable investment that takes account of the needs of all countries, and increase investment in new medicines, diagnostic tools, vaccines and other interventions.

Information on the burden of resistance and the major prevailing anti-microbial resistance patterns provides the essential knowledge base for planning interventions to combat the problem. The Ministry of Health (MOH) has therefore prioritized the collection of resistance data through the national action plan for a surveillance system for antimicrobial resistance (GoU, 2018). While resistance is of great importance for all categories of pathogens, it is particularly urgent for bacterial infections, malaria, tuberculosis as well as HIV given their contribution to the country's disease burden. This plan therefore initially emphasizes surveillance for antimicrobial resistance for these agents. Surveillance of antimicrobial resistance for other pathogens will be introduced over time using the lessons learned from this initiative.

It has been acknowledged that resistant microbes occur in humans, animals as well as the environment. This therefore calls for a One-Health approach in containing the problem. However, this plan will only focus on human and zoonotic organisms. It is anticipated that similar surveillance plans will be developed addressing the problem in animals and the environment. This data will then be aggregated to create a national one-health AMR surveillance system that will better inform more comprehensive containment strategies.

1.2 Situation Analysis

1.2.1 Epidemiologic Burden of AMR in Uganda

Prevalence data on AMR of public health importance in Uganda is obtained from published studies, student dissertations and summary reports from various laboratories. The absence of a national AMR surveillance system precludes the availability of comprehensive antibiotic resistance data. Several studies have shown that 30 – 50% of *Staphylococcus aureus* isolated over the period 2010 to 2015 were MRSA (UNAS, 2015). Importantly, *Streptococcus pneumoniae* strains isolated from oropharyngeal or nasopharyngeal specimens demonstrated a high prevalence of low-level (intermediate) resistance to penicillin ranging from 72% among HIV-infected adults, through 83.5% among healthy infants to 100% among children with sickle-cell anemia (UNAS, 2015). Vancomycin resistance amongst Enterococci isolated from the milk of cows with mastitis stood at 16% in one study while a study of surgical-site infections at Mulago Hospital reported Vancomycin resistance at 4.4%. Resistance to 3rd generation cephalosporins, some of the most widely used antibiotics in the country, ranges from 3% among fecal and urine carriage isolates from 2002 to as high as 70% among the blood culture isolates of 2014. Remarkably, resistance to carbapenems among Gram-negative rods was reported at 6% among isolates from Mbarara Hospital and at 10% among blood culture isolates at Makerere University (UNAS, 2015). As in other countries, resistance to flouroquinolones among *N. gonorrhoeae* is highly prevalent (WHO, 2018a).

1.2.2 Status of AMR Surveillance in Uganda

Uganda has a limited range of antimicrobial resistance surveillance activities associated with specific vertical disease programs. The National Tuberculosis and Leprosy Control Program operates a referral system for sputum culture and susceptibility testing for *tuberculosis* from treatment failure and retreatment cases. The program has also deployed Xpert MTB/RIF PCR-based systems for the detection of rifampicin-resistant tuberculosis across the country.

These provided data on rifampicin resistant Mycobacteria. The Malaria Control Program conducts periodic antimalarial resistance surveys to inform national treatment guidelines. The AIDS Control/ Sexually-Transmitted Infections (STI) program carried out a survey on antimicrobial susceptibility among *Neisseria gonorrhoeae* in 2010 and used the data to develop the current guidelines for syndromic management of STIs. Academic institutions have conducted a number of studies on antibiotic resistance among various bacterial agents with some of the studies published in peer reviewed journals. However, these are mostly student-driven research with limitations in geographical coverage and sample size. The Makerere University Walter Reed Project pioneered systematic antibiotic resistance surveillance which has been running since 2012(Byarugaba et al., 2016), however, it is limited in geographic coverage only operating at two hospital sites. Indeed, the system has not only generated good data on the resistance situation over time, but has also highlighted the challenges and opportunities for maintaining long term AMR surveillance in the country.
The country currently has no system for generating representative data on antimicrobial resistance, analyzing it and disseminating it to inform policy.

Currently, there are relatively few laboratories in the country that routinely perform microbiological cultures. According to a situation analysis commissioned by the Uganda National Academy of Sciences through its Global Antimicrobial Resistance Partnership committee in 2014 (UNAS, 2015), only 2 of the 7 regional referral hospitals assessed had most of the equipment, personnel and a reliable supply of consumables for routine testing, 3 of the 7 had a fair level of resourcing while 2 of the 7 were very poorly resourced. The situation was similar in the private not-for-profit facilities assessed. Mulago and Butabika National Referral Hospitals were better placed with appropriate staffing and most of the equipment. In addition, laboratories often face the challenge of lack of standardization of the testing with many using inappropriate testing protocols and inadequate quality-control procedures. As such, the utility of the data generated by some of the laboratories for surveillance is questionable.

Establishing a microbiological diagnosis is often not possible for many clinicians save for HIV, malaria and tuberculosis. Due to constrained budget, equipment and consumables for microbiological cultures are not readily available. Currently, only a few referral hospitals receive supplies for culture and susceptibility testing from the National Medical Stores. As

such, the volume of microbiological testing is too low to provide meaningful surveillance data particularly for antibacterial resistance.

The country does not have guidelines for the collection and management of data for AMR. In part, this reflects the absence of generic international guidelines from WHO before the development of the WHO-AFRO guidelines in 2013 and the Global Antimicrobial Resistance Surveillance System (GLASS) in 2015. Consequently, laboratories generating data have no mechanisms of incorporating it into the National Health Management Information System (HMIS).

Most laboratories use paper-based systems, making collating and analysis of antimicrobial susceptibility data laborious. Even among laboratories with e-HLIMS, the systems were not designed to capture critical information such as zone diameters for disk-diffusion susceptibility tests. As such, data cannot be readily retrieved from the HLIMS into software for the management of antimicrobial susceptibility data.

1.2.3. Opportunities for AMR surveillance

Despite the many challenges Uganda faces in establishing an AMR surveillance system, there are a number of opportunities that could facilitate the development and implementation of such a system. As one of the countries at the 56th World Health Assembly, Uganda adopted the Global Action Plan (GAP) on antimicrobial resistance and undertook to develop a National Action Plan (NAP) for AMR. The Ministry of Health's Epidemiological Surveillance Division (ESD), recently upgraded to the Integrated Epidemiological Surveillance Department (IESD), is staffed with epidemiologists who are responsible for coordinating disease surveillance systems. The HMIS that is managed by the MOH Division of Health Information, which collects and analyzes data from all health facilities in the country using the District Health Information System version 2 (DHIS-2). Since 2000, the ESD has been summarizing HMIS data for various priority diseases and disseminating through a weekly bulletin. Clearly, AMR surveillance could take advantage of these systems.

Though lacking in personnel, the microbiology laboratory at the Uganda National Health Laboratories and Diagnostics Services Department (UNHLDS) is a fully-equipped microbiology laboratory and has a large repository equipped for the long-term storage of isolates from the entire country. Microbiology laboratories at the Makerere University College of Health Sciences, the Uganda Virus Research Institute and Mbarara University of

Science and Technology are also well resourced to act as back-up laboratories for the national laboratory. The country also has a national specimen referral system that already transports a variety of specimens from peripheral health units to regional and national referral laboratories.

Some development partners have taken up the prevention of AMR as part of their agenda for support to Uganda. Under the US Global Health Security Agenda, the Unites States' Centers for Disease Control and Prevention (CDC) is funding a cooperative agreement to support AMR surveillance in Uganda awarded to the Infectious Diseases Institute (IDI). The World Bank, through the East African Public Health Laboratory Networking Project has undertaken to support AMR surveillance in 7 hospitals including Arua, Lacor, Mulago, Mbale, Fort Portal, Moroto and Mbarara. The United Kingdom has launched the Fleming Fund intended for low- and middle-income countries to develop a network of laboratories to support AMR surveillance.

There is commitment from the government through the NAP to set up a functional surveillance system

1.3 Justification for AMR Surveillance

At a global level, antimicrobial resistance is associated with antibiotic use naturally, however the progress is more rapid when there is misuse and overuse. (WHO, 2018b). According to the Uganda National Academy of Sciences (UNAS) report (a situational analysis) on antimicrobial resistance in Uganda (UNAS, 2015), there is increasing trends in antimicrobial resistance. More so, in Uganda, there is no AMR surveillance system in place. Surveillance for AMR provides important information that allows for the identification of trends in pathogen incidence and antimicrobial resistance, including the identification of emerging pathogens at national and global levels. Routine surveillance is critical for creating and refining approaches to controlling AMR and for guiding clinical decisions regarding appropriate treatment (WHO, 2015b). AMR surveillance can generate data to:

- Inform patient management and infection control policies and other interventions,
- Inform antibiotic stewardship,
- Foster and complement scientific research,
- Act as an alert system to inform policy makers on emerging and re-emerging highly resistant bacterial infections.

1.4 Objectives of the Uganda AMR Surveillance Program:

1. To estimate the extent and burden of AMR in major bacterial pathogens in Uganda,
2. To analyze and report Uganda data on AMR on a regular basis,
3. To detect emerging AMR in Uganda,
4. To inform the implementation of targeted prevention and control measures,
5. To assess the impact of interventions.

CHAPTER TWO: AMR SURVIELLANCE GUIDING PRINCIPLES

This chapter outline the key guiding principles and scientific methods in which the national AMR program is rooted.

2.1 GUIDING PRINCIPLES

The surveillance plan was developed in the spirit that:

1) Antimicrobial resistance is a recognised global health problem that requires international attention and collaboration,

2) The detection and control of antimicrobial resistance calls for a "One-Health" approach to disease surveillance that recognizes that resistance can arise in humans, animals, and the environment,

3) A phased approach is important in developing an integrated AMR surveillance program that has links to food and agricultural sectors.
4) The national AMR surveillance program should be aligned to national priorities and the WHO Global Antimicrobial Resistance Surveillance System (GLASS).
5) This surveillance plan is cognisant of the existence of other vertical antimicrobial surveillance programs for Malaria, TB, HIV etc.

2.2 Types of surveillance:

The choice of surveillance strategy used will reflect scientific or public health problems, taking into consideration the availability of resources, laboratory testing capacity, technical capacity to interpret results and sustainability of the program. Given the wide scope of antimicrobial resistance (Antibiotics, antivirals and antimalarial resistance), a combination of different approaches will be considered for this program (WHO, 2018c). The type of surveillance to be employed include:

- **Alert organism tracking**: This will involve the identification, confirmation, and communication of specific organisms of great public health importance, such as extensively drug-resistant *Mycobacterium tuberculosis* (XDR-TB), vancomycin-resistant *Staphylococcus aureus*, carbapenem-resistant *Pseudomonas aeruginosa*.
- **Passive surveillance**: Here surveillance site on a reporting network will be required to collect and interpret routine data and submit regular reports to ministry of health. This form of surveillance will be used for antimicrobial resistance

surveillance in the country because it is cheap and sustainable, although the data generated may be incomplete, inadequate, or untimely (McDonald, 2012)

- **Enhanced passive surveillance**: Refers to the active review, interpretation, confirmation, and investigation of results generated in the course of routine clinical care. This may involve ministry of health collecting additional specific information about the cases in addition to routine data (McDonald, 2012, WHO, 2018c) .
- **Active surveillance/Targeted surveys**: In addition to the information generated from the above surveillance types, AMR data shall be generated by one time or periodic study protocols to address specific scientific or public policy needs not adequately addressed by routine diagnostic test results. This type of surveillance will be applied to HIV drug resistance and special situations when data on a new resistance phenotype of public health importance is needed urgently (Stelling and Anibal, 2003) (WHO, 2018c).

2.3 ARM surveillance implementation methods

Sentinel site surveillance will be used to generate AMR data; sentinel sites are selected because the information can be generalised to the target population. The sites are selected based on geographic location, medical specialty, and ability to report high-quality data. Sentinel surveillance is very useful for answering specific questions and it's cheaper than population based surveillance. However, if the sentinel sites are not selected properly the data may not be representative of the general population (McDonald, 2012). Nonetheless, for a new surveillance program, sentinel sites selection has to take into account practical considerations; for example, data volume and quality, staff and financial resources, and logistics (McDonald, 2012).

2.3.1 Selecting surveillance sites

AMR surveillance sites shall be selected to ensure balanced geographic, demographic and socio-economic distribution across the country.

The selected sites shall meet the following pre-requisites:

- Access to adequate epidemiological and laboratory expertise to enable collection, analysis and reporting of data.
- An adequate health-care infrastructure that allows proper collection of clinical specimens and microbiological cultures as part of routine patient care.

- Access to microbiological testing capacity for isolation of bacteria and their antibiotic susceptibility testing. This may be on-site or through a specimen referral system.
- Capacity to sustain surveillance at the facility over time to enable analysis of trends.

Besides, Academic research institutions (centres of excellence) and other facilities that routinely perform microbiology and have attained and maintained WHO/AFRO - SLIPTA Star four status or some other form of accreditation shall be eligible for participation. The terms of reference and operations at the sentinel sites are described in the site surveillance manual.

2.3.2 Surveillance Approaches

To ensure that adequate patient and microbiology information data is collected efficiently and sustainably, the following combination of surveillance approaches shall be used at the sentinel sites (WHO, 2015b).

A. Case-finding surveillance based on routine clinical specimens at sentinel surveillance sites.
B. Case-based surveillance of clinical syndromes at sentinel sites.

A. Case-finding based on clinical specimens sent routinely to the laboratory:

This approach shall be used for bacterial pathogens and tuberculosis. It entails capture of demographic and clinical data from the laboratory request forms in addition to microbiological data generated in the laboratory.

For bacterial pathogens, the surveillance subcommittee of the Uganda National AMR Committee shall draw up and periodically review a list of anatomical sites (types) of infection, pathogens and pathogen – antimicrobial combinations for surveillance in line with the WHO GLASS recommendations as well as country priorities.

The antibiotics-pathogen combinations for surveillance shall be selected based on:

- Clinical utility of the antibiotic as one of the preferred agents (e.g. first-line antibiotic)
- An antibiotic being a surrogate for detection of resistance among commonly used antimicrobials
- Ability to detect resistance types of great public health concern.

For tuberculosis resistance surveillance, results of Xpert MTB/RIF shall be used to capture the status of rifampicin susceptibility at the various facilities where the instruments have been deployed. Data for susceptibility for the other antibiotics shall be captured from culture/line probe assay tests on sputum of patients found to be

rifampicin resistant on the Xpert MTB/RIF and retreatment cases which is routinely referred to the NTRL.

B. Case-based surveillance of clinical syndromes at sentinel sites

This approach shall target patients in defined populations presenting with symptoms/signs fitting case definitions of interest. It shall be used particularly for situations where cases are few and or organisms difficult to handle in the laboratory. Syndromic surveillance can be applied to outbreak situation, for example cholera and typhoid to determine the incidence of these disease. The clinical protocol on AMR surveillance captures some of the clinical syndrome for ARM surveillance at the sentinel sites. While laborious and costly (WHO, 2015b), surveillance of clinical syndromes shall be essential in:

- Redressing some of the potential problems seen with routinely generated data like lack of detailed clinical and epidemiological information.
- Providing more precise data about the burden of AMR in a population.
- Estimating the incidence of a resistant infection in a population.

2.4 AMR surveillance Implementation strategy

The implementation of Antimicrobial Resistance surveillance in the country will follow a phased approach, this approach was chosen because it allows for capacity building, iterative learning, and effective allocation of financial and human resources while continuously generating the required evidence. The initial phase is expected to produce capabilities, processes and tools that will be used to scale up and standardise AMR surveillance (McKenzie et al., *n.d*). Although a syndromic approach is expensive it was used as a spring board in phase 1 to build laboratory capacity of the sentinel sites and reference laboratory to isolate bacterial pathogens from particular infectious syndrome and perform antibiotic sensitivity testing. It expected that phase 2 will use this platform and capabilities to sort, set up, shine and standardise core case-based AMR surveillance. During this phase, emphasize will put on setting up management and reporting structures, and providing the necessary documents, trainings and supplies to support core passive surveillance (LSTMH, 2016). If the AMR surveillance information collected during this phase is of sufficient quality, the country should be able to participate in GLASS and use the data to inform policy and decision making. Phase 3 will be built on the capability of phase 2 to sustain, improve, extend, and advance passive surveillance. During phase 3 information on MICs and extended clinical epidemiological variables will be may be collected and analysed to provide deep understanding of AMR (LSTMH, 2016). Also, the country may consider using automated systems and incorporating AMR surveillance in medical curriculum (LSTMH, 2016).

CHAPTER THREE: LEADERSHIP, ORGANIZATION AND CAPACITY BUILDING

3.1 Leadership, Organization

The Antimicrobial Resistance National Action Plan (NAP) that was launched in 2018 lays out the leadership framework to support antimicrobial resistance surveillance in the country (GoU, 2018). With the need to have a multi-sectoral approach to combating AMR, the AMR National Action Plan (AMR-NAP) designated the National Antimicrobial Resistance Sub-Committee (NAMRSC) of the OHTWG to oversee and provide overall coordination of the implementation of the NAP in a one health approach. The NAMRSC is supported by a One Health AMR/AMU Technical Working Committee to implement the surveillance strategic objective of the plan. The leadership, organisation and management structures for AMR surveillance at the One Health level and within the ministry is detailed below.

3.1.1 One Health AMR & AMU/C Surveillance Committee

To facilitate implementation of AMR and AMU/C surveillance activities; a One-Health AMR/AMU surveillance Technical Working Committee (a sub-committee of the NAMRSC) has been formed and its functions are as below:

Support Surveillance of AMR

1. Support the implementation of a national AMR surveillance programme to generate actionable data.
2. Develop Standard Operating Procedures (SOPs), methodologies and data collection tools for surveillance of AMR in humans, Animals (Wildlife & Veterinary medicine), Environment, Food and Agriculture that are consistent and harmonized with international standards.
3. Strengthen and support the improvement of laboratory infrastructure, human resource, access to laboratory supplies and equipment for microbiological testing and quality data reporting platforms.
4. Support the routine generation and use of microbiological data on culture and sensitivity tests (diagnostic stewardship) for prioritized microorganisms and antimicrobials in health facilities, agriculture, food chain, wildlife and environment.
5. Support mechanisms for quality assurance systems and supervision to improve availability and reliability of routine microbiology laboratory testing.

6. Analyse, disseminate and share surveillance data and information to facilitate decision making on diagnoses and treatment in clinical public health, veterinary practice, environment & wildlife laboratories and food technologies.

7. Support One Health networks for data sharing at national and regional levels as well as systems for linking microbiology data to clinical and pharmaceutical data to support decisions for AMR prevention and control.

8. Establish an early warning system and monitor trends to determine the risk factors and drivers of resistance, resistance burden, impact on public & animal health, and the economy.

9. Utilize data generated, including all regions of the country and hard-to-reach areas, to evaluate and improve intervention outcomes.

10. Ensure the inclusion of AMR as a priority in the risk register, MDA plans, and any other mechanisms as needed.

Support Surveillance of Antimicrobial Use

1. Design and implement a national antimicrobial use surveillance plan that defines surveillance activities and the roles consistent with international surveillance standards.

2. Develop and implement procedures and methodologies for monitoring antimicrobials imported, used and disposed of in Uganda.

3. Monitor prescribing practices, dispensing practices, client/community use and consumption patterns in human health care settings, veterinary health practice, agriculture, aquaculture, traditional herbalists (indigenous technical knowledge groups) and communities.

4. Support collection and sharing of data to evaluate and monitor interventions aimed to improve appropriate use and access to antimicrobials.

5. Coordinate with the stewardship committee for action on the AMU/C surveillance data.

6. Support establishment of a central data collection centre accessible to all stakeholders

3.1.2 National Coordination Center (NCC) of AMR Surveillance:

AMR surveillance for HIV, Malaria, tuberculosis and bacterial/fungal pathogens shall be coordinated by the respective programs or reference laboratories as outlined below:

- Tuberculosis – National Tuberculosis and Leprosy Program

- Malaria – National Malaria Control Program
- HIV – Uganda Virus Research Institute/AIDS Control Program
- Bacterial/Fungal Infections – Uganda National Health Laboratory Services (UNHLS) (National Microbiology Reference Lab)

Each of these programs/ shall designate one of the following; epidemiologist, Clinical Microbiologist or Public Health expert as the AMR focal person.

The NCC for AMR surveillance in human Health shall oversee AMR surveillance activities in humans ensuring that the AMR surveillance system is functional. The NCC will be operationalized by three arms, the MoH AMR/AMU TWC which is linked to the OH AMR/AMU/C TWC, the epidemiology unit and the national reference laboratory. The NCC secretariat shall be based at UNHLS. The NCC should be able to conduct continuous monitoring and evaluation of the surveillance system (WHO, 2016, 2015b). The roles and responsibilities of each of the functional arms of the NCC are outlined below:

A. MoH AMR & AMU/C Technical Working Group

The human health AMR/AMU TWG which is the technical arm of the MoH National Coordination Centre (NCC) should have the following functions:

- Reviewing and defining national AMR surveillance goals and objectives within the national AMR strategy
- Preparing and disseminating national surveillance protocols.
- Coordinating data collection, analysis and reporting on the AMR situation to inform the national strategy.
- Sharing national aggregated data with other collaborators through the One Health Data Integration and Sharing Center (DISC) and with WHO and other regional and international agencies.
- Updating the Surveillance Sub-committee of the National Antimicrobial Resistance Committee on the status of AMR.
- Monitoring and evaluating the national AMR surveillance system.
- Designating a national AMR surveillance focal person to coordinate surveillance activities, data management and dissemination of surveillance reports.
- Coordinating linkages between human and animal AMR surveillance programs.
- Organize enrolment of new surveillance sites.

- Confirm unusual or new resistance patterns and report to the relevant authority

Membership of TWG

The AMR & AMU/C TWG will be composed of technical personal from the relevant departments in the ministry of health, professional associations and academia. The TWG shall remain small enough to maintain functionality, striking a balance between broad representation and the functionality of the team to steer the national AMR strategy or plan.

B. The epidemiology unit of the NCC for AMR surveillance in Human Health

The epidemiology unit of the NCC shall be based at UNHLS and will perform the following functions;

- Develop or adapt national protocols for data collection and management.
- Disseminate data management protocols and tools, and train staff in their use.
- Collect data on the progress or status of implementation
- Review national AMR data (formatting and aggregation)
- Consolidate and conduct data quality assurance (ensure that the data is of good quality)
- Support surveillance sites in collecting, analyzing and reporting epidemiological, clinical and laboratory data
- Support sentinel sites on data management, analysis and validation
- Ensure appropriate data storage.
- Review and recommend introduction of new technologies

C. National Reference Laboratory for AMR in Human Health

Each category of pathogens shall have a designated reference laboratory as follows:

- Tuberculosis – National Tuberculosis Reference Laboratory
- Malaria – Uganda National Health Laboratories services (with the Makerere University College of Health Sciences Malaria Laboratory as a backup)
- Bacteriology & Mycology - Uganda National Health Laboratories
- HIV – Uganda Virus Research Institute

The UNHLS shall be the National Reference Laboratory (NRL) for AMR in the Human Sector. It shall provide technical support to the AMR surveillance system through:

- Serve as a resource and coordinating point for laboratory expertise and share information with stakeholders

- Providing diagnostic stewardship programs that encourage adequate and appropriate utilization of microbiological services.
- Harmonizing testing protocols between participating laboratories.
- Monitoring and supporting quality assurance systems in participating laboratories.
- Confirming unusual or new resistance patterns before they are reported to the NCC.
- Providing molecular testing to study the prevailing mechanisms of resistance and for epidemiological typing of strains.
- Provide surveillance sites with guidance and technical support in AST and quality management (including coordinating external quality assurance schemes for participating laboratories).
- To liaise with the other arms of the NCC in standardizing and verifying microbiological results.
- Collaborate and conduct research in microbiology

The NRL shall identify at least 2 in-country institutional laboratories to act as a back-up for its reference testing functions and the Makerere University College of Health Sciences and Mbarara University of Science and Technology Microbiology Laboratories will serve this purpose. It shall also identify a collaborating international reference laboratory for support in case there is a need to refer specimens with highly unusual findings.

3.2 Capacity Building and Sustainability

Setting up a successful AMR surveillance program will require government commitment for sustainability. Through the National Action Plan, the government has indicted its commitment to this cause. Generating the much required quality evidence in a sustainable manner means that the ARM surveillance program in human health should take advantage of the existing systems at the designated sentinel sites. This approach calls for a need for capacity building at the different levels to have a functioning surveillance system. The site surveillance manual and clinical surveillance protocol which operationalize this AMR surveillance plan are intended to build capacity of the sentinel sites for AMR surveillance. These documents provide site surveillance teams with further details to guide and generate accurate and representative AMR data. However, it important to highlight and keep important capacity areas that will be promoted by the NAMRSC and NCC to ensure that the surveillance system produce the much needed evidence. These include:

3.2.1 Diagnostic Stewardship at surveillance sites

The AMR surveillance program shall ensure coordinated efforts to mentor both clinical and laboratory personnel in the appropriate use of microbiological services. This shall promote appropriate, timely diagnostic testing and effective patient management. It shall in the process facilitate AMR surveillance by increasing patient sampling, reducing bias and ensuring that all necessary data is captured on the laboratory request form. The site surveillance manual provides sites with details on how to promote diagnostic stewardship.

3.2.2 Human resource capacity for AMR surveillance

A human resource engagement and development plan shall be developed to address the major gaps in laboratory and surveillance personnel; that are a bottleneck to the collection of surveillance data. This shall entail:

- Performing a comprehensive gap analysis,
- Seeking support from government and development partners to recruit suitable personnel, building capacity of newly-recruited and existing personnel through training and mentoring.

3.2.3 Resource Mobilization and Financing for AMR

Implementation and expansion of AMR surveillance in Uganda shall require financial resources to build and enhance the capacity to detect AMR and monitor trends, to develop and coordinate structures and guidelines/plans. Sourcing of funds to allow implementations shall be done through the country's resource mobilization frameworks. Resources shall be mobilized through:

- **Advocacy**. Public awareness of the burden of AMR in Uganda shall be raised at national and international levels through engaging key stakeholders notably government (parliament and relevant MDAs), development partners, academia as well as the private sector.
- **Partnerships.** These shall be built with health development partners, the private sector and collaborating national and international institutions.
- **Research and innovation** The NCC shall spearhead the development of a national research agenda for AMR. Operational research shall be adopted as one of the strategies to not only improve the use of antimicrobials in hospital or community

settings but also as a mechanism to attract funding and grants from institutions or government entities with similar research agendas.

CHAPTER FOUR: DATA MANAGEMENT AND REPORTING

4.1. Data management

The primary data source shall be the microbiology laboratory request form and microbiology result report. The request form should capture basic demographic, clinical and microbiological variables.

In the case of bacterial infections, the following core patient data (WHO 2015, LSTMH, 2016) should be captured:

- Age,
- Gender,
- Specimen type (anatomical site of specimen),
- Date of sampling,
- Clinical diagnosis
- Hospital or community origin of infections (Specimens collected $\geq$ 48hours after hospitalization are considered of hospital origin while those collected from out-patients or earlier <48hours of hospitalization are of community origin. The date of admission may be required to determine origin)

Note: All microbiology request forms and microbiology result reports should be filled out completed and accurately to ensure data quality and inform patient management. However, for epidemiology reporting and analysis the above core variable will be required.

Variables generated in the laboratory shall include:

- Presence or absence of pathogen growth,
- Species identification of the isolated pathogen,
- Antibiotic sensitivity of the isolates based on zone diameters or minimal inhibitory concentrations (MICs),

At the surveillance sites, patient clinical, epidemiological and microbiology laboratory data shall be captured into an appropriate electronic data management system such as ALIS, WHONET, ms excel or any other e-HLIMS. However, it is recommended that data be captured using the e-HLIMS which should export a dataset that shall be imported into WHONET for analysis. WHONET is a WHO-developed database application used in AMR testing laboratories for the management and analysis of microbiology and epidemiology data. The software has been customized to analyze microbiology data on RIS with corresponding

95% confidence interval. Laboratories that use paper-based data collection tools, will capture data on the daily microbiology register and use WHONET for data analysis.

4.2. Reporting

Facility surveillance committees shall perform data quality checks to ensure completeness, timeliness and accuracy as well removing duplicates. In the case of bacterial pathogens, only one result should be considered for each type of pathogen for each specimen type for a period of one year (WHO, 2015). For example, if Escherichia coli is isolated from 2 different blood cultures of the same patient within one year, only the first result should be considered. Upon approval of quality, the site surveillance committee shall transmit data to the NCC in a timely manner.

The NCC shall conduct additional checks for data quality. The data will be aggregated and reported according to the AMR surveillance indicators set by the country and WHO GLASS. The structure for reporting of aggregated data by the NCC is laid in annex 3 and these AMR indictors will be used to track the extent and magnitude of AMR in Uganda. The surveillance site may also aggregate and report their data according to these indicators to help them understand the burden of AMR locally. The NCC report should describe the methodology, interpretation of results, limitations and conclusions (WHO, 2016). The NCC is mandated to disseminate human health AMR report to the MoH, surveillance sites, and other key stakeholders. Such reports shall provide an evidence-base to inform control measures and clinical guidelines. The NCC shall routinely submit data through the Data Sharing Centre (DISC) to the one health platform according to indicators in Annex 3, and report on new or unexpected resistance patterns to the relevant national authorities in a timely manner. The NCC will also submit aggregate data in the GLASS format to WHO and other regional bodies to inform regional and global efforts.

Finally, the flow of AMR surveillance data described in this chapter is illustrated in Annex 1. This diagram should guide surveillance site teams and the NCC to ensure proper utilization and dissemination of AMR data.

CHAPTER FIVE: MONITORING & EVALUATION

Monitoring and evaluation should be an integral part of the development of a national AMR surveillance system. Monitoring and evaluation is important to track implementation and helps to detect problems that may impact on the program success. It, thus, allows for continuous improvement of the program and builds capacity towards participation in GLASS (WHO, 2016). In Uganda where resource allocation may not be sufficient in the early development of the program, M&E allows tracking of resource allocation and cost-effectiveness assessment of different strategies. The monitoring and evaluation function will be the mandate of the NCC assisted by stakeholders from academia and implementing partners with technical expertise in Monitoring and Evaluation of AMR surveillance. The extent of the evaluation will also be guided by available resource (Harris, 2010).

5.1. Monitoring and Evaluation Principles

A. Models: To achieve the goal of the AMR surveillance program in Uganda; that is, "...to generate the knowledge and evidence needed through surveillance for identifying emerging and re-emerging AMR issues and informing best practices for slowing down AMR and guiding policy using the One Health approach", the country and implementing partner will need to invest resources and develop activities that will produce the required results. These results will eventually lead to the desired outcome of generating evidence that informs policy (WHO, 2016, Harris, 2010). This pathway describes a logic model of the program, and indictors have been developed to monitor the different components of the logic model. The M&E framework (annex 2) will track development of the AMR surveillance program and capacity of the program to generate quality data that can informs treatment guidelines and control measures of AMR. The M&E framework will also be used to monitor resource allocation and sustainability of the program.

The evaluation process will be guided by participation, collaboration and equitable partnership so as to allow co-learning and capacity building. Stakeholder participation will be at the core of this process to permit contextualization customization and usability of evaluation findings that is a participatory model of evaluation will be applied (Harris, 2010).

B. Methods: In the first 5 years of the plan, monitoring and evaluation will focus on process evaluation to ensure that activities are implemented with high fidelity while informing the NCC on the need to change strategy. This evaluation targets the following components. 1) Establishment of structures to support AMR surveillance, 2) core functions and quality of the surveillance program to collect analysis data and report AMR indicators, and 3) support functions like trainings to enable proper implementation of the core functions. Process evaluation will be carried out as a time-series every year to allow comparison of trends and document progress (Harris, 2010). The data collection methods should involve both quantitative and qualitative methods and the M&E team of the NCC will be responsible for developing or adapting the tools to support monitoring and evaluation.

After 5-years of the implementation of the plan, the NCC should consider conducting outcome evaluation using less rigorous designs. This may take the form of a surveys that will employ both qualitative and quantitate methods. Outcome evaluation should enhance the AMR surveillance system's ability to generate data that informs National policy and clinical guidelines (GoU, 2018, WHO, 2016). The NCC may consider conducting an efficiency assessment (cost-benefit or cost-effectiveness) of the program depending on the resources and technical expertise available (Harris, 2010).

The M&E report will be submitted to the ministry of health, one-health platform and other stakeholders and should cover the methods, interpretation of results and recommendation The reports should be used to design remedial interventions, quality improvement, projects and enlighten planners and implementations to define SMART objectives.

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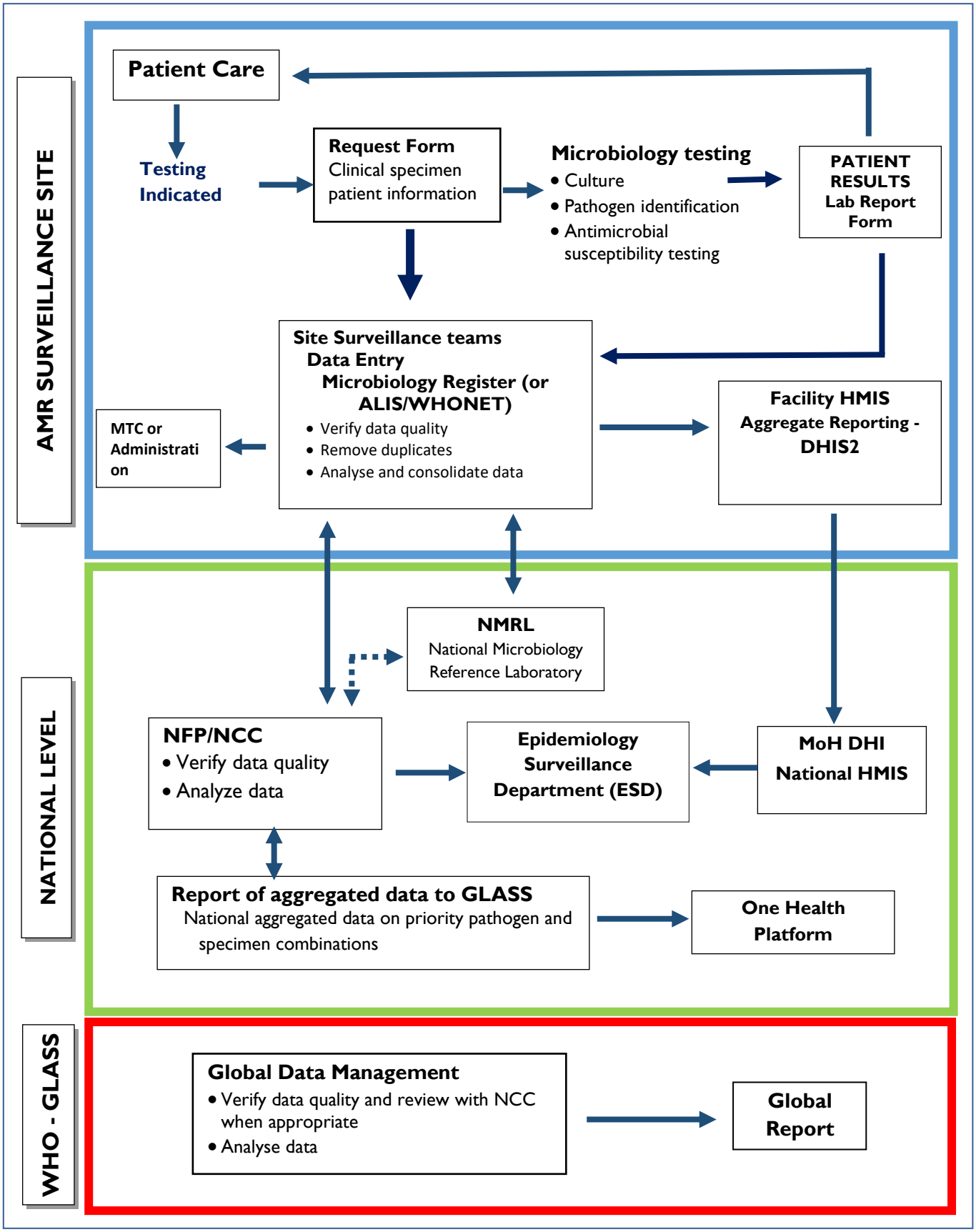
Annex 1: A schematic view of the AMR information flow



Annex 2: Monitoring and Evaluation Framework: Human Health Key Performance Indicators

1) Human Health AMR Surveillance Capacity Indicators

No	Indicator	Justification/purpose of indicator	Indicator definition/notes	Data Source	Disaggregation	Reporting Frequency	Indicator Level	Target	Responsible
Surveillance structure									
01	Presence of a fully functional National Coordinating Centre (NCC)	To track evolution and development of national oversight on AMR	A NCC with mandate, terms of reference (ToRs) and responsible person (focal point) is established. • A national multi -sectoral body responsible for AMR surveillance activities in the country. • Review performance of AMR surveillance system at national and sub-national level.	Assessment report. By the UNAMRSC	N/A	Annual	Input	1	UNAMRSC
02	Proportion of -quarterly AMR surveillance TWG meetings reports in a year that discuss AMR surveillance reports in humans	To measure the functionality of the NCC AMR TWG	In this context a year is within the calendar year, or 12 months. Can be defined at the point of initiation of the indicator. Provide a narrative that describes: - Number of NCC meetings - Number of meetings where AMR surveillance reports in humans tabled for discussion - Type of issues discussed - Key decision /action points - Overview of number /type of AMR NCC AMR TWG participants present for these discussions - Any other relevant contextual factors	NCC quarterly report	N/A	Quarterly	Output	4	UNAMRSC
03	Presence of National Focal Point (NFP)	To check the presence of a communicating mechanism for AMR surveillance activities in the country	Clearly defined mechanism of communication for AMR surveillance activities in the country	Appointment letter with well-defined TORs	N/A	Annual	Input	1	UNAMRSC

No	Indicator	Justification/purpose of indicator	Indicator definition/notes	Data Source	Disaggregation	Reporting Frequency	Indicator Level	Target	Responsible
04	Proportion of funding available for AMR surveillance activities	Tracking resource mobilisation for AMR surveillance activities	N: Available resources to implement planned annual AMR activities D: Estimated annual expenditure for planned AMR activities	Annual ministerial policy statement Annual AMR surveillance work plan	N/A	Annual	Input	1	UNAMRSC
05	Presence of a designated National microbiology Reference Laboratory (NMRL)	Measuring capacity for national microbiology reference testing	At least one NMRL is designated with agreed terms of reference to support national AMR surveillance system	Assessment report. By the UNAMRSC	N/A	Annual	Input	1	UNAMRSC
Core functions & Quality of Surveillance									
06	Proportion of priority specimen types analysed for AMR	To track capacity for AMR testing by specimen type	Priority specimen types (6) are; Blood, Urine, Stool, Urethra swab, Cervical swab and cerebral spinal fluid (CSF) N: Number of priority specimen types analysed in the AMR surveillance program D: Number of priority specimen types in the AMR surveillance program	Quarterly AMR surveillance reports	National, sub-national/regional,	Quarterly	Process	100%	NCC
07	Proportion of designated AMR sentinel sites undertaking AMR surveillance in humans	To truck coverage and access to AMR services	There are 25 designated sentinel AMR surveillance sites as per the AMR NAP N: Number of sentinel sites analysing samples for AMR surveillance D: Number of designated sentinel sites	Monthly Facility AMR surveillance reports, Quarterly NCC AMR surveillance reports	Geographical location (health regions), National and subnational /regional	Monthly, quarterly and annually	Output	100%	NFP, NMRL, Sentinel sites
08	Contamination rate	To track quality of microbiology techniques	Define contamination (provided for Adhoc) N: Number of contaminants identified D: Number of samples	Microbiology register	Specimen type	Monthly	Output	<5%	Facility Lab Manager

No	Indicator	Justification/purpose of indicator	Indicator definition/notes	Data Source	Disaggregation	Reporting Frequency	Indicator Level	Target	Responsible
			cultured with pathogenic bacterial growth						
09	EQA Pass rate of the NMRL	To track proficiency of the NMRL to produce quality results	• External quality assessment (EQA) describes a method that allows for comparison of a laboratory's testing to a source outside the laboratory. This comparison can be made to the performance of a peer group of laboratories or to the performance of a reference laboratory. 99% EQA score required	EQA report	N/A	Bi-annually	Output	95-%	Quality Assurance Officer - NHLDS
10	EQA performance of the sentinel AMR sites	To track proficiency of the sentinel AMR surveillance sites to produce quality results	Sentinel sites are participating in an EQA scheme for microbiology N: Number of AMR sentinel sites passing EQA in bacteriology D: Number of designated AMR sentinel sites participating in EQA	EQA report	N/A	Quarterly	Output	100%	Quality Assurance Officer - NHLDS
11	Capacity within National Reference Laboratories to detect and confirm alerts for antibiotic resistant bacteria	To track capacity of the NMRL to detect and confirm unusual AMR results Capacity to confirm unusual type of AMR either within the laboratory or at a reference laboratory. (WHO provides a suggested list of AMR profiles considered as "unusual AMR events". Countries should use these to assist with identifying any unusual	Number of tests performed at the centre. Number of un-usual events reported by the NMRL Number of trained Laboratory staff Availability of materials required to perform the work	Capacity assessment report	Type of unusual AMR event	Bi-annual	Process		NHLDS

No	Indicator	Justification/purpose of indicator	Indicator definition/notes	Data Source	Disaggregation	Reporting Frequency	Indicator Level	Target	Responsible
		local resistance. Besides detecting unusual resistance this also frequently identifies errors and is therefore an important quality indicator).							
12	Proportion of sentinel sites sending all isolates to the NMRL	To conduct quality assurance for sub-national capacity for AMR surveillance	Proportion of sentinel sites sending isolates to NMRL for confirmatory testing, quality assurance or molecular testing N: Number of sentinel sites sending isolates to NMRL D: Number of designated sentinel sites	Monthly NMRL report	Isolates	Monthly	Output	100%	NMRL
13	Proportion of sentinel sites sending all isolates to NMRL that register 90% agreement with NMRL test results	To track quality testing capacity for sentinel sites to correctly identify isolates (isolate ID agreement) and adequately perform AST (AST agreement)	N: Number of sentinel sites that register 90% agreement with NMRL test results D: Number of sentinel sites that sent isolates to NMRL	Monthly NMRL report	Surveillance sites, type of organism	Monthly	Output	100%	NMRL
14	Proportion of sentinel sites submitting surveillance reports to the NCC	To track submission of AMR data within the surveillance system	Number of designated AMR sentinel sites reporting to NCC. N: Number of sentinel sites submitting reports D: Number of designated sentinel sites	Monthly AMR surveillance report	N/A	Monthly	Output		NFP
15	Proportion of sentinel sites submitting surveillance reports to the NCC within agreed	To track timely movement and sharing of AMR data within the surveillance system	Timely reporting as stipulated in the HMIS (5th day of the following month) N: Number of sentinel sites submitting reports on time D: Number of designated sentinel sites	Monthly AMR surveillance report	Surveillance site	Monthly	Output	100%	NFP

No	Indicator	Justification/purpose of indicator	Indicator definition/notes	Data Source	Disaggregation	Reporting Frequency	Indicator Level	Target	Responsible
	reporting timelines								
16	Proportion of surveillance sites with complete AMR surveillance reports	To track quality of AMR data shared	100% required data elements completed. N: Number of sentinel sites with complete data D: Number of designated sentinel sites	Monthly AMR surveillance report	Surveillance site	Monthly	Output	100%	NFP
17	Submission of AMR reports to WHO/GLASS	Country contribution to global AMR surveillance system	Annual submission of AMR report to GLASS	Global AMR surveillance report	N/A	Annual	Output	1	NFP
18	Proportion of sentinel AMR sites supporting MTCs utilising data to guide procurement and development of ward protocols	To track evidence to use locally generated AMR data for informing clinical practice	N: Number of sentinel sites supporting MTCs to construct local antibiograms D: Number of designated sentinel sites	Site specific report with methodology and interpretation of results	Surveillance site	Annual	Outcome	100%	Sentinel site coordinating committees
19	Proportion of sentinel sites receiving timely feedback from the national reference laboratory	To track feedback sharing on EQA, isolates testing by NMRL with sentinel sites	Presence of a feedback mechanism between surveillance sites and the next higher level (e.g. regional or national level). NMRL should provide feedback to sentinel sites within 4 weeks of conducting EQA or isolate reception N: Number of surveillance sites receiving feedback from the NMRL D: Number of designated surveillance sites	Availability of report from NMRL	Surveillance site	Quarterly	Process	100%	NCC
Support functions (guidelines and training)									

No	Indicator	Justification/purpose of indicator	Indicator definition/notes	Data Source	Disaggregation	Reporting Frequency	Indicator Level	Target	Responsible
20	Proportion of sentinel sites with SOPs based on Internationally recognized standards to support the implementation of AMR surveillance	To track compliance to national and international standards	N: Number of sentinel sites with SOPs complying with national and international standards D: Number of sentinel sites	Support supervision assessment report conducted by NMRL	Surveillance site	Annual	Input	100%	NMRL
21	Proportion of sentinel sites with constituted surveillance committees trained in AMR surveillance.	To track human resource capacity building progress at sentinel sites and the development of a high performing national AMR surveillance system	This indicator assumes that facility AMR surveillance committees are constituted and is therefore- assessing their training N: Number of sentinel sites with constituted surveillance committees that are trained D: Number of sentinel sites with constituted AMR surveillance committees	AMR surveillance training reports	Surveillance site, cadres	Annual	Output	100%	NCC
22	Proportion of sentinel sites with functional surveillance committees	To provide technical guidance to the implementation of AMR surveillance program at facility level	Functions of the surveillance committees are defined in the national AMR surveillance program (Hold meetings, reporting, sending isolates to NMRL) N: Number of sentinel sites with functional surveillance committees D: Number of sentinel sites with constituted and trained AMR surveillance committees	AMR surveillance committee assessment report	Surveillance site	Quarterly	Output	100%	NCC

Annex 3: Structure for reporting AMR Resistance data by the NCC

No	Indicator	Justification	Indicator definition/notes	Data Source	Disaggregation	Reporting Frequency	Indicator Level	Target	Responsible	Recipient	Report (Source of data)
01	Proportion of patients with an infectious syndrome from whom a sample was taken	To track the need for clinicians to request for samples in line with the provisional diagnosis given	N: Number of patients with an infectious syndrome samples taken D: Number of patients with an infectious syndrome	Inpatient register, Outpatient register Microbiology Register [HMIS 105, HMIS 108]	Gender, age group, origin (Hospital and community), specimen type	Monthly	Output	80%	Facility AMR Coordinating Committee	DHI	N: Monthly SS report D: Monthly HMIS105, 108
02	Proportion of microbiology samples cultured in the reporting lab	To track capacity and quality of microbiology	N: Number of samples cultured D: Number of samples collected for culture	Microbiology registers, ALIS monthly microbiology report, WHONET, HMIS 105	Specimen type	Monthly	Output		Facility AMR Coordinating Committee	NCC	N: HMIS 105 and patient level dataset D: Monthly SS report
03	Percentage of microbiology samples cultured yielding pathogenic bacteria of clinical significance	To track burden of resistance by pathogen type	N: Number of microbiology samples cultured yielding pathogenic bacteria D: Total number of samples cultured	Microbiology registers, ALIS, WHONET, HMIS 105	Specimen type, Pathogen, , age group, origin (hospital or community)	Monthly, Quarterly	Output		Facility AMR Coordinating Committee	NCC	N: Patient level dataset and HMIS 105 D: patient level dataset and HMIS 105
04	Percentage of patients with resistant organisms to specific antibiotics	To track resistance of pathogens to indicated antibiotics	N: Number of isolates resistant to specific antibiotics D: Number of isolates tested for susceptibility against specific antibiotics	HMIS 105	Specimen type, Pathogen-Antibiotic, Gender, age group, origin	Monthly, Quarterly	Output		Facility AMR Coordinating Committee	NCC	N: Patient level dataset and HMIS 105 D: Patient level dataset and HMIS 105

No	Indicator	Justification	Indicator definition/notes	Data Source	Disaggregation	Reporting Frequency	Indicator Level	Target	Responsible	Recipient	Report (Source of data)
05	Incidence of AMR for various pathogen-antibiotic combinations	To track burden of resistance	N: Number of patients with resistant pathogens to specific antibiotics D: Number of hospital attendances in a year (Outpatient and Inpatient)	WHONET, ALIS, HMIS 105, HMIS 108 reports	By Pathogen-Antibiotic combination, age group, sex, by Geographic location	Annual	Outcome		National Coordinating Centre (NCC)	MOH, One Health platform	Annual report
06	Proportion of patients with bacterial isolates associated with Hospital Acquired Infections	To track HAIs	N: Number of bacterial isolates associated with Hospital Acquired Infections D: Number of hospital admissions	Microbiology Register, WHONET, ALIS, HMIS 108	Specimen type, organism isolated, age and sex.	Monthly, Quarterly	Outcome		Facility AMR and IPC Coordinating Committee	NCC	N: Patient level dataset D: Patient level dataset and HMIS 105
07	Proportion of hospital-based mortality associated with bacterial infections	To track mortality associated with bacterial infections	N: Number of hospital-based mortality cases due to bacterial infections D: Total number of hospital-based mortality cases	HMIS 108, Facility mortality register, annual sector performance report	Age and sex	Annual	Outcome		Facility AMR Coordinating Committee	NCC	Monthly Site Surveillance report
08	Percentage of hospital-based mortality associated with identified antimicrobial resistant bacteria	To track mortality associated with antimicrobial resistant bacterial infections	N: Number of hospital-based mortality associated with identified antimicrobial resistance bacteria D: Total number of hospital-based mortality cases	(Numerator) TBD HMIS 108	Age, sex and Organism, antibiotic	Annually	Outcome		Facility AMR Coordinating Committee	NCC	Monthly SS report

Annex 4: Work plan and budget summary

S/N	Activity	Target	Responsible Entity	Budget (USD) (Year 1)	Budget (USD) (5 year)
1.	**Establish a system for the coordination of AMR Surveillance**				
1.1.	Set up/ renew mandate of coordination committees (AMR surveillance subcommittee, HIV ART Committee)	Year 1 6 annual meetings	DGHS	12,000	60,000
1.2.	Designate and set up coordination centres for AMR surveillance for bacteria/fungi, T.B, Malaria & HIV	Year 1 Continued operations	• Director UNHLS • PM NTLP • PM Malaria CP • Director UVRI	50,000	250,000
2.	**Initiate surveillance activities**				
2.1.	Identify suitable surveillance sites	Year 1	• UNHLS • UVRI • NTLP • Malaria Control Program	-	-
2.2.	Develop surveillance protocols for: • Bacterial Pathogens • HIV • Malaria • Tuberculosis	Year 1 Biennial reviews	• UNHLS • UVRI • NTLP • Malaria Control Program	30,000	60,000
2.3.	Sensitize surveillance sites through initiation and diagnostic stewardship visits	Year 1	• UNHLS • UVRI • NTLP • Malaria Control Program	50,000	250,000
2.4.	Conduct biennial ART resistance surveys		•		
2.5.	Conduct biennial Malaria resistance surveys		•		

S/N	Activity	Target	Responsible Entity	Budget (1 year)	Budget (5 year)
3.	**Build laboratory capacity for AMR surveillance**				
3.1.	Build capacity of National Reference laboratories	Year 1	• UNHLS • UVRI • NTLR	500,000	2,500,000
3.2.	Build capacity of sentinel site laboratories	**Year 1:** 20% of RRH labs **Year 2:** 60% of RRH labs **Year 3:** 100% RRH labs	• UNHLS	190,000	950,000
3.3.	Increase coverage of Xpert MTB/Rif at health facilities	**Year 1:** **Year 2:** **Year 3:**	• NTRL		
3.4.	Provide consumables for AMR surveillance laboratories	**Year 1:** 20% of RRH labs **Year 2:** 60% of RRH labs **Year 3:** 100% RRH labs	• NMS	500,000	8, 900,000
4.	**Establish and operate data management systems for AMR surveillance**				
4.1.	Customize, install and maintain software at National Reference laboratories (including dashboards for AMR data sharing)	Year 1	• UNHLS, UVRI, NTRL, UNMCP	200,000	350,000
4.2.	Procure and install hardware at sentinel sites	**Year 1:** 20% of RRH labs **Year 2:** 60% of RRH labs **Year 3:** 100% RRH labs	• UNHLS, NTRL	80,000	150,000
4.3.	Install & maintain software at sentinel sites, train personnel in its use	**Year 1:** 20% of RRH labs **Year 2:** 60% of RRH labs **Year 3:** 100% RRH labs	• UNHLS, NTRL	60,000	240,000
4.4.	Prepare and disseminate annual AMR situation reports	Annually	• UNHLS • UVRI • NTLP • Malaria Control Program	50,000	250,000
4.5.	Upload data onto the Global Antimicrobial Surveillance System (GLASS) database	**Year 1**	• UNHLS • UVRI • NTLP • Malaria Control Program	-	-
5.	**Engage and build capacity of Human Resources for AMR Surveillance**				
5.1	Engage additional personnel for surveillance coordination	31 National and	PS - MOH	205, 200	1,566,000

	centres and laboratory service delivery	Surveillance Personnel			
5.2	Build personnel capacity through training/mentoring		• UNHLS • UVRI • NTLP • Malaria Control Program	100,000	1,000,000
6.	**Implement a Monitoring and Evaluation System for AMR Surveillance**				
6.1	Conduct supervisory visits to collect data	**Year 1:** 20% of RRH labs **Year 2:** 60% of RRH labs **Year 3:** 100% RRH labs	• UNHLS, NTLP	100,000	500,000
6.2	Prepare annual M&E reports	June each year	•	-	-
	Totals			**2,027,200**	**7,626,000**

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