National Strategy and Action Plan for Antimicrobial Resistance Containment in Bangladesh

[2023-2028]

2023

Directorate General of Health Services (DGHS)
Ministry of Health and Family Welfare (MoHFW)

Table of Contents

Acronyms and abbreviations

AMR	Antimicrobial Resistance
ACB	Acinetobacter Calcoaceticus-Baumannii Complex
ACSM	Advocacy, Communication and Social Mobilization
ADR	Adverse Drug Reaction
AHCAB	Animal Health Companies Association of Bangladesh
AMU	Antimicrobial Use
AMC	Antimicrobial Consumption
AMS	Antimicrobial Stewardship
AMs	Antimicrobials
ARC	Antimicrobial Resistance Containment
ASM	American Society of Microbiology
ARSP	Antimicrobial Resistance Surveillance Program
ARI	Acute Respiratory Infection
AST	Antimicrobial Susceptibility Testing
BAPI	Bangladesh Association of Pharmaceutical Industries
BARA	Bangladesh AMR Response Alliance
BCDS	Bangladesh Chemists and Druggists Society
BLRI	Bangladesh Livestock Research Institute
BMA	Bangladesh Medical Association
BSL-2	Biosafety Level Two
BFRI	Bangladesh Fisheries Research Institute
BFSA	Bangladesh Food Safety Authority
BPMPA	Bangladesh Private Medical Practitioners Association
BPCDOA	Bangladesh Private Clinic Diagnostic Owners Association
BPC	Bangladesh Pharmacy Council
BPICC	Bangladesh Poultry Industries Central Council
BSMMU	Bangabandhu Sheikh Mujib Medical University
BSM	Bangladesh Society of Medicine
BVC	Bangladesh Veterinary Council
BVA	Bangladesh Veterinary Association
CBHC	Community Based Health Care
CDC	Communicable Disease Control
CDIL	Central Disease Investigation Laboratory
CD	Cabinet Division
CLSI	Clinical and Laboratory Standards Institute
COVID 19	Coronavirus Disease 2019
CPE	Continuous Professional Education
CRE	Carbapenem-Resistant Enterobacteriaceae
CWG	Core Working Group
DAE	Department of Agricultural Extension

DGDA	Directorate General of Drug Administration
DGHS	Directorate General of Health Services
DGME	Directorate General of Medical Education
DLS	Department of Livestock Services
DOF	Department of Fisheries
DOE	Department of Environment
DVH	District Veterinary Hospital
EQA	External Quality Assessment
ESBL	Extended-Spectrum Beta-Lactamases
EUCAST	European Committee on Antimicrobial Susceptibility Testing
ETA	Endotracheal Aspirates
ETP	Effluent Treatment Plant
FAO	Food and Agriculture Organization of the United Nations
FDIL	Field Disease Investigation Laboratory
FIQCL	Fish Inspection and Quality Control Laboratory
FIAB	Feed Industries Association of Bangladesh
GAP	Global Action Plan on Antimicrobial Resistance
GAP	Good Agriculture Practice
3GC	Third Generation Cephalosporins
GAqP	Good Aquaculture Practice
GAHP	Good Animal Husbandry Practice
GVP	Good Veterinary Practice
GHSA	Global Health Security Agenda
GLASS	Global Antimicrobial Resistance Surveillance System
GoB	Government of Bangladesh
GMP	Good Manufacturing Practice
GMP	Good Management Practice
GPP	Good Pharmacy Practice
HCPs	Healthcare providers
HCFs	Health Care Facilities
HPNSP	Health, Population and Nutrition Sector Program
HSM	Hospital Service Management
HEB	Health Education Bureau
IACG	Interagency Coordination Group
ICU	Intensive Care Unit
IEC	Information, Education and Communication
IDs	Infectious Diseases
IHR	International Health Regulations
IEDCR	Institute of Epidemiology, Disease Control, and Research
IPC	Infection Prevention and Control

IQA	Internal Quality Assessment
LGD	Local Government Department
M&E	Monitoring and Evaluation
MOE	Ministry of Education
MOST	Ministry of Science and Technology
MIC	Minimum Inhibitory Concentration
MOHFW	Ministry of Health and Family Welfare
MNCAH	Maternal, Neonatal, Child and Adolescent Health
MRSA	Methicillin-resistant *Staphylococcus aureus*
NAG	National Antibiotic Guidelines
NARC	National Antimicrobial Resistance Committee
NCC	National Coordination Centre
NRL	National Reference Laboratory
NAP	National Action Plan
NCDC	Non-Communicable Disease Control
NSC	National Steering Committee
NSP	National Strategic Plan
NTC	National Technical Committee
OIE	World Organization for Animal Health
OTC	Over the Counter
PEA	Political Economy Analysis
PDR	Pan drug Resistant
PLH	Primary Level Hospitals
PMO	Prime Minister ‘s Office
PT	Proficiency Testing
PPS	Point Prevalence Surveys
QCL	Quality Control Laboratory
R&D	Research and Development
SAARC	South Asian Association for Regional Cooperation
SOP	Standard Operating Procedure
SOSB	Society of Surgeons of Bangladesh
SDGs	Sustainable Development Goals
SWOT	Strength, Weakness, Opportunity and Threat
SSI	Surgical Site Infection
STGs	Standard Treatment Guidelines
TLH	Tertiary Level Hospitals
TDR	Total drug-Resistant
ToR	Terms of Reference
UHC	Upazila Health Care
UTI	Urinary Tract Infection
US CDC	United States Centre for Disease Control and Prevention
UN	United Nations

UVH	Upazila Veterinary Hospital
WAAW	World Antibiotic Awareness Week
WHO	World Health Organization

List of the contributors of the National Strategy and National Action Plan (Not according to seniority):

Dr. Md. Akhteruzzaman	Additional Secretary, Public Health Wing, Health Service Division, MOHFW
Prof. Sayedur Rahman	Chairman, Department of Pharmacology, BSMMU
Prof Dr. Md. Nazmul Islam	Director, Communicable Disease Control (CDC) DGHS
Dr Aninda Rahman	Deputy Program Manager (DPM), CDC, DGHS
Dr. Md. Abu Sufian	Principal Scientific Officer, Department of Livestock Services (DLS)
Mr. Sujit Kumar Chatterjee	District Fisheries Officer, DOF
Dr. Monzur Morshed	Member, Bangladesh Food Safety Authority (BFSA)
Dr. Zakir Hossain Habib	Principal Scientific Officer (PSO), IEDCR
Dr. S.M. Shariar Rizvi	Evaluator, CDC, DGHS
Dr. Mohammed A. Samad	Principal Scientific Officer (PSO), BLRI
S. M. Sabrina Yesmin	Assistant Director, DGDA
Dr. Shimu Hurul Jannat	Medical Officer, CDC, DGHS
Dr. Piash Kumer Deb	Medical Officer, CDC, DGHS
Prof. S M Shamsuzzaman	Head, Department of Microbiology, DMC Professor,
Prof. Dr. Ahmed Abu Saleh	Department of Microbiology & Immunology, BSMMU
Dr. Md Abul Kalam	Global Health Security Specialist, PHN & E, USAID
Dr. Dilruba Ahmed	Head, Clinical Microbiology and Immunology Laboratory, icddr, b
Prof Dr. Nitish Chandra Debnath	Team Lead, Fleming Fund Country Grant
Dr. Khaleda Islam	Surveillance Lead, Fleming Fund Country Grant
Prof. Dr. Sitesh Chandra Bachar	Professor & Chairman, Department of Pharmacy, Dhaka University.
Dr. Alamgir Hossain	PSO (Zoonotic Disease), IEDCR
Dr. Md. Rafiqul Islam	Chief Scientific Officer, BARC
Dr. Habibur Rahman	National Technical Advisor, FAO
Dr. Hamida	National Technical advisor, FAO
Dr. Jebun Rahman	Country Project Director, MTaPS, MSH
Dr. Abu Zahid	Principal Technical Advisor, MTaPS, MSH
Md. Abdullah	Team Lead, MTaPS, MSH
Md. Abul Kalam Azad	Senior Technical Advisor, MTaPS, MSH
Dr. Amany Ayub	Technical Advisor, MTaPS, MSH
Prof. Dr. Sanya Tahmina Jhora	Lead Consultant, Updating NSP and NAP for ARC
Dr. Md. Nure Alam Siddiky	Consultant, Updating NSP and NAP for ARC
Dr. Mahamudul Hasan	Programme Officer, AMR-CDC, WHO

Executive Summary

Antimicrobial Resistance (AMR) occurs when bacteria, viruses, fungi and parasites change over time and no longer respond to medicines making infections harder to treat and increasing the risk of disease spread, severe illness and death. Antimicrobial resistance (AMR) has been recognized as a national and global public threat. The One Health initiative is an important framework for addressing AMR-related public health issues. The first national action plan for antimicrobial resistance containment was developed in 2017 for the following five years, but their mere existence was not enough. The government initiated some awareness programs and surveillance activities, yet no national Monitoring and Evaluation (M&E) framework was established for NAP activities. Progress of implementation was slow, constrained by the shortage of a trained health workforce and financial resources. Five years have passed since the development of the NAP in Bangladesh, its implementation is not up to the level that the urgency of the situation requires. Under this situation, the Government of Bangladesh has taken an important step forward to update and revise the National Strategy and Action Plan of AMR containment from 2023 to 2028. The modalities implied for the development of strategy and action plan were desk reviewing of different international guidelines, resolutions, global action plans, and national action plans of different countries as well as published scientific articles and workshop & meeting proceedings. In addition, a series of consultative processes such as focus group discussions, key informants' interviews, SWOT analysis, and multi-stakeholder consultation meetings with different sectoral focal persons, experts, professional bodies and academia has been followed.

The updated national strategy and action plan of antimicrobial resistance containment for 2023-2028 outlined the vision, mission, goal and several strategic priorities following the Global Action Plan. It also adopted the priorities of the first National Action Plan. There are a number of activities which have been identified ministry-wise and in adherence with the strategic objectives for human health, animal health, aquatic health and the environment.

Vision

A nation in which antimicrobials are recognized and managed as a valuable public health resource; and their quality and appropriate use is ensured so that the health of human, animal, aquatic and environment is secured.

Mission

Establish policies and national multi-sectoral mechanisms which support an effective and sustained AMR containment system.

Goal

Minimize the development and spread of antimicrobial resistance using one health approach.

There are eight key strategic objectives:

Key Strategy 1: Establish integrated surveillance and strengthen laboratory capacity;

Key Strategy 2: Promoting rational use of antimicrobials and antimicrobial stewardship program;

Key Strategy 3: Enabling good practices through effective sanitation, hygiene and infection prevention and control;

Key Strategy 4: Increasing stakeholder awareness and engagement;

Key Strategy 5: Strengthen multi-sectoral coordination;

Key Strategy 6: Promote innovation and research on AMR;

Key Strategy 7: Reduce the environmental spread of AMR;

Key Strategy 8: Strengthen global collaboration and partnerships;

In addition, the National action plan has also included the monitoring and evaluation frameworks to assess the progress of implementation of the plan periodically among the relevant sectors. To introduce the 'Theory of Change', prioritization of the activities of the action plan has been introduced. The basic principles of prioritization have been highlighted for better implementation of the national action plan. There are short-term, mid-term and long-term activities, some of which are overlapping and are dependent on the previous activities. Main short-term strategies include strengthening multi-sectoral coordination, advocacy, communication, awareness and motivation, development of different strategic documents and legal frameworks, data sharing and professional development. AMR containment activities will be institutionalized at different tiers with special emphasis on surveillance, evidence building on different data, data sharing and infection prevention and control, improving water, sanitation and hygiene and biosafety and biosecurity where indicated. Capacity development, advocacy, communication, and awareness building at all tiers from policymakers to end users will be in a continuum with other programs. In the long-term activities will be the establishment of antimicrobial stewardship at health care facilities which also includes regulatory activities, monitoring and surveillance and institutional capacity strengthening. Antimicrobial resistance containment champions will be identified with the strengthening of national and international collaboration and networking.

The DGHS, IEDCR, DGDA, DLS, DOF, DAE, BLRI, BFRI, DOE, BFSA and other relevant organizations and development partners have been identified as the key implement partners of the AMR national action plan.

1. Introduction

Antimicrobial resistance (AMR) occurs when bacteria, viruses, fungi and parasites change over time and no longer respond to antimicrobials making infections harder to treat and increasing the risk of disease spread, severe illness and death. It is one of the top ten global public health challenges that humanity is facing, and it poses a threat to the achievement of the Sustainable Development Goals[1].

AMR occurs naturally over time due to genetic changes. Some external drivers accelerate the process of AMR. All use of antimicrobials, including appropriate, inappropriate, over and under use are the drives for the development and spread of antimicrobial resistance Antimicrobial-resistant organisms and AMR genes are found in humans, animals, food, plans and the environment (in water, soil and air). They can spread from person to person or between people and animals, including from food of animal origin and one microorganism to another microorganism. Climate change is also playing a major role in the exacerbation of AMR by bringing humans and animals into contact frequently through global warming hence; encouraging the spread of zoonotic and vector-borne human and animal pathogens. Climate change is also increasing the pressure on food production and agriculture systems, which may lead to increased AMU in agriculture to meet global food security[2].

The impacts of AMR are wide-ranging and extremely costly, not only in financial terms but also in terms of global health, food sustainability and security, environmental well-being, and socio-economic development[3]. The emergence and spread of drug-resistant pathogens that have acquired new resistance mechanisms, continue to threaten our ability to treat common infections. Antimicrobials are becoming increasingly ineffective as drug resistance spreads globally leading to more difficult-to-treat infections and death[4]. AMR infections are estimated to cause 1290,000 deaths each year globally (Fig 1).

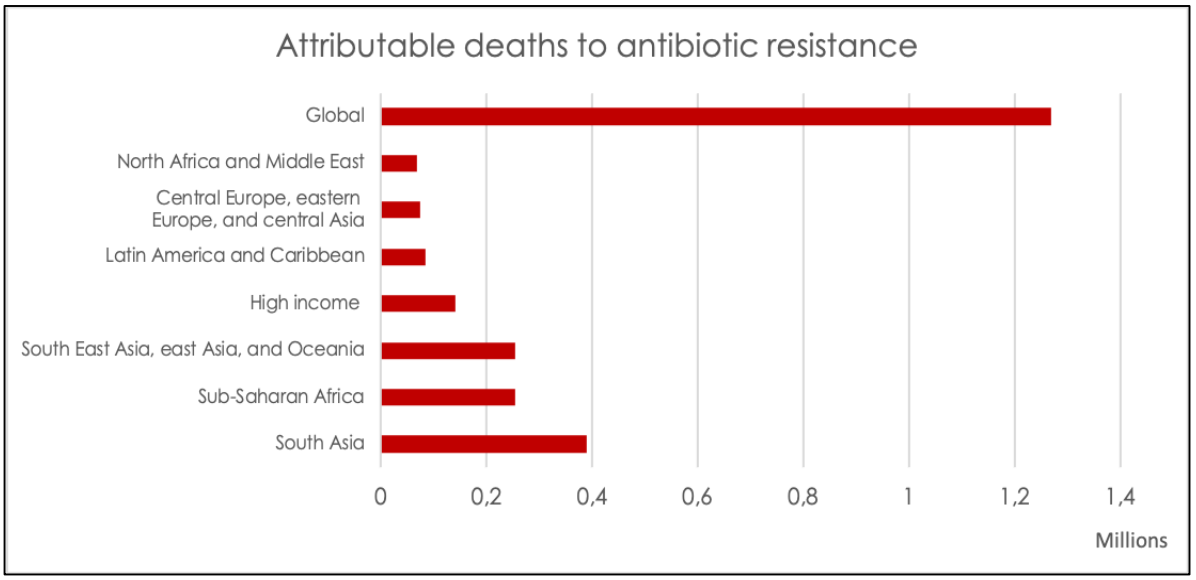

Figure1 Attributable deaths to antibiotic resistance

The figure is predicted to rise to 10 million, alongside a cumulative cost of $100 trillion, by 2050 if no action is taken[5]. The impact of AMR on global income, poverty, trade, and healthcare will hit low-income countries the most[6]. The World Bank estimates that unless AMR is contained, an extra 28 million people could be forced into extreme poverty by 2050 which ultimately threatens the achievement of the SDGs[7]. New antimicrobials are urgently needed to treat newly emerging strains of multidrug and pan-drug-resistant pathogens, as identified in the World Health Organization (WHO) priority pathogen list.

AMR as a Barrier to Achieving the SDGs

In 2015, the United Nations issued a global call to end poverty and protect the planet. As part of this vision, 17 Sustainable Development Goals (SDGs) were established to drive collective action toward ensuring better outcomes for future generations and leaving no one behind.

However, antimicrobial resistance (AMR) poses a significant threat to the progress of several SDGs, including those related to economic growth, food security, and the goal of zero hunger. Highlighting the severity of the issue, it is estimated that AMR could push 24 million people below the poverty line.

Globally, countries committed to the framework set out in the Global Action Plan (GAP) on AMR during the World Health Assembly in 2015 and committed to the development and implementation of multi-sectoral national action plans. It was subsequently endorsed by the Governing Bodies of the Food and Agriculture Organization of the United Nations (FAO) and the World Organization for Animal Health (WOAH). To ensure global progress, countries need to ensure the cost and implementation of national action plans across sectors to ensure sustainable progress. The political declaration at the United Nations (UN) High-Level Meeting on AMR, at the UN General Assembly in September 2046, confirmed that a broad, coordinated approach engaging the human, animal, plant and environmental health sectors is strongly needed. After that, several coordination platforms have been formed and are working together[8].

A tripartite joint secretariat (WHO, WOAH and FAO) has been established and is hosted by WHO to drive multi-stakeholder engagement in AMR. The key governance structure of the tripartite secretariat agreed to launch a new group including the One Health Global Leaders Group on AMR, the Independent Panel on Evidence for Action against AMR and the Multi-Stakeholder Partnership Platform. Later on, in November 2020, the UN Secretary-General formed a key global governance structure 'One Health Global Leaders Group on AMR'. The Global Leaders Group includes

members from Member States, civil society and the private sector[9].

In April 2021, the High-Level Interactive Dialogue on AMR, concluded with commitments from UN Member States to develop and implement national AMR action plans, as called for by the WHO. The major theme of the meeting was that both the global community and individual countries have not done enough to slow the spread of AMR nor mitigate its threat to human and animal health and food safety and security. They again stressed the need for countries to accelerate holistic strategies to address AMR, to educate the public about drug-resistant infections, to invest in surveillance and antibiotic development, and to apply lessons from the COVID-19 pandemic. If no action is taken, the fallout from the silent pandemic of antimicrobial resistance could be of the same or greater magnitude than the present pandemic[8].

The Global Leaders Group co-chairs hosted a UN General Assembly side event to discuss and address antimicrobial resistance (AMR) with Heads of Government and State, government Ministers and relevant stakeholders in 2022. While this side event was critical to continue the discussion of developing and implementing national action plans to address AMR, the Global Leaders Group urges all Heads of Government and State to build on this political momentum and continue to engage on AMR across all sectors with urgency and include it in all aspects of their work. The G7 and G20 countries particularly have a special role in catalyzing and galvanizing the global response against AMR.

The 'One Health' initiative is an important framework for addressing several issues threatening health, including AMR. The essence of the One Health approach in tackling AMR is that appropriate and effective collaborative efforts and partnerships are necessary across all the stakeholders including human health, animal health and environment sectors. This means that containing and controlling AMR requires coordinated and concerted action across all stakeholders, including governments, international organizations, private businesses, investors, civil society, research academia and philanthropists

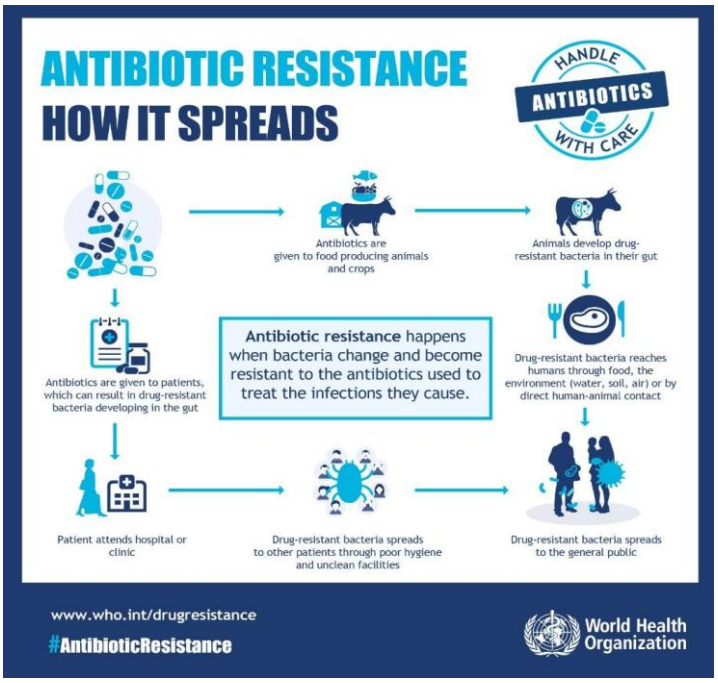

Fig 2 The possible routes of spreading the bacterial antibiotic resistance

The Antimicrobial Resistance Containment component was introduced into the Communicable Disease Control (CDC) Operation Plan (OP) of the Directorate General of Health Services (DGHS), Ministry of Health and Family Welfare (MOH&FW) in the 4th Health, Population and Nutrition Sector Program (HPNSP) as a sub-component of Antimicrobial Resistance Containment (ARC), Viral hepatitis (VH) & Diarrhea. CDC developed a National Action Plan (NAP) in 2017 which included a timeline of proposed activities along with implementing organizations. Before that, in 2015, a National Strategy on AMR containment was developed. Further, following the global advancement and special emphasis of AMR in the SDG goal as an indicator, Bangladesh has taken initiative to revise and update National Strategy and Action Plan. The National strategy and action plan has been set out for the next five years (2023-2027) for tackling AMR. It has been developed with a series of consultative processes such as focus group discussions, key informants' interviews, SWOT analysis, and multi-stakeholder consultation meetings with different sectoral focal persons, experts, professional bodies and academia. A core working group was formed for these activities. Alongside, desk review of different international guidelines, resolutions, global action plans, and national action plans of different countries as well as published scientific articles, popular articles and workshop & meeting proceedings were consulted during the development of national strategy and action plan. Finally, after year-long work, the final strategy along with the costed action plan was finalized.

1.1 The rationale of the strategy

Considering the crosscutting nature of the problem and its wider implications, efforts must be made in a One Health approach to prevent and contain antimicrobial resistance. Besides the misuse of antibiotics in humans, AMR (antibiotic resistance in particular) is known to accelerate and spread by misuse and overuse of antibiotics in rearing both terrestrial and aquatic animals for food. Antibiotics are routinely used for non-therapeutic purposes such as growth promotion and disease prevention, specifically in intensive food production systems.

Other than food and direct contact, the environment is a key route for the spread of AMR. Waste from animal and aquaculture farms, the pharmaceutical industry and healthcare settings are considered an important factor for the spread of antibiotic residue and resistant bacteria into the larger environment.

The existing NAP (2017-2022) has given more focus on human and terrestrial animals rather than aquatic health and environment. Furthermore, NAP is not costed and does not include other resources required to achieve the desired goal. There is a need to update the national strategy and action plan to ensure the rational use of antimicrobials by adopting a comprehensive One Health approach. The national strategy and action plan shall help in prioritizing the activities consistent with limited national resources and promote a united drive.

1.2 Strategic Outline

The scope of the AMR National Strategy and NAP 2023-2027 is in line with the global action plan for the containment of antimicrobial resistance adopted in 2015. This NAP shall apply to all sectors related to human health, animal health aquatic health and plant health dealing with antimicrobials and environmental health to contain the environmental spread of AMR. Besides, the national strategy and NAP for 2023-2027 have addressed all issues and initiatives of successful Antimicrobial Resistance Containment in Bangladesh. It also aligns with the Global Health Security Agenda by detecting the emergence of new drug-resistant strains of bacteria and responding by developing guidelines to respond against the emergence. The future actions and activities on AMR shall be within the strategies outlined in this document.

1.3 The Guiding Principles

The National Strategy takes into account both the causes of antimicrobial resistance and opportunities to combat the threat at national and subnational levels, including:

- Reducing the disease burden and the spread of infection.
- Improving access to appropriate antimicrobials.
- Ensuring rational use of antimicrobials.
- Strengthening health systems and their surveillance capabilities.
- Enforcing regulations and legislation.
- Encouraging the development of appropriate new drugs, diagnostic tools and vaccines.

All activities are in one health approach, and they are action-oriented, synergized, and harmonized. Political commitment is a key aspect of this strategy.

2. AMR and AMU/C Situation Analysis

2.1 Antimicrobial resistance Pattern among the common bacterial infections in the globe

High levels of antibiotic resistance have been reported globally for common bacterial infections such as urinary tract infections, sepsis, sexually transmitted infections (STIs), and certain types of diarrhoea. This trend signals a growing threat to the effectiveness of available antimicrobials. For instance, resistance to ciprofloxacin—a widely used antibiotic for treating urinary tract infections—among Escherichia coli and Klebsiella pneumoniae ranged from 8.4% to 92.9% and 4.1% to 79.4%, respectively, in countries reporting to the Global Antimicrobial Resistance and Use Surveillance System (GLASS). Colistin, often considered the last-resort antibiotic for treating life-threatening infections caused by carbapenem-resistant Enterobacteriaceae (such as E. coli and Klebsiella), has also seen emerging resistance in multiple regions, resulting in infections with no currently effective treatment options.

In 2019, a new AMR indicator was included in the SDG monitoring framework. This indicator monitors the frequency of bloodstream infections due to two specific drug-resistant pathogens: methicillin-resistant *Staphylococcus aureus* (MRSA); and *E. coli* resistant to third-generation cephalosporins (3GC). In 2019, 25 countries, territories and areas provided data to GLASS on bloodstream infections due to MRSA and 49 countries provided data on bloodstream infections due to *E. coli*. While the data are still not nationally representative, the median rate observed for methicillin-resistant *S. aureus* was 12.11% and that for *E. coli* resistant to third-generation cephalosporins was 36.0%.

Widespread resistance in highly variable strains of *N. gonorrhoeae* has compromised the management and control of gonorrhoea. Resistance has rapidly emerged to sulphonamides, penicillin, tetracycline, macrolides, fluoroquinolones, and early-generation cephalosporins. Currently, in most countries, the injectable extended-spectrum cephalosporin (ESC) ceftriaxone is the only remaining empiric monotherapy for gonorrhoea.

2.2 Antimicrobial Use (AMU) and AMR pattern in human health

2.2.1 AMU pattern in human health

AMR has been increasing over the years in Bangladesh owing to its poor healthcare standards, along with the misuse and overuse of antimicrobials which poses a regional and global threat. The magnitude of AMR infection among humans is high which has been observed in several studies from 2017 to 2020[9]. Another contributing factor is thought to be the aggressive and unethical marketing practices of pharmaceutical companies and a regulatory regime that has insufficient human, technical and logistic capacity to oversee this vast market.

2.2.1 (a) Antibiotic prescribing pattern

Several small-scale studies reported on antimicrobial prescribing and its use, varying by factors such as age and sex. For example, children (66%) were prescribed more antimicrobials than adults (44%), and the rate of prescribing antimicrobials was higher at the extremes of ages, and for males[10-12]. Third-generation antimicrobials (e.g., ceftriaxone and ciprofloxacin etc.) were prescribed quite frequently, especially by the physicians[13]

Studies have shown that it is common for hospitals in Bangladesh to prescribe two or more antimicrobials simultaneously [11-12], and more antimicrobials were prescribed in hospital settings compared to community settings[15]. Prescribing antibiotics without laboratory sensitivity tests was quite common in Bangladesh due to a reported lack of testing facilities[16-17]. Qualified prescribers from a few secondary and tertiary level hospitals were found to be aware of the treatment guidelines, but not those from the Upazila (sub-district) hospitals[18-19]. Most of the time, standard treatment guidelines for some infectious diseases like Respiratory Tract Infections (RTI) were not available in primary healthcare settings[20]. A cross-sectional study conducted in the inpatient department of seven primary-level hospitals (PLH) and six tertiary-level hospitals (TLH) in the country showed that 85.9% of patients in TLHs and 100% of patients in PLHs were prescribed antibiotics at the time of admission. Only 6.4% of patients of TLHs treated with antibiotics had culture-proven infection and the rest of the patients of TLH and all the patients of PLH were treated with antibiotics empirically[21]. Antimicrobials were commonly prescribed for fever, common cold, cough, diarrhoea and acute respiratory infection (ARI)[13, 17, 19]. Baseline and post-intervention surveys on dispensing practices in Dhaka city found that awareness-building and educational efforts had limited impact on promoting the rational use of antimicrobials. [14].

Systematic comprehensive monitoring by DGDA followed by penalties for non-compliant pharmacies could improve drug seller practices.[14]

2.2.1(b) Non-compliance and self-treatment

Patients' non-compliance with scheduled dosage, and consequently facilitating the emergence of AMR, was a common phenomenon found in the literature reviewed[16, 22, 23, 24]. This may be as high as 50% as patients used to stop taking antimicrobials as soon as the symptoms alleviated[16]. When prescribed antimicrobials did not work in the short-term, patients usually considered the doctors as incompetent[23-24]. The prevalence of self-treatment patients was found to be quite high[24-25]. It was found to be common for illnesses such as dysentery, diarrhoea and food poisoning (36%); cold, cough and fever (28%); and presumed infection of some sort (13%)[26]. Reasons behind this self-treatment practice included advice from traditional healers (41%), prior experience with the

particular antibiotic for the particular illness (33%), knowledge about antibiotics (17.5%), and waiving doctors' consultation fees (1%). Moreover, the unavailability of qualified doctors and easy accessibility of antibiotics as over-the-counter drugs (OTC) make it more complicated.

2.3 AMR pattern in human health

In an AMR surveillance study, the Antimicrobial Susceptibility Testing (AST) result of *E. coli* showed the highest resistance (60%) to ciprofloxacin, ceftazidime, and ceftriaxone while low resistance (10%) to amikacin and imipenem. Consecutively, the susceptibility pattern of *S. aureus* showed the highest resistance to ceftazidime (70%) followed by cloxacillin (60%), ceftriaxone (605) whilst very low resistance (5%) to amikacin and vancomycin. Successively, the AST result of *Pseudomonas* revealed the highest resistance (50%) to netilmicin, ciprofloxacin, and moderate resistance (30%) to ceftazidime and ceftriaxone while the lowest resistance (5%) to imipenem. Similarly, the sensitivity of *Klebsiella* showed higher resistance (40%) to ceftriaxone, and ciprofloxacin, medium resistance (20%) to amikacin, imipenem and low resistance (5%) to azithromycin[27].

A comparative study of antibiotic susceptibility patterns for urinary tract infections in a tertiary hospital in Bangladesh from 2011 to 2016 showed increased resistance to commonly used and relatively inexpensive antibiotics. The most powerful antibiotics were meropenem, imipenem, tazobactam and Amikacin, whose sensitivity ranges from 99% to 100%. This increasing resistance over five years is due to irrational prescription and consumption of the most commonly used antibiotics such as ceftriaxone, cefixime and amoxicillin-clavulanic acid. Meropenem, imipenem and tazobactam are highly expensive medicines which makes it very difficult to purchase for most of the people of the community[28]. In another study, uropathogenic *E. coli* was found to be highly resistant to amoxicillin (95%)[29]. More than 80% of MRSA isolates were also found to be resistant to ampicillin, amoxicillin, cefixime and azithromycin[30].

Institute of Epidemiology, Disease Control and Research (IEDCR) conducted an AMR surveillance study across the country among the 9 medical college hospitals during 2017- 2020. A total of 19,263 samples were processed during the period. Among these samples, 57% of wound swabs and 48% of Endotracheal Aspirates (ETA) showed positive growth which indicates poor IPC in hospital settings. The three most common bacteria *E. coli, K. pneumoniae, P. aeruginosa* were isolated from four common samples: wound swab (1717), urine (1694), sputum (502) and ETA (424)[31].

2.3.1 In urine

Five types of pathogens were identified from the urine sample where *E. coli* showed the most

abundance, followed by *K. pneumoniae*. The AST results of *E. coli* and *K. pneumoniae* showed low resistance to imipenem, amikacin and gentamicin. Imipenem showed the lowest resistance (about 30%) to the pathogens. Both *E. coli* and *K. pneumoniae*, showed less than 10% resistant pattern to imipenem. Amikacin showed less than 20% resistance and gentamicin showed less than 30% resistance to both *E coli* and *K. pneumoniae*. All generations of cephalosporins showed high resistance to *E. coli* ranging from 54-76%[31]. Ciprofloxacin which was used commonly and empirically for clinically suspected Urinary Tract Infection (UTI) treatment showed 61% resistance. On the contrary, nitrofurantoin showed only 20% resistance to *E. coli*. Nitrofurantoin is a very useful drug for UTIs because it quickly filters out of the blood and is concentrated in the urinary system. However, it has been the least choice drug for physicians due to some side effects and the availability of more advanced antibiotics. This might be a cause that it still retains its high sensitivity. High resistance patterns of *S. aureus* and *P. aeruginosa* are the most commonly used antibiotics in this surveillance. The resistance of cefoxitin and clindamycin to *S. aureus* isolates were 80% and 55% respectively[31].

2.3.2 In wound swab

The most abundant organism isolated from the wound swab was P. aeruginosa, which showed more than 65% resistance to commonly used antibiotics except imipenem which had 49% resistance. The E. coli and K. pneumoniae showed least resistance (25% -27%) to imipenem. Similarly, E. coli and K. pneumoniae showed high resistance (86-91%) to ceftriaxone. Half of the S. aureus isolates were resistant to cefoxitin and 53% of the isolates showed resistance to clindamycin31. The high resistance to the watch group of antibiotics, imipenem (41%) is very alarming.

2.3.3 In endotracheal aspirate

Endotracheal aspirates were taken from the ICU patients and all the antibiotics showed high resistance (more than 60%) to the three identified pathogens (E. coli, K. pneumoniae and P. aeruginosa). 63% K. pneumoniae and 75% P. aeruginosa showed resistance to imipenem. Successively 28% of K. pneumoniae and and 25% of P. aeruginosa showed resistance to amikacin. ACB complex showed more than 80% resistance to all the used antibiotics. All three pathogens, showed more than 90% resistance to cefepime, a reserve group antibiotic, indicating a very alarming but frequently observed scenario in ICU settings[31].

2.3.4 In blood

In a blood sample, *Salmonella* was found to be the most abundant (64.9%) while *E. coli*, *K. pneumoniae*, and *Staph. aureus* was found to be 17.2%, 8.3% and 9.6% respectively. AMR indicator of SDG monitors the frequency of bloodstream infections due to two specific drug-resistant

pathogens: methicillin-resistant *Staphylococcus aureus* (MRSA) and *E. coli* resistant to third-generation cephalosporin (3GC). The *E. coli* showed high resistance to 3GC (ceftazidime 70% and ceftriaxone 82%)[31].

2.4 AMU and AMR pattern in animal and aquatic health

2.4.1 AMU and AMR pattern in animal health

In Bangladesh, the extent of antimicrobials usage in animal health production is unknown and data on national sales of antimicrobials are unreliable[9]. Antimicrobials are generally used for the treatment and prevention of poultry diseases, but some farmers use them also for growth promotion to increase feed conversion32. The commonly used antimicrobials in livestock farming are ampicillin, levofloxacin, gentamicin, neomycin, oxytetracycline, doxycycline, ciprofloxacin, enrofloxacin, sulfamethoxazole-trimethoprim, erythromycin and tylosin. On the contrary, the commonly used antimicrobials in poultry farming are penicillin, ampicillin, cloxacillin, gentamicin, streptomycin, oxytetracycline, ceftriaxone, ciprofloxacin, amoxicillin and sulfamethoxazole-trimethoprim[33].

The AST results of *E. coli* isolated from livestock and poultry showed wider range of resistance to penicillin (100%), tetracycline (72-100%), oxytetracycline (78-93%), sulfamethoxazole-trimethoprim (51-88%), ampicillin (89.5-100%), amoxicillin (92-95%), streptomycin (19-70%), erythromycin (89%), ciprofloxacin (50%), chloramphenicol (43-50%), gentamicin (8-28%), enrofloxacin (55%), and norfloxacin (50%)34-39. Similarly, the AST result of *Salmonella* spp. Recovered from poultry revealed a wider range of resistance to ciprofloxacin (70-88%), ampicillin (66-75%), tetracycline (77-84%), gentamicin (33-68%), nalidixic acid (22-60%), streptomycin (44-77%)40. While very low resistance (5-8%) was observed to chloramphenicol, azithromycin, imipenem, amikacin and sulfamethoxazole-trimethoprim40. Likewise, the AST result of *Streptococcus* spp. in livestock and poultry showed a wider degree of resistance to streptomycin (70-100%), amoxicillin (30-100%), and ampicillin (60-100%)41. Sequentially, the AST result of *Staphylococcus* spp. Revealed broader range of resistance to penicillin (82-100%), amoxicillin (42-100%), ampicillin (97%), streptomycin (70--100%), oxytetracycline (74-78%), ciprofloxacin (17-50%), sulfamethoxazole-trimethoprim (30%), gentamicin (18%) cefixime (73.9%), cloxacillin (82.6%) and oxacillin (56-98%)[42-44]. The third-generation cephalosporin (ceftriaxone, cefotaxime, ceftazidime, and aztreonam) including meropenem, amikacin was found almost sensitive to *Salmonella* spp.[40,45].

2.4.2 AMU and AMR pattern in aquatic health

There is no reliable data on antimicrobial usage in the aquaculture sector of Bangladesh. There is no defined governance structure to monitor the use of antimicrobials in the aquatic sector. The commonly used antimicrobials in aquatic farming are chlorsteclin, oxytetracycline, azithromycin, erythromycin, nitrofurans, furazoliodine, amoxicillin, chloramphenicol, sulfadiazine & trimethoprim and chlortetracycline[9].

The AST result of Aeromonas hydrophila showed resistance to streptomycin (100%) and ampicillin (100%)46. In another study, the AST result of Aeromonas spp. showed resistance to ampicillin (25%) and streptomycin (25%). The AST result of Aeromonas hydrophila revealed different degrees of resistance to ciprofloxacin (92%), levofloxacin (84%), gentamicin (60%), azithromycin (48%), tetracycline (16%), oxytetracycline (4%), chlortetracycline (12%) while novobiocin, ampicillin and penicillin were found complete resistance47. The AST result of predominant bacteria (Klebsiella spp., Pseudomonas spp., E. coli, Staphylococcus spp. and Vibrio spp.) in fish samples showed diverse resistance to tetracycline (100%), penicillin (100%), sulfonamides (80%) and fluoroquinolones (80%) with complete sensitive to carbapenems and cephalosporin. The AST result of Vibrio cholerae in Pangasius fish revealed resistance to penicillin (100%) followed by tetracycline (45.16%), erythromycin (24.19%) and nalidixic acid (14.52%) while sensitive to chloramphenicol (96.77%) followed by cefixime (93.54%), ceftriaxone (93.54%) amoxicillin+clavulanate (90.32%) and sulfamethoxazole+ trimethoprim (88.71%) respectively[48].

2.4.3 AMR in the environment

Injudicious management of animal waste, particularly used poultry litter and manure is causing environmental pollution. It was found in a study that about 3,079 metric tons of poultry manure is produced per day and 50% of this is directly used in aquaculture[14]. Besides, the hospitals of Dhaka city are also contributing to the process by discharging untreated medical wastes in the water, resulting in the presence of high levels of resistant *E. coli* in the water[49]. In addition, antimicrobials were found to be used routinely to increase food animal production, resulting in the spread of antibiotic-resistant organisms from farms to the environment to the community[49].

Medical infectious waste contains pathogens and poses a risk of disease transmission (e.g. waste contaminated with blood and body fluids; laboratory cultures and microbiological stocks; waste including excreta and other materials from patients infected with highly infectious diseases)[50]. The total healthcare waste including infectious waste generated in hospitals varies from 1.28 kilograms to as high as 3.47 kilograms per patient per day. It has been found that only about 9% of hospitals in Bangladesh follow waste disposal guidelines, 4% of which follow their guidelines and about 5% follow government guidelines[51]. The Ministry of Health and Family Welfare (MoHFW) has begun to address medical waste management as a priority in the Health, Nutrition and Population Sector Program (HNPSP). The medical waste management program is one of the performance indicators under MoHFW though there is insufficient monitoring[52].

The AST pattern of non-typhoidal *Salmonella* in a wet market environment showed a broad range of resistance to ciprofloxacin (64-69%) followed by nalidixic acid (53-62%), tetracycline (55- 60%),

ampicillin, (59-75%) and streptomycin (44-88%); moderate resistance to gentamicin (40- 47%), amoxicillin-clavulanate (27-35%), sulfamethoxazole-trimethoprim, (28-47%) and chloramphenicol (20-22%) with almost complete sensitive to azithromycin, amikacin, meropenem and third-generation cephalosporins (ceftriaxone, cefotaxime, ceftazidime, and aztreonam)[45]. In a study, the ESBL gene *bla*NDM-1 was found in *Klebsiella pneumoniae, E. coli, Acinetobacter* spp., and *Enterobacter* spp. Isolated from hospital-adjacent waste water samples[49].

In another study, the ESBL gene CTX-M and *bla*SHV-was found in *E. coli* isolated from surface water[53]. It was found in a study that urban surface waters are particularly rich in antibiotic resistance genes, with a higher number of them associated with plasmids, indicating that they are more likely to spread horizontally. The abundance of antibiotic-resistance genes was strongly correlated with the abundance of bacteria that originate from the human gut, suggesting that the uncontrolled release of human waste is a major driver for the spread of antibiotic resistance in the urban environment. Improvements in sanitation may thus be a key intervention to reduce the dissemination of antibiotic-resistant bacteria[54].

2.5 Status of National Action Plan Implementation in Bangladesh

A study was conducted recently to explore the current situation of the National Action Plan (NAP) on Antimicrobial Resistance (AMR) implementation in Bangladesh and examined how different sectors (human, animal, and environment) addressed the AMR problem in policy and practice (55). The study concluded that the implementation of NAP has been slow. The study mentioned that the coordination across human, animal, and environmental sectors is not optimal, with the environment sector notably absent. While some hospital-based awareness programs and surveillance activities have been initiated, there was no national Monitoring and Evaluation (M&E) framework for NAP activities. Progress is hindered by a shortage of trained health workforce, financial resources, and the impact of the COVID-19 pandemic. During the COVID-19 pandemic, the use of antimicrobial drugs has increased significantly and the current NAP implementation was not successful in controlling that. Future policies and practices need to be cognizant of the slow progress to prevent a potential catastrophe.

3. Strength, Weakness, Opportunity and Threat (SWOT) Analysis

3.1 Strength

Governance

Bangladesh is a signatory of the "Jaipur Declaration-2011" for the containment of antimicrobial resistance through the implementation of integrated AMR activities in a multi-sectoral approach. The Communicable Disease Control (CDC) program of the Directorate General of Health Services (DGHS) of the Ministry of Health and Family Welfare (MoHFW) of Bangladesh completed the formation of different national and local level committees such as the National Steering Committee (NSC), National Technical Committee (NTC), and Core Working Group (CWG), in April 2012 to contain antimicrobial resistance through one health approach. The MoHFW approved all committees in October 2012. Further, the national focal person along with sectoral focal persons were also identified. Recently the governance structure also has been modified, revised and subsequently approved by the NTC meeting.

National Strategic Plan of AMR in 2011-2016

The Core Working Group (CWG) prepared a "national strategy for ARC in Bangladesh: 2011- 2016" and was approved by the National Steering Committee (NSC). The main focus of the national strategy for ARC was to: establish a multi-sectoral approach to planning, coordination and implementation of ARC activities; promote and ensure rational use of antimicrobial agents in human health, livestock and fisheries; promote and strengthen infection prevention and control measures to minimize the emergence and spread of AMR; promote and strengthen biosafety and biosecurity principles and practices and containment measures; review, update and strengthen regulatory provisions; strengthen surveillance system for AMR containment; promote operational research and education in the area of AMR; and establish advocacy, communication and social mobilization.

National Action Plan of AMR in 2017-2022

The CWG conducted several consultative meetings during the period of 2016 and early 2017 and developed the "National Action Plan of ARC for 2017-2022" in early 2017 which was approved by the NSC. The major focus of the national action plan was: ensuring the rational use of antimicrobials; and ensuring infection prevention and control (IPC) activities in healthcare facilities and at community level; establishing an integrated surveillance system; increasing advocacy, communication and social mobilization (ACSM) for health care providers, drug sellers, community members and owners of animal farms and fisheries; and ensuring adequate funding for basic and operational research.

National surveillance system and laboratory network

The national AMR surveillance strategy for 2020-2025 has been developed recently with the support of The Fleming Fund grant. IEDCR and DLS have been identified as the focal institutes to monitor and coordinate AMR surveillance in the human health and animal health sectors in the country. Since 2016, the IEDCR has conducted countrywide AMR surveillance, beginning with five sentinel sites, then scaling up to nine, with the support of the Government of Bangladesh (GoB), the Global Health Security Agenda (GHSA), and the World Health Organization (WHO); this support is anticipated to end by 2021. The Bangladesh Livestock Research Institute (BLRI) has been conducting AMR surveillance in the livestock and poultry value chain system with the financial and technical support of the Global Health Security Agenda (GHSA); the CDC Atlanta, United States; and the Government of Bangladesh. The Department of Livestock Services (DLS) also conducts AMR surveillance on a small scale with the support of FAO and other overseas funding.

In the human health sector, IEDCR is hosting the National Reference Laboratory for AMR (NRL-AMR) and nine other microbiology laboratories of the medical colleges are closely working with IEDCR. In animal health, DLS is hosting a Central Disease Investigation Laboratory (CDIL) and two sentinel Field Disease Investigation Laboratory (FDIL) to conduct AMR surveillance. Bangladesh Livestock Research Institute (BLRI) has established a designated and dedicated biosafety level two (BSL-2) AMR research laboratory with state-of-the-art facilities. The AMR laboratory of BLRI has made good networking and collaboration with many national and international partners for conducting AMR surveillance. For the Aquatic health (AqH) sector, Fish Inspection and Quality Control Laboratory (FIQCL), Savar is working as the sentinel laboratory and BLRI has been given the responsibility to work as special NRL-AMR for the AqH sector and providing support to FIQCL.

Quality Improvement Secretariat (QIS): The QIS works directly under the MOHFW. Its mandate is to oversee the nationwide activities of the quality improvement of healthcare service delivery. QIS guides and oversees quality improvement activities through an M&E framework, protocols, guidelines, SOPs, tools and collaboration with other departments and organizations. They work directly on hospital services, medical waste management, antimicrobial stewardship and IPC.

National policies and strategies to combat AMR

There are a quite number of policies, guidelines, ordinances and laws currently exist in the human, animal, aquatic and environmental sectors of Bangladesh. Of these, several (human=3; animal=4; environment=4) policies addressed the AMR issue directly or indirectly (Hoque et al., 2020). These important policies and acts are- The Drug and Cosmetic Act of 2023, national guidelines on the pharmacovigilance system in Bangladesh, 2017; development of clinical guidelines for sub-district

level, 2013; BSMMU antibiotic guideline, 2012; animal and fish feed act, 2010; national livestock development policy, 2007; Bangladesh animal and animal product quarantine act, 2005; Bangladesh veterinary council act, 2019; fish & fish products inspection & quality control act, 2020, fish hatchery act, 2010; environment court law, 2010; guideline for assessment of effluent treatment plant, 2008; medical waste management & processing rules, 2008 and environment protection act, 1995. In addition, there is a task force formed by the Director General of Drug Administration (DGDA) and endorsed by MOHFW which approves the Standard Operation Procedure (SOP) and protocol to monitor antimicrobial consumption.

To restrict the selling of AMs without the prescription of registered physicians, the Government of Bangladesh (GoB) has passed the Drug and Cosmetic Act 2023. Under the new act, selling antibiotics without a physician's prescription is subjected to a 20000-taka penalty. The act complements the National Drug Policy 2016 which provides guidance for pharmacovigilance and also strengthens monitoring the sale and dispensing of drugs without prescription. There is also a common Standard Treatment Guidelines (STGs) for infectious diseases along with a few tertiary hospitals having their STGs. Bangladesh AMR Response Alliance (BARA) has developed STGs for poultry and humans (Murgi and Manush) that are available to BARA members in the form of an app and have the potential for wider use. These policy documents dealt with different aspects of the prevention and control of AMR in clinical settings.

In 2007, the Ministry of Fisheries and Livestock formulated the National Livestock Development Policy which highlighted inadequate veterinary services and weak implementation of regulatory frameworks as barriers to address disease burden in this sector. Specific laws on different aspects of food animals and fish were developed in 2010 when the use of antimicrobials, growth hormones, and pesticides was banned. For violating this law, a person might face up to one year's imprisonment or a fine of up to BDT 50,000 only (USD 650). To prevent the contamination of the environment, specific guidelines are advised for waste management e.g., guidelines for assessment of effluent treatment Plant 2008, Medical Waste Management and Processing Rule 2008, and Environment Protection Act 1995. These guidelines are indirectly linked with AMR prevention and control in the environment. Furthermore, Bangladesh promulgated the Food Safety Act, 2013 which emphasizes safe food production and marketing to protect life and health.

3.2 Weakness

The major policy gaps found in the current NAP are the absence of financial modality of the defined activities. Previous NAP had several activities, albeit it was difficult to formulate an operational plan under the sectoral plan due to the absence of costing of the activities. One important area was

the lack of activities in the previous NAP. Findings a Point Prevalence Survey (PPS) indicates very high-level usage of antibiotics in hospital settings, of which most are either prophylactic (medical and surgical prophylaxis) or provided empirically without complete laboratory diagnosis. The study found that in tertiary hospitals (referral teaching hospitals), more than 80 per cent of patients were receiving antibiotics. Though overuse and misuse were regarded as the main drivers of the AMR, there were few numbers of activities for the Antimicrobial Stewardship (AMS) program for all sectors. There was no monitoring and evaluation framework for the previous NAP which is an essential part of monitoring the implementation. Despite having a very good collaboration between human health and livestock departments, important stakeholders of One Health like the Environmental, agricultural and aquaculture sectors were not well addressed in the previous NAP. In addition, there are other weaknesses identified in the existing antimicrobial resistance containment in Bangladesh. These are discontinuity of policy in addressing AMR issues; weak coordination and integration mechanism on AMR at the national level; ineffectiveness of law enforcement; fragmented information and database on AMR trends; lack of effective mechanisms to regulate the use of antimicrobials in animal farms, aquatic farms, hospitals and clinics; AMR surveillance system that has not yet been responsive on time; lack of adequate resources in terms of skilled manpower and competent microbiology laboratories to address AMR surveillance and research. The continuous flow of funds to implement the activities in time is another issue. According to a Political Economic Analysis (PEA), only the Human health sector has the dedicated budget for AMR from the HPNSP, while the animal health sector has a very limited budget. Other sectors do not have any dedicated budget for AMR. Research and innovations in other sectors need to be improved. CDC, DGHS has a very limited budget for research activities. Other sectors have no dedicated funding for AMR-relevant research.

3.3 Opportunity

Bangladesh is a signatory of SDG, GHSA and IHR-2005. AMR has got highest priority in the country's political commitment. In addition, Bangladesh has well-structured healthcare facilities and has close partnerships with global communities (WHO, OIE and FAO).

3.4 Threat

The national AMR program is facing various challenges in implementing the existing NAP. AMR is not as visible as many of the health emergencies, it is difficult to understand the policymakers about the intensity and severity of the problem. The health budget is underfunded; as a consequence, the budget allocation to ARC is the least among all the programs of CDC, and DGHS. Lack of awareness of the AMR threat from policymakers to end-users, from regulatory bodies to health professionals, from industrial producers to farmers is a major threat to achieving the goals.

In addition, there are a number of general threats have been encountered for ARC in Bangladesh. These are the habitual practice of self-medication with antimicrobial medicines; people can access antimicrobial medicines easily; resistance to legislative strengthening and enforcement to control the distribution of antimicrobial medicines; intangible characteristic of AMR due to its asymptomatic feature which differs from other infectious diseases that can be detected and understood more easily; speed of transportation and globalization increases the risks of antimicrobial resistant bacteria becoming more widespread; insufficient knowledge and technologies on AMR containment; shortage of new antimicrobials and random use of antimicrobial medicines in animal and aquatic farming.

4. The National Strategic Plan for ARC

The Bangladesh National Strategy and Action Plan on AMR is a multi-stakeholder plan for the sectors directly impacted including human health, animal health, aquatic health and the environment. The national strategy serves as the country road map for action on AMR and therefore, requires the political commitment at the highest level to support the strategies and activities outlined in the operational plan. The Director General of Health Services (DGHS), Institute of Epidemiology, Disease Control and Research (IEDCR), Director General of Drug Administration (DGDA), Department of Livestock Services (DLS), Department of Fisheries (DOF), Department of Agriculture Extension (DAE), Bangladesh Livestock Research Institute (BLRI), Bangladesh Fisheries Research Institute (BFRI), Department of Environment (DOE), Bangladesh Food Safety Authority (BFSA) and other sister organizations will take leading roles for antimicrobial resistance containment in Bangladesh.

Vision

A nation in which antimicrobials are recognized and managed as a valuable public health resource; and their quality and appropriate use is ensured so that the health of human, animal, aquatic and environment is secured.

Mission

Establish policies and national multi-sectoral mechanisms which support an effective and sustained AMR containment system.

Goal

Minimize the development and spread of antimicrobial resistance using one health approach.

Strategic Priorities

The national strategy and action plan for ARC outlines the priorities and interventions to be implemented during 2021-2026 to tackle the public health challenge of AMR in Bangladesh. The eight strategic areas have been identified following the AMR Global Action Plan (WHO, FAO, OIE).

Key Strategy 1: Establish integrated surveillance and strengthen laboratory capacity;

Key Strategy 2: Promoting rational use of antimicrobials and antimicrobial stewardship program;

Key Strategy 3: Enabling good practices through effective sanitation, hygiene and infection prevention and control;

Key Strategy 4: Increasing stakeholder awareness and engagement;

Key Strategy 5: Strengthen multi-sectoral coordination;

Key Strategy 6: Promote innovation and research on AMR;

Key Strategy 7: Reduce the environmental spread of AMR;

Key Strategy 8: Strengthen global collaboration and partnerships;

Objectives and activities of the key strategies

Key Strategy 1: Establish integrated surveillance and strengthen laboratory capacity;

A number of forty-six activities have been proposed under four different objectives for human, animal and aquatic health. The major proposed activities are updating the national AMR surveillance protocol/ SOP, designating a national AMR surveillance centre for human, animal and aquatic sectors, establishing national /sentinel reference laboratories, harmonization of sensitivity testing and sufficient skilled workforce as well as capacity development for the laboratories.

Key Strategy 2: Promoting rational use of antimicrobials and antimicrobial stewardship program;

There sixty activities have been proposed under four different objectives in alignment with key strategy 5. The most important proposed activities are a review of existing regulations and regulatory framework; development of national antibiotic policy and guidelines; development of standard treatment guidelines; good pharmacy practices; and antimicrobial stewardship programs etc.

Key Strategy 3: Enabling good practices through effective sanitation, hygiene and infection prevention and control ;

There twenty-seven activities have been planned under three different objectives to address the key strategy 4. The major proposed activities are the development and operationalization of national infection prevention and control (IPC) policy and guidelines; immunization, hygiene, sanitation and biosafety in health care settings; good farm practices, biosecurity practices; hazard analysis and

critical control point (HACCP) in agro-processing and good manufacturing practices (GMP) in feed mills, pharmaceuticals, hospital & farm waste management etc.

Key Strategy 4: Increasing stakeholder awareness and engagement;

There twenty-six activities have been identified for human, animal and aquatic health under three different objectives in accordance with key strategy 2. The major proposed activities are formulation of key policy messages; development of information, education and communication materials; promote behavioural change of the prescribers; changes of the lifestyle and integration of AMR in pre-service and in-service training programs of professionals and health workers etc.

Key Strategy 5: Strengthen multi-sectoral coordination for planning and implementation of ARC in one health approach;

There nineteen activities have been proposed under five different objectives in accordance with this strategic area. The most important activities are the selection of national focal person; sectoral focal person; governance structure; and regular organization of national technical committee meeting, steering committee meeting and core working group meeting etc.

Key Strategy 6: Promote innovation and research on AMR;

There seventeen activities have been proposed under three different objectives to address the key strategy 6. Those objectives are: to create a supportive and sustainable environment for AMR research; to promote the development of innovative technologies and knowledge translation of AMR research; and to disseminate science-based evidence on AMR intervention. The most important proposed activities are the mobilization of the AMR research budget; establishment of the AMR innovation fund; public and private partnership on AMR research; development of new and alternatives to antimicrobials, publishing AMR and AMU data and translating and dissemination of AMR research into information for professionals and general public etc.Research is required for the exploration of the relationship between climate change and AMR in Bangladesh and strategies to mitigate the impact of climate change on AMR. Activities will focus on the exploration and compilation of existing evidence for a relationship between climate change and AMR in Bangladesh through a scoping review. This will be followed by research activities for further exploration of the possible relationships and impact of climate change on AMR in Bangladesh. This will guide further planning for strategies for mitigation of the impact of climate change on AMR including aligning with the Health National Adaptation Plan for climate change in Bangladesh.

Key Strategy 7: Reduce the environmental spread of AMR;

There eleven activities have been proposed under three different objectives in adherence with key

strategy 7. The major proposed activities are the development of SOP and guidelines for waste management from hospitals, pharmaceuticals, animal farms, and aquatic farms; the development of new policies, acts and regulations and proper disposal of expired/ unused antimicrobials etc.

Key Strategy 8: Strengthen global collaboration and partnerships;

There are a few activities that have been proposed to strengthen global collaborations and partnerships. The important activities are collaboration meetings/ seminars among the international stakeholders to review AMR activities and challenges; strengthen and streamline international networking and collaborations for capacity building, resource, knowledge, and experience sharing etc.

5. Action Plan

The AMR action plan describes the activities to be implemented or actions to be taken in line with the broad strategic areas and objectives recommended. Lead implementers as well as relevant collaborators have been identified. The list of collaborators may be modified/ expanded during the implementation. The lead national partners are DGHS, IEDCR, DLS, DOF, BLRI, BFRI, DAE, BFSA, DOE, Medical schools and Veterinary schools who have a pivotal role in implementing the operation plan of ARC. Besides, there are several international organizations that can extend their technical and financial support to implement the operation plan. The lead international partners would be WHO, OIE, FAO, US-CDC, USAID, GHSA, Fleming Fund, UNICEF, DFID and many other development and donor organizations.

Strategy 1

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
Key Strategy 1: Establish integrated surveillance and strengthen laboratory capacity;						
1. To improve the surveillance and diagnostic capabilities of hospitals, and laboratories;	**Human Health**					
	1.1.1: Ensure sufficient laboratory human capacity and other resources through planning and resource mobilization;	Insufficient human resources. A laboratory evaluation was recently conducted with the support of Fleming Fund.	Sufficient laboratory capacity and resources ensured	CDC, IEDCR, DGHS	HSM, UHC, Medical college, Medical Universities.	2023-2027
	1.1.2: Explore potential areas to strengthen financing of laboratory tests in public and private sectors;	No potential areas have been selected at present.	Financing of laboratory tests explored	CDC. DGHS	IEDCR, HSM, BSMMU	2023-2027
	1.1.3: Update/ revise National AMR surveillance protocol and SOPs;	Developed with the support of USCDC and ASM, but not yet updated	AMR surveillance protocol and SOPs updated/ revised	IEDCR	CDC, DGHS, HSM, Medical colleges, BSMMU	Completed
	1.1.4: Establish a national reference laboratory for AMR (NRL-AMR) with ToR;	NRL has been established at IEDCR	NRL- AMR established	IEDCR	CDC, DGHS	Completed
	1.1.5: Establish several sentinel/ regional reference laboratories for AMR with TOR;	Established in 2017 with EDPs' funding. No regional reference	Sentinel Reference Laboratory established	CDC, DGHS	IEDCR, HSM,	Completed

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
		laboratory established yet.				
	1.1.6: Expand Antimicrobial Resistance Surveillance Program (ARSP), and Antimicrobial Susceptibility Testing (AST) to peripheral hospitals;	No routine AMR surveillance by Government fund	ARSP and AST expanded to peripheral hospitals	CDC, DGHS	IEDCR, HSM	2023-2027
	1.1.7: Harmonization of quality laboratory testing of AST/ MIC;	No harmonization in quality testing of AST and MIC	Laboratory testing harmonized	IEDCR	CDC, HSM, Private hospitals and diagnostics	2023-2027
	1.1.8:Upgrade the capacity of reference, sentinel/ regional and private laboratories to conduct AMR surveillance;	Needs assessment is required. It needs government funding.	The capacity of reference and sentinel laboratories strengthened	CDC, DGHS, IEDCR	Relevant NRL/ sentinel, private laboratory	2023-2027
	1.1.9: Establish IQA and EQA system of national reference laboratory and sentinel laboratories;	IQA/ EQA are not organized in a regular manner	IQA and EQA of the laboratories established	IEDCR	CDC, DGHS, HSM	2023-2027
	Animal and Aquatic Health					
	1.1.1: Ensure sufficient laboratory human capacity and other resources through planning and resource mobilization;	A laboratory evaluation was recently conducted with the support of Fleming Fund	The capacity of laboratory human resources increased.	DLS, DOF	DOF, BLRI, BFRI	2023-2027

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	1.1.2: Update/ develop AMR surveillance protocol and SOPs;	BLRI developed SOP/ protocol with the support of USCDC otherwise all are institute base	AMR surveillance protocol and SOPs developed/ updated	DLS, DOF	BLRI, BFRI	Completed
	1.1.3: Establish a national reference laboratories for AMR (NRL-AMR) with ToR;	NRL-AMR in animal health sector are established. No initiative has taken in aquatic sector in aquatic sector.	NRL-AMR established in animal and aquatic sector	DLS, DOF	BLRI, BFRI	Completed
	1.1.4: Establish several sentinel/ regional reference laboratories for AMR with ToR;	FDIL Feni and FDIL Joypurhat has been selected as sentinel AMR laboratory in animal health sector. No regional reference laboratory established.	Sentinel/ regional reference laboratory established	DLS, DOF	BLRI, BFRI	Completed

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	1.1.5: Expand Antimicrobial Resistance Surveillance Program (ARSP), and Antimicrobial Susceptibility Testing (AST) to regional and district hospitals;	Regional (FDIL) and district hospitals do not have AST capacity	ARSP and AST expanded to FDIL and district hospital	DLS, DOF	BLRI, BFRI	2023-2027
	1.1.6: Strengthen the capacity of reference and sentinel/ regional, private laboratories to monitor AMR surveillance;	Need to know the baseline data	The capacity of laboratories strengthened	DLS, DOF	BLRI, BLRI, private labs	2023-2027
	1.1.7: Establish IQA and EQA system of reference laboratories and sentinel laboratories;	IQA/ EQA are not organized in a regular manner	IQA and EQA of the laboratories established	BLRI, BFRI	DLS, DOF	2023-2027
	Environmental Sector					
	1.1.1: Engage with environment laboratories and relevant offices with AMR surveillance;	Not yet engaged	Environment laboratories engaged with AMR surveillance	DOE	CDC, DGHS	2023-2024
	1.1.2: Assess capacities of environment laboratories;	Not yet assessed	The capacity of environmental laboratories assessed	DOE	CDC, DGHS	2024

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	1.1.3: Conduct environmental surveillance for AMR and residues;	Environmental surveillance for AMR and residues are scattered way conducted	Environmental surveillance of AMR and residue conducted	DOE	CDC, DGHS, DLS, DOF	2023-2027
	1.1.4: Develop monitoring and surveillance protocols, SOPs on AMR, AMs residues and waste disposal from hospitals, health facilities, clinics, animal clinics and animal & aquatic farms;	Need to develop	Monitoring and surveillance protocols of AMR and AMs residues developed	DOE	CDC, DLS, DOF	2024
2. To capacitate health workers based on required competencies for different areas of AMR work;	**Human Health**					
	1.2.1: Assess skill of human resources for effective surveillance, e.g. infectious disease specialists, microbiologist, epidemiologist, clinical pharmacists, nursing staffs, medical technologists, etc.	Baseline assessment is needed.	Skill and number of human resources assessed	CDC, DGHS	IEDCR, HSM	2024

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	1.2.2: Send technical personnel to relevant local and foreign trainings on monitoring, surveillance, Good Laboratory Practices (GLP), sensitivity testing methods and the operation of laboratories, including compliance to accreditation standards;	Some local training has been conducted in a small scale for selected hospitals.	Number of trainings organized for the health personnel	CDC, DGHS	HSM, Medical college, UHC,	2023-2027
	Animal and Aquatic Health					
	1.2.1: Assess skill and quantity of human resources for surveillance;	Baseline assessment is needed.	Skill and number of human resources assessed	DLS, DOF	BLRI., BFRI	2024
	1.2.2: Train technical/ laboratory personnel on monitoring, surveillance and testing methods, GLP and the operation of laboratories, including compliance to accreditation standards;	Very few small-scale training organized with animal and aquatic health personnel	Number of trainings organized	DLS, DOF	BLRI. BFRI	2023-2027
	1.2.3: Develop skills of veterinary and fisheries service staff for sampling of AMR surveillance;	There is little skill of the veterinary and fishery personnel	The skill of veterinary and fisheries service staffs developed	DLS, DOF	BLRI, BFRI	2023-2027
	Environment					
	1.2.1: Train staff for environmental monitoring on hospital, pharmaceuticals and agriculture waste management;	No such training organized	Environmental monitoring competencies enhanced	DOE	CDC	2023-2027

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
3. To institutionalize well-developed surveillance, monitoring and reporting systems/ networks at all levels in human, animal, aquatic and environment sectors;	Human Health					
	1.3.1: Designate a national coordinating center for AMR surveillance;	IEDCR has been designated as national AMR surveillance coordination center	A national coordinating center for AMR surveillance designated	CDC, DGHS	IEDCR	Completed
	1.3.2: Establish a system for the national surveillance of antimicrobial use in human health;	No AMU surveillance in place. A protocol has been developed.	AMU surveillance system established	DGDA	IEDCR	2023-2025
	1.3.3: Establish a system for the national surveillance of antimicrobial consumption (AMC) in human health;	DGDA has conducted AMC surveillance earlier. A protocol has been developed.	AMC surveillance system established	DGDA	CDC, IEDCR, BAPI, HSM, UHC	Completed
	1.3.4: Establish a web-based laboratory network for AMR surveillance data and information dissemination and sharing;	Dashboard has been developed.	A web-based laboratory network established	IEDCR, CDC	HSM, BSMMU	Completed
	1.3.5: Point prevalence survey of antimicrobial prescription in tertiary hospital;	survey done in several hospitals. Needs to be done in regular interval.	Point prevalence survey conducted	DGDA, CDC	CDC, DGHS	2023-2027
	1.3.6: Establish a web-portal for AMC surveillance;	Yet not developed	A web-portal for AMC surveillance established	DGDA	CDC, DGHS	2024
	1.3.7: Pilot survey on AMs prescription for AMU surveillance;	A pilot survey conducted	Pilot survey on AMs prescription conducted	DGDA,CD C	CDC, DGHS	Completed

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	1.3.8: Develop e-prescription system that will include the collection of data on antimicrobial use;	No e-prescription system in place. MIS is working on it.	E-prescription system developed	MIS, CDC, DGHS	HSM, UHC	2023
	1.3.9: Training on e-prescription system (integrated with pharmacovigilance);	No baseline information	Training on e-prescription system conducted	MIS, CDC, DGHS	IEDCR, HSM, UHC	2023-2027
	1.3.10: Adopt e-prescription system in hospitals;	Yet to commence	E-prescription system in hospital settings adopted	MIS, CDC, DGHS	IEDCR, HSM, UHC	2023-2027
	1.3.11: Introduction of pharmacovigilance system;	Started with small scale	Pharmacovigilanc e system introduced	DGDA	CDC, DGHS	Completed
	Animal and Aquatic Health					
	1.3.1: Finalize and approve AMR surveillance and monitoring plan for animal and aquatic health;	Surveillance plan developed with the assistance of Fleming Fund	Surveillance and monitoring plan finalized and approved	DLS, DOF	BLRI, BFRI	Completed

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	1.3.2: Designate a national coordinating center for AMR surveillance;	DLS has been designated as national AMR surveillance coordination center	A national coordinating center for AMR surveillance designated	DLS	DOF, BLRI, BFRI	Completed
	1.3.1: Establish a system for the national surveillance and monitoring of antimicrobial use (AMU) in food producing animals;	Some pilot study conducted on AMU at farm level	AMU surveillance system established	DLS, DOF, DGDA	BLRI, BFRI, Farms	2023-2025
	1.3.4: Conduct AMR surveillance in food-producing animals and their products: meats, milk, eggs and fish & fishery products, etc.	AMR surveillance are not conducted in an organized manner	AMR surveillance conducted in an organized manner	DLS, DOF	BLRI, BFRI	2023-2027
	1.3.5: Develop evidence based document of AMU and AMR trends in food- producing animals;	Only AMs import data available and limited AMR surveillance data in place	AMU and AMR trends documented	DLS, DOF	BLRI, BFRI	2023-2027
	1.3.6: Harmonization of antimicrobial sensitivity testing in compliance with CLSI / EUCAST guidelines;	Laboratory activities are not synchronized	Antimicrobial sensitivity testing harmonized in compliance with similar standard	DLS, DOF	BLRI, BLRI, Vet. Schools	2023-2027
	1.3.7: Conduct antimicrobial residue surveillance in livestock, poultry, fish inputs and products;	No reliable baseline data. But QC lab of DLS, DOF and FSL of BLRI has started in small scale	Antimicrobial residue surveillance conducted in livestock, poultry and fish products	DLS, DOF	BLRI, BFRI	2023-2027

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	1.3.8: Establish a web-based laboratory network for AMR surveillance data and information dissemination and sharing;	No inter-sectoral web based laboratory network. DLS has its own BAHIS network	A web-based laboratory network for surveillance data sharing established	DLS	BLRI, DOF, BFRI	Completed
	1.3.9: Establish a web-portal for AMC surveillance;	Yet not developed	A web-portal for AMC surveillance data sharing established	DLS, DOF DGDA	DGDA	2024
	1.3.10: Conduct annual point prevalence surveys (PPS) -Pilot survey on AMs prescription -Develop e-prescription system at the veterinary health settings that will include the collection of data on antimicrobial use -Training on e-prescription system (integrated with pharmacovigilance) -Adopt e-prescription system in the veterinary hospitals	No baseline information on PPS There is no e- prescription system	Annual point prevalence surveys conducted	DLS	BLRI, DOF, BFRI	2023-2027

Strategy 2

	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
Key Strategy 2: Promoting rational use of antimicrobials and antimicrobial stewardship program;						
1. To review and implement guidelines for rational use of antimicrobials;	Human Health					
	2.1.1: Review existing regulations and regulatory framework to combat AMR	Baseline data available but not thoroughly reviewed	Legal framework revisited/revised/ modified	CDC	HSM, CBHC, UHC of DGHS, BMA, BPMPA	Completed
	2.1.2: Integrate antimicrobials, AMR and AMS principles and concepts in medical, dental education curricula and in the continuing professional education (CPE) for health professionals;	Basic information on AMR is included in the MBBS and BDS curriculum	Basic principles of AMs, AMR & AMS included in medical education curricula	DGME, BMDC	CDC, CME	2023-2027
	2.1.3: Develop national antibiotic policy and AMS guidelines;	No antibiotic policy yet developed. AMS guideline being developed	National antibiotic policy and guidelines developed	CDC	DGDA, HSM, UHC, BSMMU, BMA, BPMPA	2023
	2.1.4: Development/ update of Standard Treatment Guidelines (STG) for infectious diseases (IDs) - Analysis of baseline data of IDs burden and antimicrobial sensitivity (AMS) pattern to develop STGs -Encourage use of STGs to private HCPs/ HCFs -Update STGs annually based on AST data by HCFs -Open access to STGs by HCFs/ HCPs (public and private)	STG developed	STGs for IDs developed/ updated -Analysis of ID and AMS data done -Number of private HCFs completed development of STG -STGs available in the website as open access	CDC	IEDCR, Professional bodies like BMA, BPMPA and professional societies.	Completed

	Activities	Baseline	Performance- Indicator(s)	Lead Agency	Implementing Partners	Timeline
	2.1.5: Develop Standard Treatment Guidelines (STG) for ICU patients	No such STG has been developed yet	STG for ICU patients developed	CDC	HSM, BSMMU, Leading private hospitals	2024
	2.1.6: Ensuring uninterrupted availability of quality AMs at all levels of HCFs;	Need assessment is a demand of time	Made available AMs in HCFs	HSM, DGDA	CDC, HSM, CBHC, UHC of DGHS,,	2023-2027
	2.1.7: Recycling the use of AMs;	No such practice has been initiated	The recycling use of antimicrobials practiced	DGDA	CDC, HSM, UHC, CBHC, BSMMU	2023-2027
	2.1.8: To maintain the courses and duration of the AMs;	Sometimes patients are reluctant for courses and duration of AMs	Courses and duration of AMs maintained	CDC	HSM, UHC, CBHC, BPCDOA	2023-2027
	2.1.9: Develop AMs prescription and dispensing policy;	No such policy developed yet. Will be mentioned in AMS guideline.	AMs prescription and dispensing policy developed	DGDA,	BPC,	2023
	2.1.10: Restrict the selling of AMs without the prescription of registered physicians.	Drug and cosmetic act 2023 passed. Under the new act, selling antibiotics without physician's prescription is subjected to 20000-taka penalty. There are some Model Pharmacy which are supposed to restrict OTC sale of AMs. But no restriction in other pharmacies	Over the counter selling of antimicrobials restricted	DGDA	BPC, CDC, BCDS	2023-2027

	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	2.1.11: Develop a prescription audit system for antimicrobials;	No prescription audit system. Will be included in the AMS guideline.	Prescription audit system developed	CDC, DGHS	IEDCR, DGDA, Professional societies, BSM, BSS, OGSB, BPA, BSP	2023
	Animal Health and Aquatic Health					
	2.1.1: Review existing regulations and regulatory framework to combat AMR;	Baseline information available	Existing regulatory framework reviewed	DLS, DOF	-	Completed
	2.1.2: Develop national antibiotic policy for animal and aquatic health;	No policy has been formulated	National antibiotic policy developed	DGDA	DLS, DOF	2024
	2.1.3: Development of standard treatment guidelines (STGs);	Developed STG for poultry diseases. But no STG for other endemic and economic important animal and aquatic diseases.	Standard treatment guidelines developed	DLS, DOF	BLRI, BFRI	Completed
	2.1.4: Initiation of Antimicrobial Stewardship Program (ASP) in central, regional and district veterinary hospitals and fisheries laboratory;	No ASP yet initiated in animal and aquatic health sector	Antimicrobial Stewardship Program initiated in animal and aquatic sector	DLS, DOF	BLRI, CDIL, FDIL, District hospitals, FIQCL	2023-2027
	2.1.5: Restrict the selling of AMs (Vet) without the prescription of registered veteranier.	Drug act passed. Still, Antibiotics are sold in medicine shops as well as in animal feed shops.	Over the counter selling of antimicrobials restricted	DGDA	DLS, DOF, BCDS, AHCAB	2023-2027
	2.1.6: Recycling the use of AMs;	No such practice has been initiated	The recycling use of antimicrobials practiced	DGDA	DLS, DOF, CDIL, FDIL, DVH, UVH	2023-2027

	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	2.1.7: To maintain the courses and duration of the AMs;	Sometimes patients are reluctant for courses and duration of AMs	Courses and duration of AMs maintained	DLS, DOF	CDIL, FDIL, DVH, UVH	2023-2027
	2.1.8: Develop AMs prescription and dispensing policy;	No such policy developed yet	AMs prescription and dispensing policy developed	DGDA,	DLS, DOF	2024
	2.1.9: Develop a prescription audit system for antimicrobials;	No prescription audit system	Prescription audit system developed	DLS, DOF	DGDA	2024-2026

	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
2. To create an enabling environment for the rational use of antimicrobials;	Human Health					
	2.2.1: To enforce and enhance regulations on antibiotic prescription and use	No monitoring and regulations on prescription and use	Regulation imposed on antibiotic prescription and use	DGDA	BMDC, HSM, CBHC, UHC of DGHS, BMA, BPMPA	2023-2027
	2.2.2: Implement, monitor and evaluate antimicrobial stewardship in public healthcare facilities;	AMS program piloted in few hospitals.	AMS implemented, monitored and evaluated in health care settings	CDC, DGHS	HSM, CBHC, UHC of DGHS, BMA.	2023-2027
	2.2.3: Implement antimicrobial stewardship in private hospitals and clinics;	Only few leading private hospitals are implementing AMS programs	ASP implemented in private hospitals and clinics	CDC, DGHS	HSM, CBHC, UHC of DGHS, BMA, BPMPA BPCDOA	2023-2027
	2.2.4: Implement antimicrobial stewardship in pharmacy;	No AMS program in pharmacist	ASP implemented in pharmacist	DGDA	BPC, DCU, CDC	2023-2027
	2.2.5: Document and disseminate best practices in AMs	No best practice of AMs documented.	Best practice of AMs documented	DCU, CDC	BMA, BPMPA, HSM, UHC, CBHC	2023-2027
	2.2.6: AMS in adherence with quality laboratory testing (AST);	Rudimentary	Quality laboratory testing (AST/ MIC) ensured	HSM	CDC	2023-2027

	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	2.2.7: Monitor AMS program including implementation of Standard Treatment guidelines (STG) in all health facilities;	STG in place	Implementation of AMS and NAG monitored	CDC	HSM, CBHC, UHC of DGHS, BMA, BPMPA	2023-2027
	2.2.8: Ensure good pharmacy practices (GPP) at all points of sale of AMs;	No GPP yet developed	Good pharmacy practices ensured	DGDA	BFC	2023-2027
	2.2.9: Ensuring good manufacturing practices (GMP) of AMs in human sectors;	No GMP yet practiced	Good manufacturing practices ensured	DGDA	BFC, BAPI	2023-2027
	2.2.10: Offer AMS Internship/fellowship program for hospital pharmacists;	Pharmacists are not properly placed in most of the hospitals	Offer AMS fellowship to pharmacist	DGDA, CDC	PCB, University, DGHS	2023-2027
	Animal and Aquatic Health					
	2.2.1: Registration of veterinary drug producer establishments and products;	Registration of veterinary drug producer and products by DGDA in place	Registered veterinary drug producer and products	DGDA,	BAPI	Completed
	2.2.2: Strict enforcement of existing regulations regarding medicated feeds “animal and fish feed act, 2010”	Regular monitoring in place	Animal and fish feed act strictly enforced in feed company	DLS, DOF	FIAB, Commercial feed supplier/ company	2023-2027
	2.2.3: Development of guidelines for the regulation of antimicrobials in animal drinking water ;	No guideline	AMs uses guideline in drinking water developed	DLS, DOF	Animal and aquatic farming community	2024

	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	2.2.4: Motivate veterinary practitioners on the prudent use of antimicrobials;	Public veterinarian (1400) sensitized through refresher AMR training	Veterinary practitioners motivated on prudent use of AMs	DLS	Veterinary practitioner	2023-2027
	2.2.5: Ensure maintenance of the withdrawal period of AMs used in animal health and fisheries to prevent residual effect in human health;	No standard practice and protocol in place	AMs withdrawal period maintained before harvesting	DLS, DOF, BFSA	Animal and aquatic farming community	2023-2027
	2.2.6: Restrict the use of AMs in animal by traditional healers and non-veterinarians;	No initiative in place	The use of AMs restricted	DLS, DOF	BVC	2023-2027
	2.2.7: AMS in adherence with quality laboratory testing (AST)	Few laboratories has the capacity to quality AST	Quality laboratory testing of AST ensured	DLS, DOF	CDIL, FDIL BLRI, FIQCL	2023-2027
	2.2.8: Monitor AMS program including implementation of antibiotic guidelines;	No AMS monitoring program.	Implementation of AMS and NAG monitored	DLS, DOF	CDIL, FDIL, District hospitals, FIQCL	2023-2027
	2.2.9: Ensure good pharmacy practices (GPP) at all points of sale of AMs;	No baseline survey data	Good pharmacy practices ensured	DGDA, DLS, DOF	Drug store/ Pharmacy, BCDS	2023-2027
	2.2.10: Ensuring good manufacturing practices (GMP) for producing AMs;	The GMP inspection was performed by DGDA but not regularly	Good manufacturing practices of AMs ensured	DGDA	BAPI, DLS, DOF	2023-2027
	2.2.11: Conduct monitoring and surveillance of animal and aquatic feeds establishments;	Regular monitoring and registration are in place	Regular monitoring and surveillance conducted	DLS, DOF	FIAB, Feed manufacturers	2023-2027
	Human Health					

	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
3. To improve the marketing authorization and post- marketing surveillance of antimicrobials;	2.3.1: Monitor the quality of registered antimicrobials in the market;	National Control Laboratory (NCL) and mini lab, DGDA tested the quality of AMs	The quality of antimicrobials assessed	DGDA	CDC, BAPI, BCDS	2023-2027
	2.3.2: Harmonize regulatory framework in the production and use of antimicrobials;	There is no harmonization policy in place	Regulatory framework on production and use of AMs harmonized	DGDA	CDC, DCU, BAPI	2023-2027
	2.3.3: The use of technologies to increase surveillance and detect counterfeit, falsified and substandard drugs in the market;	DGDA drug verification apps are in place	Falsified and substandard AMs in the market identified	DGDA	CDC, BCDS, BAPI	2023-2027
	Animal and Aquatic Health					
	2.3.1: Develop a database of registered antimicrobials, including quantitative production and importation;	The AMs import database is available but there are no accurate production data	AMs production and importation database developed	DGDA,	AHCAB, BAPI	2023-2027
	2.3.2: Monitor the quality of veterinary AMs;	DGDA drug verification apps are in place	The quality of veterinary AMs assessed	DGDA,	AHCAB, BAPI	2023-2027
	2.3.3: Monitor and penalize the marketing of unregistered and banned antimicrobials in animal and aquaculture practices;	No such monitoring mechanism in place	Penalized due to marketing of unregistered and banned AMs	DGDA,	AHCAB, BAPI	2023-2027

	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	2.3.4: Strictly enforcement and incentivize adherence to regulations on antibiotic prescription, dispensing, and use in animal and aquatic farming;	No such regulation in place	AMs prescription, dispensing and use strictly monitored	DGDA	Prescriber, drug seller and farmers	2023-2027
	2.3.5: Require all antimicrobials to adhere with Good Manufacturing Practices (GMP);	No basic data for monitoring GMP	Good manufacturing practices of AMs ensured	DGDA	BAPI	2023-2027
4. To impose policy enforcement on rational use of antimicrobials in markets, farms and communities;	Human Health					
	2.4.1: Review and assess current policies related to the use of antimicrobials;	Baseline information available	Current AMs/ drug policies reviewed	CDC, Drug Policy-DGDA	HSM, UHC, CBMC	Completed
	2.4.2: Conduct dialogue with prescribers, stakeholders, industry and local government departments;	No such dialogue yet conducted	Number of dialogues conducted among the stakeholders	DGDA	CDC, HSM, UHC, CBMC	2023-2027
	2.4.3: Develop a system for monitoring and implementation of existing regulations;	No such monitoring system in place	Number of monitoring conducted on existing regulations	DGDA	CDC	2023-2027
	2.4.4: Enforcement of medical audit	No medical audit in place	Medical audit performed	CDC, IEDCR	HSM, UHC, CBHC	2023-2027
	Animal and Aquatic Health					

	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	2.4.1: Review and assess current policies related to the use of antimicrobials;	No current polices on use of AMs in food animals and fish	Current policies reviewed and assessed	DLS, DOF	Prescribers, farming community	2023
	2.4.2: Conduct dialogue with clients, stakeholders, industry and local government departments on AMs use;	No such dialogue conducted	Stakeholder dialogue conducted	DLS, DOF	Relevant stakeholders	2023-2027
	2.4.3: Develop a system for monitoring and implementation of existing regulations on AMs use;	No mechanism yet to develop	Monitoring system developed	DLS, DOF	Farms and Industry	2023-2027
	2.4.4: Engage local governments in the implementation of regulations, especially in use of antimicrobials in animal and aquatic farms;	No such engagement in place	Local government departments engaged in rational use of AMs	DLS, DOF	Local government departments	2023-2027
	2.4.5: Issuing of office memorandum on the prudent use of veterinary drugs;	No such memorandum issued	Office memorandum issued	DLS, DOF	Veterinary practitioners and farmers	2023
	2.4.6: Create a joint coordination activities between DLS, DOF and DGDA	No effective joint regulatory framework in place	Joint regulatory framework developed	DGDA, DLS, DOF	Farms and industry	2023

	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	2.4.7: Strengthen regulatory activities and monitoring system for veterinary drugs and aquatic medicine. Strength Veterinary cell at DGDA to regulate veterinary drugs;	DGDA already has veterinary cell with dedicated manpower	A veterinary cell in DGDA made functional	DGDA	WHO, USAID, Different NRAs, DLS, DOF.	Completed

Strategy 3

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
Key Strategy 3: Enabling good practices;						
1. To enhance capacities of health personnel and community health workers for infection prevention, disease prevention, sanitation and hygiene;	**Human Health**					
	3.1.1: Address AMR problems in both public and private healthcare facilities in a systematic and integrated manner;	No systematic and integrated program. A very few private hospitals address AMR problem within their own facilities.	AMR problem properly addressed in public and private healthcare facilities	CDC, DGHS	HSM, CBHC, UHC of DGHS, Private Hospitals	2023-2027
	3.1.2: Development and implementation of IPC guidelines across all tiers of HCFs;	IPC guidelines across all tiers of HCFs has been developed	IPC guidelines developed and implemented	CDC, DGHS	IEDCR, HSM, CBHC, UHC of DGHS.	Completed
	3.1.3: Development of tier-wise IPC SOPs to all HCFs;	SOPs developed.	IPC SOPs developed for all tiers of HCFs	CDC, DGHS	HSM, CBHC, UHC of DGHS, IEDCR	Completed

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	3.1.4: Formation of national and local IPC committees in each HCFs with TOR;	National IPC committee developed. The circulation was given by CDC, DGHS to form local IPC committees in the HCFs with TOR.	National and local IPC committees formed	CDC, DGHS	HSM, CBHC, UHC of DGHS, IEDCR.	Completed
	3.1.5: Conduct orientation and training on IPC guidelines and SOPs;	Randomly organized introduction and training on IPC guidelines	Orientation and training on IPC guidelines and SOPs conducted	CDC, DGHS	HSM, CBHC, UHC of DGHS, IEDCR.	Completed
	3.1.6: Strengthen competency of infection control personnel;	A survey has been done on IPC competency. Regular initiative needed.	Competency of infection control personnel strengthened	CDC, DGHS	HSM, CBHC, UHC of DGHS, IEDCR.	2023-2027
	3.1.7: Introduction and sensitization to HCPs about IPC practices such as use of PPE, hand washing, hygienic measures and sanitation practices, antiseptics and disinfectant;	No exact baseline data	HCPs introduced and sensitized about IPC practices	CDC, DGHS	EPI, HSM, CBHC, UHC of DGHS.	Completed
	3.1.8: Ensuring effective immunization practices by the HCPs;	Immunization database is available	Effective immunization practice by the HCPs ensured	CDC, DGHS	HSM, CBHC, UHC of DGHS	2023-2027

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	3.1.9: Ensure standard IPC practice to prevent surgical site infection (SSI);	No basic information	Standard IPC practice to prevent surgical site infection ensured	CDC, DGHS	HSM, CBHC, UHC of DGHS	2023-2027
	3.1.10: Integrate infection prevention and control in other existing public health programs;	No such initiative was taken by the competent authority	IPC integrated in other public health programs	CDC, DGHS	HSM, CBHC, UHC of DGHS, Professional bodies	2023-2027
	3.1.11: Development of guidelines for hospital waste management practices;	There are guidelines, but operations are limited to the color bins in most of the facilities.	Hospital waste management guidelines developed	CDC, DGHS	DGME, DG Nursing, CME, BMDC, BFC.	Completed
	3.1.12: Incorporate IPC in the medical, dental, health technology, nursing and pharmacy curricula;	The IPC in the course is limited to the scope of antisepsis, disinfection and sterilization methods.	IPC incorporated in medical academic curricula	CDC, DGHS	MOE	Completed

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	3.1.13: Emphasize on the topics of hygiene, sanitation, and IPC including biosafety and biosecurity in school curricula as well as in teachers' training curricula;	Basic concept of hygiene, sanitation and IPC is present but the concept of biosafety and biosecurity is not present in school curricula as well as in teachers' training curricula;	The IPC included in school and teachers training curricula	CDC, DGHS	HSM, CBHC, UHC of DGHS, MOE	Completed
	Animal and Aquatic Health					
	3.1.1: Implement Good Biosecurity, Good Agricultural Practices (GAP) and Good Aquaculture Practices (GAqP) in the farming system;	GAP and GAqP are not practiced in farms, some corporate commercial farms practiced good biosecurity measures	Good Agricultural Practices in farming system implemented	DLS, DOF, DAE	Farming Community	2023-2027
	3.1.2: Strengthen the capacity of national animal and aquatic health services to combat diseases;	In 2015, OIE performed a PVS gap analysis for DLS, but there was no baseline for DOF	The capacity of national animal and aquatic health services strengthened	DLS, DOF	OIE	2023-2027
	3.1.3: Strengthen vaccination campaign in the animal farms;	No national data available but commercial farms maintained their own record	The vaccination campaign strengthened	DLS	Farming community, BPICC	2023-2027

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	3.1.4: Incorporate the topic of hygiene, sanitation, disease prevention and biosecurity in veterinary/ fisheries professionals and paraprofessionals training curricula;	It's included in some training courses, but not everywhere	Biosecurity and disease prevention courses included in training curricula	DLS, DOF	All relevant organizations/ departments	2023-2027
2. To implement coordinated programs on sanitation, hygiene and infection prevention and control in hospitals, health facilities, animal clinics and farms;	Human Health					
	3.2.1: Develop national infection prevention and control policy;	No national infection prevention and control policy	IPC policy developed	CDC, DGHS	HSM, CBHC, UHC of DGHS, DGNM	2024
	3.2.2: Monitoring of IPC activities at health facilities by IPC national committee;	No national IPC committee was formed for monitoring the activities	IPC committee formed to monitor the activities	CDC, DGHS	HSM, CBHC, UHC of DGHS, DGNM	2023-2027
	3.2.3: Improve biosafety and biosecurity practices in all health care settings;	Some biosafety and biosecurity guidelines are in place	Biosafety and biosecurity practices improved in healthcare settings	CDC	HSM, CBHC, UHC of DGHS, DGNM	2023-2027
	Animal and Aquatic Health					
	3.2.1: Improve biosafety and biosecurity practices in all animal hospitals, clinics, & famrs;	A small number of poultry farms adopted biosecurity practices	Biosecurity & biosafety practices improved in animal health care settings and farms	DLS, DOF	Animal hospitals, farms	2023-2027

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	3.2.2: Develop biosafety protocol for animal hospitals, clinics, & other animal health care settings;	No such protocol in place	Biosafety protocol developed	DLS, BLRI	Animal hospitals	2023
3. To improve good agricultural and biosecurity practices in animal and aquatic farms;	Animal and Aquatic Health					
	3.3.1: Development of guidelines on Good agriculture practice (GAP), Good veterinary practice (GVP) and Good aquatic practice (GAqP);	No guideline on GAP, GVP, GAqP.	Good farm practices guidelines developed	DLS, DOF	Animal and aquatic farming community	2023
	3.3.2: Develop biosecurity protocol/ guideline for animal and aquatic farms;	In 2009 the biosafety guidelines for commercial poultry farms were adopted. No such guidelines for aquatic farms	Biosecurity protocol/ guideline developed	DLS, BLRI , DOF	Animal and aquatic farms	2023
	3.3.3: Ensure strict implementation of biosecurity measures in animal and aquaculture farms, with adherence to Good Animal Husbandry Practices (GAHP); Good Veterinary Practices (GVP); Good Aquaculture Practices (GAqP);	Large commercial poultry farms practicing strict biosecurity practices but lack in small scale farming system	Biosecurity measures strictly ensured in animal and aquatic farms	DLS, DOF	Animal and aquatic farming community	2023-2027
	3.3.4: Implement HACCP system in agro-processing plants;	No national baseline data but few commercial industry adopted HACCP	HACCP adopted in agro-processing plants	DLS, DOF, BFSA	Agro-processing industry	2023-2027

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	3.3.5: Implementation of Good Manufacturing Practices (GMP) for feed mills, pharmaceuticals, importers, manufacturers, and suppliers;	No regular surveillance mechanism to oversee the GMP. Many commercial feed mills and pharmaceuticals maintained GMP	GMP implemented in production settings	DLS, DOF, BFSA,	Agro-based industry	2023-2027

Strategy 4

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
Key Strategy 4: Increasing stakeholder awareness and engagement;						
1. To improve the awareness among the key policymakers on AMR;	Human Health					
	4.1.1: Produce key messages related to the impact of AMR on human health at individual level, community level and national level;	Policy Brief developed.	The key messages on impact of AMR on human health produced	CDC, IEDCR	HSM, CBHC, UHC of DGHS, MOHFW, MOW, MOST.	Completed
	4.1.2: Produce evidence on the economic impact of AMR in human health sectors;	The economy analysis of AMR was completed by Fleming Fund	The economic impact of AMR in human health sector assessed	CDC, DGHS	IEDCR, HSM, CBHC, UHC of DGHS, MOHFW	Completed
	Animal and Aquatic Health					

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	4.1.1: Produce key messages related to the impact of AMR on animal/ aquatic health at herd level, community level and national level;	Not done	The key messages on impact of AMR on animal/ aquatic health produced	DLS, DOF	BLRI, BFRI	2023
	4.1.2: Produce evidence on the economic impact of AMR in animal & aquatic health sectors;	The economy analysis of AMR was completed by Fleming Fund	The economic impact of AMR assessed	DLS, DOF	BLRI, BFRI	Completed
2. To increase public awareness on the rational use of antibiotics;	**Human Health**					
	4.2.1: Produce/ update information, education and communication (IEC) materials on AMR (brochure, leaflets, posters);	Some basic posters, banners and flyers are already in place	IEC materials on AMR developed	CDC, DGHS	All relevant stakeholders	2023-2027
	4.2.2: Dissemination of information on IEC through electronic and print media, posters, festoons and banners;	Some IEC materials distributed on the eve of World Antimicrobial Awareness Week (WAAW)	IEC materials on AMR disseminated.	CDC, DGHS	All electronic and print media	2023-2027
	4.2.3: Implement general IEC and advocacy activities round the year in different settings especially in communities to affect behavior change;	Some basic posters, banners, handbills etc. are disseminated only to WAAW.	Number of IEC and advocacy activities conducted round the year	CDC, DGHS	HSM, CBHC, UHC of DGHS	2023-2027

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	4.2.4: Advocate healthy lifestyle, cost-effective and essential immunization and other non-pharmaceutical measures to reduce IDs burden;	No such activity	Number of advocacy programs conducted	CDC, DGHS	HSM, CBHC, UHC NCDC, HEB, EPI, IEDCR,	2023-2027
	4.2.5: Conduct effective, targeted health promotion and communication initiatives about AMR, AMU, and AMS in various settings (e.g., health facilities, educational institutes, work place) through various channels (social media, television, print media, theaters, etc.) directed towards consumers;	No such activity	Number of health promotional and communication initiatives conducted	CDC, DGHS	Health Education and Promotion OP, School Health Program of MNCAH OP of DGHS, DGME, MOE, MOST, Print and Electronic media	2023-2027
	4.2.6:Promote behavioral change of prescribers (qualified and unqualified), nurses, pharmacists, drug retailers and community (users) regarding use of AMs through intense training, counseling, monitoring & evaluation;	Such activities have not yet performed	Behavioral change of the prescribers promoted	CDC, DGDA,	HSM, Hospitals and clinics OP, CBHC, UHC, BPC, Professional organizations.	2023-2027
	4.2.7: Observance of WAAW, world hand washing day, national food safety day with festive mood;	These occasions are celebrated separately by different organizations	WAAW, world hand washing day and national food safety day observed	CDC, DGHS	All relevant stakeholders	2023-2027

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	4.2.8: Engage with local government departments on AMR advocacy and awareness;	Not yet engaged	Local government departments engaged on AMR advocacy and awareness	CDC, DGHS	All relevant government stakeholders	2023-2027
	4.2.9: Conduct advocacy meetings with community peoples including community leaders, teachers and religious leaders;	Piloted community advocacy in 5 upazilla	Number of advocacy meetings conducted	CDC, DGHS	CBHC, UHC, BMA, BPMPA and other professional/ civil society organizations, NGOs	2023-2027
	Animal and Aquatic Health					
	4.2.1: Conduct KAP studies for farmers, feed millers/dealers, and other stakeholders on prudent use of AMs and impact of AMR;	Few studies are conducted in haphazard manner	KAP studies for farmers, millers, dealers conducted	BLRI, BFRI, Veterinary schools, Fishery schools	DLS, DOF	2023-2025
	4.2.4: Conduct nationwide advocacy campaign on prudent use of antimicrobials and food safety;	DLS and BPICC jointly conducted advocacy program in division level	Number of advocacy campaign conducted	DLS, DOF	MOE, MOST, BFSA	2023-2027
	4.2.3: Improve public awareness on AMR through social, print and electronic media;	Limited only on WAAW	Public awareness on AMR improved	DLS, DOF	Electronic and print media	2023-2027

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	4.2.4: Conduct advocacy meetings with stakeholders especially with farm owners, feed miller, drug seller, chick seller etc.;	No such advocacy meeting was held. However, 1,400 field veterinarians and livestock officials from Upazila received training on the effects of AMR. They should hold advocacy meetings at the Upazila level	Number of advocacy meetings organized	DLS, DOF	All relevant stakeholders	2023-2027
	4.2.5: Produce and distribute information, education and communication (IEC) materials on AMR (brochure, leaflets, posters);	Basic posters and some IEC materials were distributed on the occasion of WAAW	IEC materials produced and distributed	DLS, DOF, BFSA	All relevant stakeholders	2023-2027
	4.2.6: Promote behavioral change of prescribers (qualified and unqualified), pharmacists, drug retailers and community (users) regarding use of AMs through intense training, counseling, monitoring & evaluation;	No such activity	Promoted the behavioral changes of the stakeholders	DLS, DOF, DGDA	All relevant stakeholders	2023-2027
	4.2.7: Observance of WAAW, zoonotic disease day, world hand washing day, national food safety day with festive mood;	WAAW celebrated by DLS, BLRI, National food safety day celebrated by BFSA	WAAW, world hand washing day and national food safety day observed	DLS, BFSA, DOF, DGDA	BLRI, BFRI	2023-2027
	Human Health					

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
3. To integrate AMR prevention and reduction in pre-service and in-service training for health and allied professionals;	4.3.1: Incorporate AMR, rational use of AMs in the medical, dental, health technology, nursing, pharmacy and microbiology curricula;	There is basic information is in the MBBS, Dental course	Rational use of AMs and AMR incorporated in course curricula	CDC, DGHS	DGME, nursing colleges, Universities, and health technology	2023-2025
	4.3.2: Integrate AMR awareness, prevention and reduction in pre-service and in-service trainings of health professionals and workers;	There is no such topic in the training course	AMR integrated in pre-service and in-service training module	CDC, DGHS	All relevant stakeholder organizations	2023-2025
	4.3.3: Development of newsletter on antibiotics, antimicrobials and AMR and circulate among the health professionals (	Recently CDC, DGHS has published its first newsletter on AMR	Two newsletters annually published	CDC, DGHS	All relevant organizations and professionals	2023-2027
	Animal and Aquatic Health					
	4.3.1: Implement risk communication plan specifically anchored to good agricultural practices targeting veterinarians, feed millers, suppliers, and farm owners;	No such activity	Number of risk communication programs organized with relevant stakeholders	DLS, DOF	Farming community, Industry people and other stakeholders	2023-2027
	4.3.2: Incorporate AMR and rational use of AMs in the veterinary and fisheries curricula;	Basic AMs information in veterinary courses, but not detailed about AMR	Rational use of AMs and AMR incorporated in course curricula	DLS, DOF	Veterinary and Fisheries schools and BVC	2023-2025

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	4.3.3: Integrate AMR awareness, prevention and reduction in pre-service and in-service training of animal and aquatic health professionals and workers;	1,400 DLS staff received training on antimicrobial resistance with the support of the World Bank project.	AMR integrated in pre-service and in-service training module	DLS, DOF	Relevant departments/ organizations	2023-2024

Strategy 5

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
Key Strategy 5: Strengthening multi-sectoral coordination for planning and implementation of ARC in one health approach						
1. To articulate a joint national action plan to combat AMR in one health approach;	5.1: Selection of national focal point (NFP) and national coordinator (NC) with Terms of Reference (TOR);	NFP has been selected but NC has not yet been selected	NFP and NC selected along with TOR endorsed	CDC, DGHS	All relevant stakeholder organizations	Completed

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	5.2: Identify the important sectors for collaboration to implement ARC;	Human health and animal health departments work closely together. However, the fisheries, agriculture, environment and food safety authority are not actively involved.	Important departments for cooperation with ARC identified	CDC, DGHS	DGHS, DGME, DG Nursing, IEDCR, DLS, DGDA, BLRI, DOF, DOE, DAE, and BFSA, PMO, CD	Completed
	5.3: Selection of sectoral focal points (SFP) for human health, animal health, aquatic health, agriculture, environment, drug administration and food safety authority;	SFP for human health, animal health, drug administration, fisheries and food safety authority has been nominated but SFP for agriculture, environment has not yet been nominated.	Sectoral focal point selected	CDC, DGHS	DLS, DOF, DAE, DOE, DGDA and BFSA -	Completed
	5.4: Update the structure of multi-sectoral coordination and technical committees (NSC, NTC, CWG);	NSC, NTC and CWG are in place	The structure of technical committees (NSC, NTC, CWG) updated and modified	CDC, DGHS	All relevant stakeholders	Completed

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	5.5: Conduct regular meetings of NSC, NTC and CWG to make plan and monitor the implementation of ARC;	NSC meeting is irregular; NTC and CWG meetings are also organized irregularly when necessary	At least one NSC meeting and two NTC and CWG meetings every year conducted	CDC, DGHS	All members of the committees	2023-2027
2. To promote AMR as a national priority;	5.2.1: Issuance of an office memorandum to include government stakeholders (i.e., DGHS, IEDCR, DGDA, DLS, DOF, BLRI, BFRI, DAE, DOE &BFSA) in national coordination group;	An office order issued in 2016 did not include all stakeholders	Office memorandum issued (If possible the memorandum can be issued in adherence with cabinet division or prime minister's office)	CDC, DGHS	All relevant stakeholder organizations	Completed
	5.2.2: Joint venture advocacy to promote AMR as a food safety issue of prime importance;	No such joint venture advocacy conducted	Number of joint advocacy programs conducted	CDC, DGHS	All sectoral organizations	2023-2027
3. To uphold accountability and ownership among various sectors in the prevention and reduction of AMR;	5.3.1: Establish subcommittees within sectoral partners (e.g., surveillance, research and coordination);	Only IPC committee structured up to Upazila level but not functional in most of the health care settings.	Sectoral subcommittees formed	DGHS, DLS, DOF, DOE, DAE	All relevant sectoral partners	2024

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	5.3.2: Establish national coordination secretariat lead by national coordination centre (NCC) to coordinate with all relevant sectors and actors;	No such secretariat yet established	National Coordination Secretariat established	CDC, DGHS	All relevant sectoral partners	2024
4. To allocate adequate resources for AMR initiatives in all relevant sectors;	5.4.1: Assess the need of resources to combat AMR;	No baseline document	The need of resources to combat AMR assessed	CDC, DGHS	IEDCR, DLS, DOF, DAE, BLRI, DGDA, BFRI, and DOE	Completed
	5.4.2: Include AMR in annual budget planning of the different agencies involved;	Only CDC, DGHS have budgets specifically for AMR. The budgets of other stakeholders are not earmarked for ARC.	Annual budget for AMR in different agencies included	CDC, IEDCR, DLS, DOF, BLRI, DAE, DOE and BFSA	All relevant sectoral organizations	2023-2027
	5.4.3: Identify priority areas for inter-sectoral cooperation;	No baseline document	Priority areas for inter-sectoral cooperation identified	CDC, DGHS	IEDCR, DLS, DOF, DOE, DGDA	2023
	5.4.4: Identify the gap of the resource need and the existing resource allocation;	Economical analysis done.	The resource gap identified	CDC, DGHS	IEDCR, DLS, DOF, DOE, DGDA, DAE, BLRI, BFRI	Completed

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	5.4.5: Enhance national and international partnerships for AMR initiative;	There is partnership with few organizations (WHO, OIE, US-CDC, FAO, USAID, icddr'b)	International partnership enhanced	CDC, DGHS	OHB, WHO, OIE, FAO, USCDC, USAID, icddr'b, etc.	2023-2027
	5.4.6: Identify the possible sources for ARC containment;	Possible sources have been identified in another study	Possible resources identified	CDC, DGHS	IEDCR, DLS, DOF, DOE, DAE, BLRI, BFSA, DGDA, development/ donor organizations	Completed
5. To continue collaboration for the achievement of key performance indicators;	5.5.1: Regularly submit reports/required information of the inter-sectoral members to the national coordination secretariat;	No baseline information	Inter-sectoral members regularly submitted report	CDC, DGHS	IEDCR, DGDA, DLS, DOF, DOE,DAE	2023-2027
	5.5.2: National coordination secretariat periodically presents their activities to the NSC and NTC;	No such secretariat/ in operation	At least once a year national coordination secretariat presented their activities to NSC and NTC	CDC, DGHS	All stakeholders	2024-2027
	5.5.3: National coordination secretariat publishes an annual report on the follow up activities of action plan;	The annual report has not yet been published, but a newsletter published by CDC, DGHS	Annual report published in a regular manner	CDC, DGHS	IEDCR, DLS, DOF, DGDA, DOE, BLRI, BFRI, BFSA	2023-2027

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	5.5.4: Organize annual dissemination workshops for data on AMs use, consumption and AMR surveillance	The annual dissemination has not been organized in a regular manner	Antimicrobial use, consumption and resistance data disseminated	CDC, DGDA	IEDCR, DLS, DOF, DOE, DAE, BLRI, BFRI	2023-2027

Strategy 6

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
Key Strategy 6: Promote innovation and research on AMR;						
1. To create a supportive and sustainable environment for AMR research;	Human Health					
	6.1.1: Mobilize budget for AMR research;	No designated budget for AMR research	Research budget mobilized	CDC	IEDCR,, BSMMU, Relevant agencies	2023-2027

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	6.1.2: Develop an integrated AMR research agenda prioritizing genetic and molecular basis & trends of AMR, development of new types of antimicrobials, novel therapies, alternative to antimicrobials such as prebiotics and probiotics etc.	No research agenda yet identified	Research thematic areas identified	CDC, IEDCR	CDC, BSMMU, Relevant agencies, Universities	2023-2027
	6.1.3: Establish an AMR innovation fund;	No such fund	AMR innovation fund established	CDC	IEDCR, BSMMU, Universities	2024
	6.1.4: Piloting studies to assess the impact of one health AMR containment initiatives	No designated budget	Piloting in 2 upazillas	CDC	IEDCR,, BSMMU,R elevant agencies	2023-2028
	Animal and Aquatic Health					
	6.1.1: Develop an integrated, targeted AMR research agenda for animal and aquatic health and products (meats, milk, eggs and fish) and other related areas;	No integrated AMR research agenda in place	Research priority areas identified	DLS, DOF, BLRI, BFRI	Veterinary/ Fishery schools, Universities	20244
	6.1.2: Coordinate with public and private research agencies, think tanks, academic and professional societies to strengthen research collaboration;	No collaborative research on AMR between public and private	Coordination among the public and private research agencies established	DLS, DOF, BLRI, BFRI	Veterinary/ Fishery schools and Relevant organization	2024
	6.1.3: Establish an AMR research and innovation fund;	No regular research fund. BARC provided some research funds recently.	AMR research innovation fund established	DLS, DOF	BLRI, BFRI, Universities	2024

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
2. To promote development of innovative technologies and knowledge translation of AMR research;	Human Health					
	6.2.1: Support universities, think tanks, experts and researchers who conduct innovation technologies for AMR, antibiotics and alternative to antibiotics;	No such support provided on AMR research	Technical and financial support extended for research and innovation on AMR	CDC	IEDCR, Universities and research organizations	2023-2027
	6.2.2: Encourage private sector collaboration to increase investments in R&D for antimicrobials;	No public and private collaboration on AMR research	Number of private sector engaged in collaborative research	DCU, CDC, IEDCR	BAPI, Universities	2023-2027
	Animal and Aquatic Health					
	6.2.1: Prioritize research that benefit small holder farmers (i.e. concepts and technology they could use in their farms);	No research priority yet to develop	Research priority developed considering small holder farming community	DLS, DOF	BLRI, BFRI, Vet. Schools, Fishery school, Universities	2024
	6.2.2: Conduct research on good agricultural practices, novel therapies, new antibiotics and alternatives to antimicrobial agents;	No such research initiatives yet conducted	Research conducted on set priority areas	BLRI, BFRI	Veterinary schools, Fishery school, Universities	2023-2027

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	6.2.3: Strengthen inter-agency collaboration for innovative research;	No collaborative AMR research	Inter-agency collaboration strengthened	BLRI, BFRI	Veterinary schools, Fishery school, Universities	2023-2027
3. To disseminate science based evidence on AMR intervention;	Human Health					
	6.3.1: Publish national data on AMU and AMR annually	Not published yet	AMU and AMR data published annually	CDC	DGDA, IEDCR,	2023-2027
	6.3.2: Translate and disseminate AMR research into information for professionals and general public;	Not disseminated yet	AMR research translated into information	IEDCR	CDC, BSMMU	2023-2027
	Animal and Aquatic Health					
	6.3.1: Publish national data on AMU and AMR annually;	Not published yet	AMU and AMR data published annually	DLS, DOF	BLRI, BFRI, Vet school	2023-2027
	6.1.2: Establish comprehensive database for AMR research;	No comprehensive database on AMR research	AMR research database established	DLS, DOF	BLRI. BFRI, Vet. Schools, Fishery school, Universities	2023-2027

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	6.3.3: Disseminate research findings to stakeholders and industry to augment policy formation;	No such initiatives taken yet	Translated research findings into information for policy intervention	BLRI, BFRI	DLS, DOF, Vet. School, Fishery school, Universities	2023-2027
	6.3.4: Publish research results in peer-reviewed, scientific journals (adherence with CLSI/ EUCAST standards);	Published regularly	AMR research published in reputed peer reviewed journal	BLRI, BFRI	DOF, BFRI, Vet school, Fishery school, Universities	2023-2027
4. To explore relationship between climate change and AMR in Bangladesh and strategies to mitigate impact of climate change on AMR	6.4.1: To conduct scooping review to understand existing evidence for relationship between climate change and AMR in Bangladesh	No such initiatives taken yet	Scooping review report published	CDC	IEDCR, BSMMU, Relevant agencies, Universities	2024-2025
	6.4.2: To conduct research activities for further exploration of the possible relationships and impact of climate change on AMR in Bangladesh	No such initiatives taken yet	Research(s) completed and published in reputed journals	CDC	IEDCR, BSMMU, Relevant agencies, Universities	2025

	6.4.3: Modeling exercise for prediction of impact of climate change on AMR in Bangladesh	No such initiatives taken yet	Modeling exercise completed and published in reputed journals	CDC	IEDCR, BSMMU, Relevant agencies, Universities	2025-2026
	6.4.4: Development of strategies and plan for mitigation of impact of climate change on AMR including aligning with Health National Adaptation Plan for climate change in Bangladesh	No such strategy and plan are available	Strategy and plan have been developed	CDC	IEDCR, BSMMU	2025-2026

Strategy 7

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
Key Strategy 7: Reduce environmental spread of AMR						
1. To conduct risk assessment for AMR spreading in the environments;	7.1.1: A national comprehensive AMR risk assessment in environment should be undertaken;	Risk assessment has not yet been carried out	Environmental AMR risk assessment conducted	DOE	CDC, IEDCR, DLS, DOF, BAPI	2024

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	7.1.2: Develop guidelines and SOPs on waste management (farm, hospital, pharmaceutical etc.;	No SOPs and guideline yet developed	waste management SOPs and guideline developed	DOE	DGHS, DLS, DOF	2024
2. To reduce the risk and drivers that can cause the emergence of AMR in the environments;	7.2.1: Proper disposal of effluents from pharmaceutical industries;	No good practices are in place	Pharmaceutical waste disposed properly	DOE	BAPI	2023-2027
	7.2.2: Proper disposal of sewage and wastes discarded from hospitals and clinics;	No good practices are in place	Hospital and clinic wastages disposed	DOE	HSM, UHC, BPCDOA, Private hospitals	2023-2027
	7.2.3: Proper disposal of sewage and wastes discharged from animal and aquatic farms;	No good practices are in place	Animal/ aquatic farms wastages properly disposed	DOE	DLS, DOF, Farming community	2023-2027

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	7.2.4: Reduce the land application of poultry farm wastes;	Poultry farm wastes randomly used in agricultural land	Reduced the land application of manure and sludge	DOE	DLS, DOF, DAE, Farmers	2023-2027
	7.2.5: Proper disposal of unused/expired antibiotics from domestic settings;	Farmers are reluctant to proper disposal of leftover antibiotics	Disposed properly unused/ expired antibiotics	DOE, DLS, DOF	CDC, DGDA , BAPI and Farmers	2023-2027
	7.2.6: To ensure the ETP in every pharmaceuticals industries;	DOE and DGDA monitor the ETP of pharmaceuticals industries	Ensured ETP in every pharmaceuticals industries	DGDA,	All pharmaceuticals company, BAPI	2023-2027
3. To initiate policy support to prevent environmental contamination;	7.3.1: Review/ develop new policies, act or regulation to address spreading of AMR in the environment;	Most of the policies/ act are backdated	Policies/ regulations reviewed/ updated	DOE	Farms and Industry	2024

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
	7.3.2: Develop policy on registration of farms, factories, slaughter houses, wet markets, aquaculture units, food processing units, feed manufacturers, health care facilities and veterinary care facilities;	No mandatory registration policy yet developed	Registration process of farms and factories developed	DOE	DLS, DOF, DGDA, Department of food, local government	2023-2027
	7.3.3: Enforcement of laws and regulations to adhere with the environment;	Not in regular	Environment laws and regulations enforced	DOE	Relevant departments	2023-2027

Strategy 8

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
1. Institutional networking and collaboration for the exchange of best practices in combating	8.1.1: Conduct collaboration meeting/ seminars among the international stakeholders to review AMR activities and challenges;	Not yet conducted in regular	international collaboration meeting conducted	CDC, IEDCR, DLS, BLRI, DOF	Countries and organizations (WHO, OIE, FAO)	2023-2027

Objectives	Activities	Baseline	Performance-Indicator(s)	Lead Agency	Implementing Partners	Timeline
AMR and capacity building;	8.1.2: Strengthen and streamline international networking and collaborations for capacity building, resource and experience sharing;	Still few collaborations are in place	International networking strengthened and streamlined	CDC, DLS, IEDCR, DOF, BLRI, BFRI	WHO, OIE, FAO and development partners	2023-2027
	8.1.3: Inter-institutional and inter-governmental networking for technical support;	Intergovernmental collaboration is very poor	Inter-institutional and inter-governmental networking strengthened	CDC, DLS, IEDCR, DOF	WHO, OIE, FAO, SAARC, development partners	2023-2027
	8.1.4: Exchange of best practice in combating AMR;	Not in regular pace	Best practice and experience shared with other countries	CDC, DLS, IEDCR, DOF	Any countries/ organizations	2023-2027

6. Prioritization of the Activities

A theory of change explains how the activities undertaken by an intervention contribute to a chain of results that lead to the intended or observed impacts. A theory of change is often developed during the planning stage but can also be useful for monitoring and evaluation. A good theory of change can help to implement activities. We have prioritized the activities in the context of the theory of change concept to achieve short-, medium and long-term goals. We should consider resources and capacity during the implementation of the activities. We can follow some basic pedagogy during the prioritization of the activities. The basic principles of prioritization have been highlighted for better implementation of the national action plan of antimicrobial resistance containment.

Short-term initiatives: We have to address some activities as the foremost and prime agenda to achieve the short-term goal. The following important activities can be prioritized as the short-term initiatives:

Midterm initiatives: We can prioritize some activities as mid-term initiatives to achieve the midterm goal. The following activities can be considered as the midterm initiatives:

Long-term Initiatives: Some activities can be prioritized as long-term initiatives to achieve long-term goals. The long-term initiatives may address the mission and vision of the national action plan. The long-term initiatives may be considered:

7. Monitoring and Evaluation Framework

Monitoring and evaluation (M&E) is an integral part of the AMR National Strategy and Action Plan (NSP & NAP) to ensure objective review and monitoring of the implementation progress. The NSP & NAP of Antimicrobial Resistance Containment (2021-2026) serves as the national road map for action on AMR in Bangladesh. The lead government departments who are responsible for implementing the operation plan are the DGHS, IEDCR, DLS, DOF, DOE, DAE, BLRI, BFRI and BFSA. During the period of implementation, each implementing agency will make a report on the progress of its activities and achievements through different indicators. There some milestones have been identified for monitoring and evaluation of the progress of the national action plan. There also have been set some measurable tools and indicators to assess and evaluate the progress of the major landmark of the national action plan.

Strategies	Outcome Indicators	Output Indicators	Baseline	Timeline	Indicators/ Measurable Tools
S 1: Establish integrated surveillance and strengthen laboratory capacity;	Established integrated surveillance and strengthened laboratory capacity;	National and sentinel reference laboratories are identified to support AMR surveillance;	Only NRL identified in human health	By 2023	KII, office memorandum, scientific reports, regular disseminations, publications, annual reports, newsletter, web portal, dashboard;
		The capacity of national and sentinel reference laboratories strengthened;	All laboratories are not capable enough	By 2023	
		Update/ Revise AMR surveillance protocol and SOPs;	AMR surveillance SOPs are in place	By 2023	
		National AMR surveillance data is collated and shared;	No data repository yet to establish	2023-2026	
		Sectoral AMR surveillance data is shared through common platform;	No data sharing platform	By 2023-2026	
S 2: Promoting responsible use of antimicrobials ;	Optimized use of antimicrobials in human, animal and aquatic health;	Optimized AMC and AMU in human health;	No baseline on AMC and AMU	2023 & 2026	
		Optimized AMU in animal health;	No baseline on AMU	2023 & 2026	
		Optimized AMU in aquatic health;	No baseline on AMU	2023 & 2026	

Strategies	Outcome Indicators	Output Indicators	Baseline	Timeline	Indicators/ Measurable Tools
		Standard Treatment Guidelines (STGs) for all HCFs are developed;	All HCFs has no STGs	2024	Surveys, e-prescription, prescription audit, surveillance reports, monitoring of antimicrobials manufacturing report, antimicrobials import report, KII;
		Antimicrobial Stewardship (AMS) program is introduced in human and animal health care facilities;	AMS program is limited only in few tertiary level hospitals	2025	
		Standard treatment guidelines for endemic and economic important animal diseases are developed;	No STGs for endemic diseases;	2023	
		Good pharmacy practices and good manufacturing practices of antimicrobials are ensured;	No baseline data	2025	
S 3: Enabling good practices ;	Enabled good practices:	IPC committees are formed in all tiers of HCFs;	No countrywide data	By 2023	Reports, key informant interviews, vaccination report, surveys, newsletter and annual reports
		Development of IPC guidelines across all tiers of HCFs;	No baseline data	By 2023	

Strategies	Outcome Indicators	Output Indicators	Baseline	Timeline	Indicators/ Measurable Tools
		Regular meeting of IPC committees are held	No baseline data	2024-2026	
		IPC practices such as use of PPE, hand washing, hygienic measures and sanitation practices are ensured;	No baseline data	2023-2026	
		Number of HAIs in surgical wards.	No baseline data	2023-2026	
		Hospital waste management is ensured;	No baseline data	2023-2027	
		Biosecurity and good farm practices are ensured in animal and aquatic farms;	Scattered data available	2023-2026	
		Vaccination coverage is improved in the animal farms;	No baseline national data	2023-2026	
S 4: Increasing stakeholder awareness and engagement ;	Increased stakeholder awareness and engagement: ;	Number of advocacy and communication campaign organized on AMR risks in human, animal and aquatic health; can we mention a minimum number?	No exact baseline information	2024 & 2026	Knowledge, Attitude and Practice (KAP), Performance Evaluation Audit (PEA), studies, survey, training module, KII,

Strategies	Outcome Indicators	Output Indicators	Baseline	Timeline	Indicators/ Measurable Tools
		Number of training institutions included AMR modules in their curricula;	No baseline information	2023 & 2026	awareness campaign reports;
		Number of training and continuous education on AMR organized in human health sector;	No exact baseline information	2023 & 2026	
		Number of training and continuous education on AMR organized in the animal and aquatic sector;	Scattered data are available	2023 & 2026	
		Number of training and continuous education on AMR organized in farming (animal and aquatic), food production, food safety and the environment;	No baseline information	2024 & 2026	
S 5: Strengthening multi-sectoral coordination for planning and implementation of ARC in one health approach;	Strengthened multi-sectoral coordination for planning and implementatio n of ARC;	Sectoral participation of DGHS, DLS, DOF, DAE, DOE, DGDA and BFSA is ensured in national coordination mechanism;	Sectoral FP for DGHS, DGDA, DLS, DOF has been identified	By 2023	

Strategies	Outcome Indicators	Output Indicators	Baseline	Timeline	Indicators/ Measurable Tools
		Regular coordination meeting with all sectoral FP is established;	Yet to establish	By 2023	Key informant interview (KII); reports; office memorandum, annual report, dissemination workshop;
		Update the structure of multi-sectoral coordination and technical committees such as CWG, NTC and NSC;	Yet to update the committees	By 2023	
		Sectoral sub-committees is formed (e.g. surveillance, research and coordination);	No sectoral subcommittees on AMR	By 2023	
S 6: Promote innovation and research on AMR;	Increased R&D on new medicines, diagnostics, vaccines and other interventions	Increased investment in R & D to address AMR;	No dedicated research funding	2024-2026	New medicine, diagnostic and vaccines available in the market
S 7: Reduce environmental spread of AMR;		Waste management policies and guidelines are developed/ revised;	Few policies are in place.	By 2023	Waste management policies and guidelines;
	Reduced environmental spread of AMR;	Farm, medical and pharmaceutical waste is properly managed;	No proper waste management system in place for data	2023-2026	monitoring and law enforcement

8. Glossary

Antimicrobial: An active agent, such as a medicine, that on application to living tissue or through systemic use – kills, prevents or inhibits the growth of microorganisms. Antimicrobials include antibiotics, antiseptics, antifungals, antivirals, and antiparasitics.

Antimicrobial Resistance (AMR): The ability of microorganisms including bacteria, viruses, fungi and parasites to develop a capability to grow or survive in the presence of antimicrobials, and to pass this trait on via their genes to other microorganisms.

Antimicrobial Stewardship (AMS): The safe and appropriate use of antimicrobials to reduce harm while also curtailing the incidence of antimicrobial resistance.

Biosecurity: Efforts to prevent, respond to and recover from pests and diseases that threaten the economy and environment.

Food and Agriculture Organization of the United Nations (FAO): A specialized agency of the United Nations that leads international efforts to defeat hunger, and share knowledge to improve agriculture, forestry and fisheries practices as well as ensuring good nutrition and food security for all.

Good Agricultural Practice (GAP): GAP can reduce unnecessary use of antimicrobials in livestock, aquaculture and crops with little impact on animal health and/or productivity. The development of animal (terrestrial and aquatic) husbandry and production system guidelines that focus on infection prevention and using antibiotics only to treat sick animals would be a useful tool.

Good Manufacturing Practice (GMP): GMP is a system for ensuring that products are consistently produced and controlled according to quality standards.

Good Pharmacy Practice (GPP): GPP is the practice of pharmacy that responds to the needs of the people who use the pharmacists' services to provide optimal, evidence-based care.

Infection Prevention and Control (IPC): IPC is a practical, evidence-based approach which prevents patients and health workers from being harmed by avoidable infection as a result of antimicrobial resistance.

Multi-drug resistant: Resistant to multiple classes of antimicrobials.

One Health: Collaborative multi-disciplinary work at local, national, and global levels to attain optimal health for people, animals and the environment.

Pharmacovigilance: Pharmacovigilance, also known as drug safety, is the pharmacological science relating to the collection, detection, assessment, monitoring, and prevention of adverse effects with pharmaceutical products.

Standard Treatment Guidelines (STGs): It outlines the recommended treatment options for a specific disease or medical condition (e.g., HIV and AIDS) or a range of medical conditions.
Along with essential medicines lists (EMLs) and formularies, STGs help promote rational medicine use.

Tripartite Agencies: A formal international partnership to combat health threats associated with interactions between humans, animals and the environment, consisting of the Food and Agriculture Organization, the World Health Organization and the World Organization for Animal Health.

World Health Organization (WHO): A specialized agency of the United Nations concerned with international public health.

World Organization for Animal Health (OIE): The international standard-setting body working to improve animal health and welfare.

9. Governance Structure

The National Steering Committee (NSC), National Technical Committee (NTC), and Core Working Group (CWG) with Terms of Reference has been revised for Antimicrobial Resistance Containment in Bangladesh.

National Steering Committee (NSC)

The purpose of the NSC on Antimicrobial Resistance is to oversee and coordinate policy decisions for activities related to antimicrobial resistance in all sectors in accordance with AMR-related public health goals.

Terms of reference

- The NSC will be responsible for approving the National Strategy and Action Plans and any other guidance on antimicrobial resistance control that have a wide range of policy implications, based on the recommendations provided by the National Technical Committee (NTC).
- The NSC will supervise and guide the activities of the NTC and will review the annual report on the progress of the National Antimicrobial Resistance Control (NARC) Programme submitted by the NTC.
- The NSC will review the advocacy and policy recommendations by NTC based on generated AMR surveillance data and take necessary actions based on the evidence.
- The NSC will review the proposed budget for activities outlined in Action Plans and recommend what the concerned line ministries to include in their respective budgets.
- Facilitate collaboration with internal and external agencies and organizations for AMR-related activities;
- The NSC will meet at least once a year and at shorter intervals when required.

Membership structure

The NSC consists of the following membership structure:

Chairperson: Honourable Minister, Ministry of Health and Family Welfare

Co-chairpersons: Honourable Minister, Ministry of Fisheries and Livestock, Honourable Minister, Ministry of Environment, Forest & Climate change, Honourable Minister, Ministry of Agriculture

Member-Secretary: Secretary, Ministry of Health and Family Welfare

- ***Members*** (not according to a warrant of precedence):

1. Attorney General of Bangladesh
2. Secretary, Ministry of Agriculture
3. Secretary, Ministry of Livestock and Fisheries

4. Secretary, Ministry of Environment, Forest & Climate Change
5. Director-General, Directorate General of Health Services
6. Director-General, Directorate General of Drug Administration
7. Director-General, Directorate General of Medical Education
8. Director-General, Directorate General of Nursing and Midwifery
9. Director-General, Medical Services (armed force)
10. Director-General, Department of Livestock Services
11. Director-General, Department of Fisheries
12. Director-General, Department of Environment
13. Director-General, Department of Forest
14. Director General, Department of Agriculture Extension
15. Director General, Bangladesh Livestock Research Institute
16. Director General, Bangladesh Fisheries Research Institute
17. Chairman, Bangladesh Food Safety Authority
18. President, Consumers Association of Bangladesh
19. Member Director (Livestock), Bangladesh Agriculture Research Council
20. Director General-1/Representative, Prime Minister Office
21. Director General, Press Institute of Bangladesh
22. Principal Information Officer/representative, Press Information Department
23. Country Representative, World Health Organization
24. Country Representative, Food and Agriculture Organization
25. Country Representative, UNICEF
26. Mission Director, USAID Bangladesh
27. Country Director, USCDC, Bangladesh
28. Head, United Kingdom Department for International Development (DFID)
29. Executive Director, International Centre for Diarrheal Disease & Research (icddr,b)
30. Chair, One Health Secretariat
31. National Coordinator, One Health Bangladesh
32. President/Secretary General, Bangladesh Medical Association
33. President/Secretary, Bangladesh Veterinary Association
34. President/Secretary, Bangladesh Association of Pharmaceutical Industries
35. President/Secretary, Bangladesh Bar Council

National Technical Committee

The purpose of the National Technical Committee on Antimicrobial Resistance shall be to review the approach and initiatives for combating AMR and make recommendations on technical issues.

Terms of reference

- Act as a technical advisory body to the National Steering Committee on the Antimicrobial Resistance Containment (ARC) Programme.
- Develop the Strategy, Action Plans, and Guidelines for the Prevention and Control of Antimicrobial Resistance and other policy documents for submission to the NSC for final approval.
- Periodically review the above-mentioned policy documents and submit to NSC for necessary decisions.
- Prepare budgets for the different activities outlined in the Action Plan.
- Monitor and evaluate the implementation of the ARC programme and submit an annual report on progress to the NSC.
- Work based on feedback from the Core Working Group (CWG) and different Sectoral Working Groups.
- Meet at least half-yearly, and additionally, if the situation requires.

Membership structure

- ***Chairperson:*** Director General of Health Services
- ***Co-chairperson:*** Additional Director General (Admin), DGHS; Director, Animal Health and Administration, DLS; Additional Director General, DOF;
- ***Member-Secretary****:* Director (Disease Control), DGHS and National Focal Point, ARC Programme
- ***Members*** *(not according to a warrant of precedence)*:
    1. Director, Institute of Epidemiology, Disease Control, and Research
    2. Director (Quality Control, P. marketing, Surveillance & C. Drug Testing Lab), DGDA
    3. Director (Veterinary), Directorate General of Drug Administration
    4. Director (Hospitals), Directorate General of Health Services
    5. Director, Institute of Public Health
    6. Representative from the Director General of Medical Services (armed forces)
    7. Director, Livestock Research Institute, Department of Livestock Services
    8. Principal Scientific Officer/representative, Fish Inspection and Quality Control, Department of Fisheries
    9. Head/representative, Department of Microbiology, Bangabandhu Sheikh Mujib Medical

University

10. Head/representative, Department of Pharmacology, Bangabandhu Sheikh Mujib Medical University
11. Head/representative, Department of Microbiology, Dhaka Medical College
12. Head/representative, Department of Pharmacology, Dhaka Medical College
13. Member Secretary, Sectoral working group for AMR Surveillance in Human Health
14. Member Secretary, Sectoral working group for AMR Surveillance in Animal Health
15. Dean/representative, Faculty of Pharmacy, University of Dhaka
16. Head/representative, Department of Microbiology, Bangladesh Agricultural University
17. Head/representative, Department of Microbiology, Chottogram Veterinary and Animal Sciences University
18. Chief Scientific Officer/representative, Animal Health Research Division, Bangladesh Livestock Research institute
19. Chief Scientific Officer/representative, Livestock Division, Bangladesh Agricultural Research Council
20. General Secretary/representative, One Health Bangladesh
21. President/Secretary, Bangladesh Medical and Dental Council
22. President, Bangladesh Veterinary Council
23. President/Secretary, Bangladesh Pharmacy Council
24. President/Secretary, Bangladesh Society of Medicine
25. President/Secretary, Bangladesh Society of Infectious & Tropical Diseases
26. President/Secretary, Bangladesh Society of Surgeons
27. President/Secretary, Bangladesh Paediatric Association
28. President/Secretary, Obstructive and Gynaecological Society of Bangladesh
29. President/Secretary, Bangladesh Pharmacological Society
30. President/Secretary, Bangladesh Society of Medical Microbiologists
31. President/Secretary, Bangladesh Veterinary Association
32. Representative from the World Health Organization
33. Representative from the Food and Agriculture Organization
34. Director, Office of Population, Health, Nutrition and Education, USAID/Bangladesh
35. Representative from International Centre for Diarrheal Disease & Research (icddr,b)
36. Representative from Fleming Fund
37. Representative from IPC Alliance, Bangladesh.

Core Working Group

The Core Working Group on Antimicrobial Resistance shall provide technical and operational inputs to the designated national coordinating centre for AMR, i.e. Communicable Disease Control to develop and implement the National Action Plan on Antimicrobial Resistance.

Terms of reference

The Core Working Group (CWG) is a smaller group of technical experts, typically representatives from the relevant sectors involved in AMR surveillance. The main functions of the CWG include:

- Develop draft policy documents, including guidelines and strategic action plans, in response to NTC requests.
- Monitor and evaluate of implementation of different components of the National Action Plan.
- Prepare and submit to NTC a quarterly report on the status of the National AMR Control Programme.
- Act as the coordinating body, liaising among sectoral working groups and with national reference laboratories, the National Coordination Centre, and the One Health Secretariat.
- Support and monitor the activities of the surveillance network and laboratories within it to ensure the quality of AMR surveillance data generation, reporting, analysis, and sharing at all levels.
- Meet at least quarterly and more often, if required.
- Provide secretarial support to the NTC.

If needed, members can be co-opt

Membership structure

Chief Coordinator: Director (Disease Control), DGHS & National Focal Point

Coordinator: One Designated Officer of CDC, Directorate General of Health Services (DGHS)

Members:

1. Sectoral focal person, Directorate General of Health Services
2. Sectoral focal person, Department of Livestock Services
3. Sectoral focal person, Department of Fisheries
4. Sectoral focal person, Department of Environment
5. Sectoral focal person, Department of Agriculture Extension
6. Sectoral focal Person, Bangladesh Food Safety Authority
7. Representative, Department of Microbiology, Institute of Epidemiology, Disease

Control, and Research

8. Representative, Antimicrobial Resistance Action Centre, Bangladesh Livestock Research Institute
9. Representative, Department of Pharmacology, BSMMU
38. Representative from the Bangladesh Society of Medicine
39. Representative from the Bangladesh Society of Microbiology
40. Representative from Bangladesh Society of Infectious & Tropical Diseases
10. Deputy Director/representative, Drug Administration
11. DPM from Hospital Management Service, DGHS
12. DPM from Upazila Health Care, DGHS
13. DPM, IHR, Emerging & Re-emerging Diseases, CDC, DGHS
14. Head/representative, Epidemiology wing, Department of Livestock Services
15. Representative, Department of Microbiology, Bangladesh Agricultural University
16. Representative, Department of Microbiology, University of Dhaka
17. Representative from WHO (AMR focal)
18. Representative from FAO
19. Representative from USAID
20. Representative from Fleming Fund
21. Scientist/representative, Microbiology Lab., International Centre for Diarrheal Disease and Research(icddr,b)

Sectoral Working Groups

- Each Sectoral Working Group (SWG) will work as a forum for the surveillance sites, laboratory networks, and reference laboratories within the sector.
- Work experiences, surveillance findings, and aid issues will be shared within the SWG to facilitate joint learning and problem-solving.
- The SWG will report on the progress and challenges faced by the Core Working Group (CWG) and the National Technical Committee (NTC).
- The SWG, along with the appropriate national reference laboratory (NRL) of the sector, will ensure high safety and quality standards through established protocols for laboratory quality and participation in a national quality assurance programme.
- SWG members will participate in supportive supervisory visits to the sentinel sites (each site should be visited at an interval of every two months).
- SWG will convene monthly meetings and prepare quarterly progress reports for submission to CWG/NTC.
- Membership of each SWG will be decided by NTC with a recommendation from CWG.

10. References

1. *World health Factsheet* 2020, Antimicrobial resistance. Geneva, World Health Organization, 2020.
2. Complexities in understanding antimicrobial resistance across domesticated animal, human, and environmental systems. David W. Graham, Gilles Bergeron, Megan W. Bourassa et.al. Ann. Ann. N.Y. Acad. Sci. 1441 (2019) 17–30 C 2019
3. Reduce unintentional exposure and the need for antimicrobials, and optimize their use. July 2018. IACG.
4. Review on Antimicrobial Resistance. (2014). Antimicrobial resistance: tackling a crisis for the health and wealth of nations. Review on Antimicrobial Resistance.
5. Murray CJ, Ikuta KS, Sharara F, Swetschinski L, Aguilar GR, Gray A, Han C, Bisignano C, Rao P, Wool E, Johnson SC. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. The lancet. 2022 Feb 12;399(10325):629-55.
6. Tackling antimicrobial resistance in Bangladesh: A scoping review of policy and practice in human, animal and environment sectors. Roksana Hoque, Syed Masud Ahmed ,Nahitun Naher et. al. Published: January 27, 2020. Open access journal, PLOS ONE. https://doi.org/10.1371/journal.pone.0227947
7. World Bank. (2017). *Drug-resistant infections: a threat to our economic future*. World Bank.
8. High-level Interactive Dialogue on Antimicrobial Resistance (AMR), held on 29 April 2021. New York City, USA
9. WHO.2020. Present Situation. Drug Resistant to Bacteria. https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance
10. Musa, Antibiotic use and Resistance in Bangladesh Situation Analysis and Recommendations", January 2018
11. Datta SK, Paul TR, Monwar M, Khatun A, Islam MR, Ali MA, et al. Patterns of prescription and antibiotic use among outpatients in a tertiary care teaching hospital of Bangladesh. Int J Pharm Pharm Sci. 2016; 8(11):54. https://doi.org/10.22159/ijpps.2016v8i11.9827
12. Fahad B, Matin A, Shill M, Asish K. Antibiotic usage at a primary health care unit in Bangladesh. Australasian Medical Journal (Online). 2010; 3(7):414. https://doi.org/10.4066/AMJ.2010.322
13. Begum MM, Uddin MS, Rahman MS, Nure MA, Saha RR, Begum T, et al. Analysis of prescription pattern of antibiotic drugs on patients suffering from ENT infection within Dhaka Metropolis, Bangladesh. Int J Basic Clinic Pharmacology. 2017; 6(2):257–64
14. Sayeed MA, Iqbal N, Ali MS, Rahman MM, Islam MR, Jakaria M. Survey on Antibiotic Practices in Chittagong City of Bangladesh. Bangladesh Pharmaceutical Journal. 2015; 18(2):174–8. https://doi.org/10. 3329/bpi.v18i2.24318

15. Chowdhury F, Sturm-Ramirez K, Al Mamun A, Iuliano AD, Chisti MJ, Ahmed M et al. Effectiveness of an educational intervention to improve antibiotic dispensing practices for acute respiratory illness among drug sellers in pharmacies, a pilot study in Bangladesh. BMC Health Serv Res. 2018; 18(1):676. https://doi.org/10.1186/s12913-018- 3486-y PMID: 30170573
16. Rashid MM, Chisti MJ, Akter D, Sarkar M, Chowdhury F. Antibiotic use for pneumonia among children under-five at a pediatric hospital in Dhaka city, Bangladesh. Patient Prefer Adherence. 2017; 11:1335. https://doi.org/10.2147/PPA.S140002 PMID: 28831244
17. Haque MA. Antimicrobial use, prescribing, and resistance in selected ten selected developing countries: A brief overview. Asian J Pharm Clin Res. 2017; 10(8):37–45. https://doi.org/10.22159/ajpcr.2017. v10i8.19468 19.
18. Biswas M, Roy DN, Rahman MM, Islam M, Parvez GM, Haque MU et al. Doctor's prescribing trends of antibiotics for out-patients in Bangladesh: A cross-sectional health survey conducted in three districts. Int J Pharma Sciences Res. 2015; 6(2):669–75. https://doi.org/10.13040/IJPSR.0975-8232.6(2).669– 75
19. Afreen S, Rahman MS. Adherence to treatment guidelines in a university hospital: Exploration of facts and factors. Bangladesh J Pharmacol. 2014; 9(2):182–8. https://doi.org/10.3329/bjp.v9i2.18537
20. Ahmed SM, Islam QS. Availability and rational use of drugs in primary healthcare facilities following the national drug policy of 1982: is Bangladesh on right track? J Health Popul Nutr. 2012; 30(1):99. https:// doi.org/10.3329/ jhpn.v30i1.11289 PMID: 22524126
21. Faiz MA, Basher A, editors. Antimicrobial resistance: Bangladesh experience. Regional Health Forum. 2011; 15(10: 1–8. Available from: http://origin.searo.who.int/publications/journals/regional_health_ forum/media/2011/V15n1/rhfv15n1p1.pdf
22. Ministry of Health and Family Welfare. Environmental Assessment and Action plan For the Health. Population and Nutrition Sector Development Program (HPNSDP) 2011-2016. 2011.
23. Chouduri AU, Biswas M, Haque MU, Arman MS, Uddin N, Kona N, et al. Cephalosporin-3G, Highly Prescribed Antibiotic to Outpatients in Rajshahi, Bangladesh: Prescription Errors, Carelessness, Irrational Uses are the Triggering Causes of Antibiotic Resistance. J Appl Pharm Sci. 2018; 8(06):105–12.
24. Sutradhar KB, Saha A, Huda NH, Uddin R. Irrational use of antibiotics and antibiotic resistance in southern rural Bangladesh: perspectives from both the physicians and patients. Annu Res Rev Biol. 2014; 4 (9):1421–30. 33.
25. Saha MR, Sarwar S, Shill MC, Shahriar M. Patients' Knowledge and Awareness towards Use of Antibiotics in Bangladesh: A Cross-sectional Study Conducted in Three Tertiary Healthcare Centers in Bangladesh. Stamford J Pharmaceutical Sciences. 2010; 3(1):54–8.

https://doi.org/10.3329/sips.v3i1.6799

26. Saha T, Saha T. Awareness Level of Patients Regarding usage of Antibiotics in a Slum Area of Dhaka City, Bangladesh. SSRG Int J Med Science 2018; 5(9):10–16.

27. Biswas M, Roy MN, Manik MIN, Hossain MS, Tapu STA, Moniruzzaman M, et al. Self-medicated antibiotics in Bangladesh: a cross-sectional health survey conducted in the Rajshahi City. BMC Public Health. 2014; 14(1):847
28. Rahman, M. S., & Huda, S. (2014). Antimicrobial resistance and related issues: An overview of Bangladesh situation. *Bangladesh Journal of Pharmacology*, *9*(2), 218-224.
29. A follow up study of Bacteriology and Antibiotic Sensitivity Pattern of Urinary tract infection in a tertiary Care Hospital in Bangladesh. J of Bacteriology and Parasitology. 09(01), January 2017. doi:10.4172/2155-9597.1000334
30. Nahar A, Hasnat S, Akhter H, Begum N. Evaluation of antimicrobial resistance pattern of uropathogens in a tertiary care hospital in Dhaka city, Bangladesh. South East Asia J Public Health. 2017; 7(2):12–8
31. Ahmed AA, Salam MA, Hossain MS, Aktar MB, Juyee NA, Hasan SA. Trends in antibiotic resistance patterns of methicillin resistant and methicillin sensitive Staphylococcus aureus in Khwaja Yunus Ali Medical College Hospital. KYAMC Journal. 2018 May 9; 9(1):6–10.
32. Habib, Z. H., Alam, M. A., Bably, N. N., Khan, I. A., Rizvi, S. S., Shirin, T., & Flora, M. S. (2021). The findings of Antimicrobial Resistance Surveillance in Bangladesh (2016-2020). *medRxiv*.
33. Masud, A.A., Rousham, E.K., Islam, M.A., Alam, M.U., Rahman, M., Mamun, A.A.,
34. Sarker, S., Asaduzzaman, M. and Unicomb, L., 2020. Drivers of antibiotic use in poultry production in Bangladesh: Dependencies and dynamics of a patron-client relationship. *Frontiers in veterinary science*, *7*, p.78.
35. BLRI. (2021). Project completion report of BLRI component. National Agricultural
36. Technology Project, Bangladesh Agricultural Research Council, Farmgate, Dhaka-1215.
37. Bag, M. A. S., Khan, M. S. R., Sami, M. D. H., Begum, F., Islam, M. S., Rahman, M. M., ...& Hassan, J. (2021). Virulence determinants and antimicrobial resistance of *E. coli* isolated from bovine clinical mastitis in some selected dairy farms of Bangladesh. *Saudi Journal of Biological Sciences*.
38. Ievy, S., Islam, M., Sobur, M., Talukder, M., Rahman, M., & Khan, M. F. R. (2020). Molecular detection of avian pathogenic *Escherichia coli* (APEC) for the first time in layer farms in Bangladesh and their antibiotic resistance patterns. *Microorganisms*, *8*(7), 1021.
39. Sobur, M. A., Sabuj, A. A. M., Sarker, R., Rahman, A. T., Kabir, S. L., & Rahman, M. T. (2019). Antibiotic-resistant *Escherichia coli* and *Salmonella spp.* associated with dairy cattle

and farm environment having public health significance. *Veterinary world*, *12*(7), 984.

40. Parvin, M., Talukder, S., Ali, M., Chowdhury, E. H., Rahman, M., & Islam, M. (2020). Antimicrobial resistance pattern of *Escherichia coli* isolated from frozen chicken meat in Bangladesh. *Pathogens*, *9*(6), 420.

41. Rahman, M. M., Husna, A., Elshabrawy, H. A., Alam, J., Runa, N. Y., Badruzzaman, A.T. M., ... & Ashour, H. M. (2020). Isolation and molecular characterization of multidrug-resistant *Escherichia coli* from chicken meat. *Scientific Reports*, *10*(1), 1-11.
42. Amin, M. B., Sraboni, A. S., Hossain, M. I., Roy, S., Mozmader, T. A. U., Unicomb, L., ... & Islam, M. A. (2020). Occurrence and genetic characteristics of mcr-1-positive colistin-resistant *E. coli* from poultry environments in Bangladesh. *Journal of global antimicrobial resistance*, *22*, 546-552.
43. Siddiky, N.A., Sarker, M.S., Khan, M., Rahman, S., Begum, R., Kabir, M., Karim, M., Rahman, M., Mahmud, A. and Samad, M.A., 2021. Virulence and Antimicrobial
44. Resistance Profiles of *Salmonella enterica* serovars isolated from chicken at Wet Markets in Dhaka, Bangladesh. *Microorganisms*, *9*(5), p.952.
45. Al Amin, M., Hoque, M.N., Siddiki, A.Z., Saha, S. and Kamal, M.M., 2020. Antimicrobial resistance situation in animal health of Bangladesh. *Veterinary World*, *13*(12), p.2713.
46. Jahan, M., Rahman, M., Parvej, M. S., Chowdhury, S. M. Z. H., Haque, M. E., Talukder, M. A. K., & Ahmed, S. (2015). Isolation and characterization of *Staphylococcus aureus* from raw cow milk in Bangladesh. *Journal of Advanced Veterinary and Animal Research*, *2*(1), 49-55.
47. Parvin, M., Ali, M., Talukder, S., Nahar, A., Chowdhury, E. H., Rahman, M., & Islam, M. (2021). Prevalence and Multidrug Resistance Pattern of Methicillin Resistant *S. aureus* isolated from frozen chicken meat in Bangladesh. *Microorganisms*, *9*(3), 636.
48. Hoque, M. N., Das, Z. C., Rahman, A. N. M. A., Haider, M. G., & Islam, M. A. (2018). Molecular characterization of *Staphylococcus aureus* strains in bovine mastitis milk in Bangladesh. *International journal of veterinary science and medicine*, *6*(1), 53-60.
49. Siddiky, N. A., Sarker, M. S., Khan, M. S. R., Rahman, M. T., Kafi, M. A., & Samad, M. A. (2021). Virulence and antimicrobial resistance profile of non-typhoidal *Salmonella enterica* serovars recovered from poultry processing environments at wet markets in Dhaka, Bangladesh. *bioRxiv*.
50. Hoque N. (2012). Pathogenicity of Aeromonas hydrophild in Silver Carp Hypophthalmichthys molitrix and its control trials. A thesis submitted to the Department of Bangladesh Agriculture University, Mymensingh in partial fulfilment of the requirement for the degree of Master of Science in Agriculture.
51. Ahammed T., Chakra Borty S., Monir M.S. Begum N. Islam MA. And Kabir S.M.L. (2016). Iwlation. identification and molecular detection of Aeromonas hydrophilld from diseased

stinging cath5h Shing (Heteropneustes fossilisi Asian-Australasian Journal of Bioscience and Biotechnology. 125-133.

52. BLRI. 2019. Food Safety Study Report. The study conducted in collaboration with International Food Policy Research Institute, Bangladesh
53. Islam MA, Islam M, Hasan R, Hossain MI, Nabi A, Rahman M, et al. Environmental spread of NDM-1- producing multi-drug resistant bacteria in Dhaka, Bangladesh. Appl Environ Microbiology. 2017: AEM. 00793–17
54. WHO (2014). Safe management of wastes from health-care activities. Second edition. By Edited by Yves Chartier, Jorge Emmanuel, Ute Pieper, Annette Prüss, Philip Rushhraok, Ruth Stringer, William Townend, Susan Wilburn and Raki Zghondi, World Health Organization, 2014
55. Biswas A, Amanullah A, Santra S. (2011), Medical waste management in the tertiary hospitals of Bangladesh, an empirical enquiry. ASA univ Rev_2011; 5:10
56. Ministry of Health and Family Welfare. Environmental Assessment and Action Plan for the Health. Population and Nutrition Sector Development Program (HPNSDP) 2011-2016. 2011.
57. Haque A, Yoshizumi A, Saga T, Ishii Y, Tateda K. ESBL-producing *Enterobacteriaceae* in environmental water in Dhaka, Bangladesh. Journal of Infection and Chemotherapy. 2014; 20(11):735–7. https:// doi.org/10.1016/j.jiac.2014.07.003 PMID: 251031
58. McInnes, RS., Uz-Zaman, MH., Alam, IT., Ho, SFS., Moran, RA., Clemens, JD., Islam, MS. and van Schaik, W., 2021. Metagenome-Wide Analysis of Rural and Urban Surface Waters and Sediments in Bangladesh Identifies Human Waste as a Driver of Antibiotic Resistance. Msystems, 6(4), pp.e 0013
59. Ahmed, S. M., Naher, N., Tune, S. N. B. K., & Islam, B. Z. (2022). The implementation of National Action Plan (NAP) on Antimicrobial Resistance (AMR) in Bangladesh: Challenges and lessons learned from a cross-sectional qualitative study. Antibiotics, 11(5), 6