2016-2023

National Antimicrobial Resistance (AMR) Surveillance Report, Bangladesh

Sectoral Co-ordination Center (Human Health) for AMR Surveillance
Institute of Epidemiology, Disease Control & Research (IEDCR)
Ministry of Health and Family Welfare (MOH&FW)
Government of the People's Republic of Bangladesh

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Report on National Antimicrobial Resistance Surveillance, Bangladesh, 2016-2023

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“Urgent action is required to stop the spread of antimicrobial resistance. Without action, we face a future where we will be unable to treat infections in humans, animals and plants. We must work together to protect our medicines”

- Her Excellency Sheikh Hasina,
Prime Minister of Bangladesh
Co-chair of the Global Leaders Group on AMR
The Global Leaders Group host side event at UN General Assembly on AMR
22 September 2022

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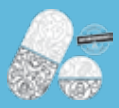
Abbreviations

ACSM	:	Advocacy, Communication and Social Mobilization
AHRD	:	Animal Health Research Division
AMC	:	Antimicrobial Consumption
AMR	:	Antimicrobial resistance
AMU	:	Antimicrobial Use
AqH	:	Aquatic Health
ARC	:	Antimicrobial Resistance Containment
AST	:	Antimicrobial susceptibility testing
BAHIS	:	Bangladesh Animal Health Intelligence System
BLRI	:	Bangladesh Livestock Research Institute
BSL	:	Biosafety Level
CAPTURA	:	Capturing Data on AMR Patterns and Trends in Use in Regions of Asia
CCU	:	Coronary Care Unit
CDC	:	Communicable Disease Control
CDIL	:	Central Disease Investigation Laboratory
CLSI	:	Clinical & Laboratory Standards Institute
CoNS	:	Coagulase negative Staphylococci
CRE	:	Carbapenem-resistant Enterobacteriaceae
DGDA	:	Directorate General of Drug Administration
DGHS	:	Directorate General of Health Services
DLS	:	Department of Livestock Services
DVH	:	District Veterinary Hospital
EQA	:	External Quality Assurance
ESBL	:	Extended-spectrum beta-lactamase
FAO	:	Food and Agriculture Organization of the United Nations
FCPS	:	Fellowship of college of Physician and Surgeon
FDIL	:	Field Disease Investigation Laboratory
FIQCL	:	Fish Inspection and Quality Control Laboratory
GHSA	:	Global Health Security Agenda
GLASS	:	Global Antimicrobial Resistance Surveillance System
GLG	:	Global Leaders Group
HAI	:	Hospital Acquired Infection
HDU	:	High Dependency Unit
HPNSP	:	Health, Population and Nutrition Sector program
ICU	:	Intensive Care Unit
IEDCR	:	Institute of Epidemiology Disease Control and Research
IPC	:	Infection Prevention and Control
IPD	:	Inpatient Department

IQA	:	Internal Quality Assurance
IQC	:	Internal Quality Control
KIA	:	Kligler Iron Agar
M. Phil	:	Master of Philosophy
MBBS	:	Bachelor of Medicine and Bachelor of Surgery
MDR	:	Multidrug resistance
MoFL	:	Ministry of Fisheries and Livestock
MoHFW	:	Ministry of Health and Family Welfare
MRSA	:	Methicillin resistant *Staphylococcus aureus*
NAP	:	National Action Plan
NCC	:	National Coordination Center
NIC	:	National Influenza Centre
NRL	:	National Reference Laboratory
OIE	:	Organization for Animal Health
OPD	:	Outpatient Department
ORT	:	Oral Rehydration Therapy
PCR	:	Polymerase Chain Reaction
PDR	:	Pan drug resistance
PICU	:	Pediatric Intensive Care Unit
PPS	:	Point Prevalence Survey
PRTC	:	Poultry Research and Training Center
QC	:	Quality Control
QJS	:	Quadripartite Joint Secretariat
RT-PCR	:	Real Time Polymerase Chain Reaction
SCC	:	Sectoral Coordination Center
SDG	:	Sustainable Development Goals
SOP	:	Standard Operating Procedure
SCANU	:	Special Care Newborn Unit
UNEP	:	United Nations Environment Programme
UNGA	:	United Nations General Assembly
UTI	:	Urinary Tract Infection
VH	:	Viral Hepatitis
VRE	:	Vancomycin resistant Enterococci
VRSA	:	Vancomycin resistant Staphylococcus aureus
WHA	:	World Health Assembly
WHO	:	World Health Organization
WOAH	:	World Organization of Animal Health
XDR	:	Extensively drug- resistant



Definitions

MDR: MDR is defined as non-susceptibility to at least one antimicrobial agent in three or more antimicrobial categories

XDR: XDR is defined as non-susceptibility to at least one agent in all but two or fewer antimicrobial categories (i.e., bacterial isolates remain susceptible to only one or two categories)

PDR: PDR is defined as non-susceptibility to all agents in all antimicrobial categories (i.e., no agents tested as susceptible for that organism)

MRSA: Includes *S. aureus* cultured from any specimen that tests oxacillin-resistant, cefoxitin-resistant by standard susceptibility testing methods (CLSI), or by a laboratory test that is FDA-approved for MRSA detection from isolated colonies; these methods may also include a positive result by any FDA-approved test for MRSA detection such as polymerase chain reaction (PCR) or positive PBP2a from specific sources

VRE: Vancomycin-resistant Enterococci; *Enterococcus faecalis, Enterococcus faecium,* or *Enterococcus species* unspecified (only those not identified to the species level) that is resistant to vancomycin, by standard susceptibility testing methods or by results from any FDA-approved test for VRE detection from specific specimen sources

CRE: Any Enterobacteriaceae testing resistant to Meropenem or Ertapenem by standard susceptibility testing methods (i.e., minimum inhibitory concentrations of ≥ 4 mcg/mL for Meropenem or ≥ 2 mcg/mL for Ertapenem) OR by production of a carbapenemase (i.e., KPC, NDM, VIM, IMP, OXA-48) demonstrated using a recognized test (e.g., polymerase chain reaction, metallo-β-lactamase test, Modified-Hodge test, Carba-NP)

Preface

Antimicrobial resistance (AMR) has emerged as one of the greatest threats to public health in the 21st century. The common medicines that were used to treat infections caused by bacteria, parasites, viruses, and fungi have become resistant and thus threatens the effectiveness of prevention and treatment. Institute of Epidemiology, Disease Control & Research (IEDCR) as a mandated organization by the Ministry of Health & Family Welfare, Government of Bangladesh, is responsible for conducting disease surveillance, and has been leading the AMR surveillance for human health since 2016. In addition of being a sectoral coordination center (Human Health), the IEDCR also has a "National Reference Laboratory" for surveillance of antimicrobial resistance. There are two types of surveillance, 'Case-based surveillance' and 'Laboratory-based surveillance' which provides data on trends and patterns of resistant microorganisms.

Eleven medical colleges and institutes are included as sentinel sites for the case-based surveillance. Twenty-one laboratories are recently included in laboratory-based surveillance. All the sentinel sites send laboratory and epidemiological data weekly and the central team of IEDCR regularly analyzes and updates the data. The analyzed data is uploaded yearly in WHO (GLASS) Global Antimicrobial Resistance Surveillance system platform through the Communicable Disease Control Program of the Directorate General of Health Services (CDC, DGHS). Every year, IEDCR shares the AMR surveillance data with all the relevant stakeholders and policy makers to help develop action-plan for effective policies and practices and further plans at national and international levels.

For the first time we are going to publish a full **"Report on National Anti-Microbial Resistant Surveillance, Bangladesh, 2016-2023"**. Some data about antibiotic usage are also showcased. Compiling and analyzing all this data in a thoughtful manner was indeed a big challenge. For this, I would like to congratulate Professor Dr. Zakir Hossain Habib and his full team for their hard work on data compiling, cleaning, analyzing, and writing a wonderful report within a short time.

I am thankful to the Centers for Disease Control and Prevention (CDC), Atlanta, USA, and the World Health Organization for their continuous financial and technical support. I also acknowledge the Fleming fund country Grant, SafetyNet, for their support to upgrade the laboratories and HR support. I am hopeful that this report will fully benefit all the stakeholders and the policymakers to think and plan for the effective policies to contain the AMR.

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Executive Summary

The AMR surveillance conduced in Bangladesh since 2017 is a unique, as it is mainly a case-based AMR surveillance. Ten tertiary medical college hospitals and one infectious disease hospital have been included to represent the whole country. It collects not only the laboratory data but also other data like epidemiological, clinical, comorbidity, antibiotic usage etc. which can be used for further analysis and research. So, the data of antibiotic usage in the major tertiary care hospitals of the country have also been included here. However, as per protocol of the surveillance, sample number and variety are limited to urine, blood, stool, sputum, endotracheal aspirate and wound swab and the pus. The sample variety as well as number has been significantly increased with the inclusion of lab-based surveillance in 2022 where primarily different private laboratories and their peripheral branches are included covering the district level population. The newly added private laboratories test a variety of samples from indoor as well as outdoor patients. However, they do not collect detailed data of the patients other than the laboratory data. The antibiogram presented here combines both sets of data from case-based and laboratory-based surveillance. There is a significant difference in susceptibility pattern of organisms isolated from indoor, outdoor, ICU and burn unit patients. So, we have also analyzed accordingly.

Highlights of the data

This report presents data from 2017 to June 2023 including data from 70,002 patients, 44,316 isolates. Among the isolates 8654 are from case-based surveillance and 35662 from lab-based surveillance. So, case-based surveillance includes 24.26% of total isolates.

The total number of samples tested in case-based surveillance is 34,340 and the number of isolates is 8654 indicating 25% growth of organisms. Highest growth yielded from wound swab sample (57%) and lowest growth from stool sample (9%). Here *E. coli* is excluded from stool sample as it may represent normal flora of the gut.

In case-based surveillance 49% of samples were collected from OPD and 39% samples were collected from ward and 12% from ICU patients.

In both case and lab-based surveillance the most frequent culture positive organism is *E. coli* constituting 31% and 27% of all isolated organisms respectively.

In case-based surveillance from urine, blood, wound swab, endotracheal aspirate, sputum and stool sample the highest isolated pathogen were *E. coli, Salmonella spp., Pseudomonas aeruginosa, K. pneumoniae, K. pneumoniae and V. cholerae respectively*.

The total number of culture positive isolates from lab-based surveillance is 35,662. The highest isolated organism from all the samples was *E. coli* constituting 27% of all organisms. Here the most isolated pathogen from urine, blood, wound swab, stool, throat swab, high vaginal swab and nipple discharge were *E. coli, Salmonella spp*., *S. aureus*, *E. coli, K. pneumoniae, E. coli and S. aureus* respectively.

In case-based surveillance the overall susceptibility pattern of different antibiotics in OPD, ward and ICU showed significant differences. In ICU patients' lowest susceptibility was observed whereas in OPD patients the susceptibility was quite high relative to ICU. In case of Cefepime the difference was found to be highest 41% (9% in ICU and 50% in outdoor). Linezolid (70%) was found highest susceptible at ICU as well as ward where they are found to be susceptible 70% and 75%. At OPD Carbapenem (84%) followed by Linezolid (82%) were found to be most susceptible.

In lab-based surveillance most of specimen was urine (70%) and blood (10%) from different locations (indoor, outdoor, ICU) patients. In urine sample Amikacin, Fosfomycin and Carbapenem antibiotics were seen (highly sensitive around 90% sensitivity). Whereas Nitrofurantoin showed less susceptibility (72%) and 3rd generation cephalosporin Ceftriaxone showed poor susceptibility (47%).

Susceptibility of *E. coli* in urine and non-urine sample were analyzed and found that it was less susceptible in non-urine sample than urine. In blood sample Moxifloxacin, Carbapenem and Ceftriaxone were found with high susceptibility.

In *candida* spp. Flucytosine (97%), Voriconazole (92%) and Micafungin (92%) were found with highest susceptibility.

The two most common samples in case-based surveillance are urine and blood. In urine samples from all OPD, ward and ICU patients Amikacin was the highest susceptible antibiotic with susceptibility of 82%, 80% and 25% respectively.

In blood samples from OPD, ward and ICU patients Gentamicin (98%) and Ceftriaxone (93%), (89%) and Gentamicin (77%), Linezolid (77%) and Tetracycline (53%) were the two topmost effective antibiotics.

We have analyzed the susceptibility trend of antibiotics over the surveillance period and found most of them are more or less except Linezolid and Clindamycin. In case of both are increasing.

Extended Spectrum Beta Lactamase (ESBL) producing *E. coli* and Methicillin Resistant *S. aureus* (MRSA) organisms are selected by WHO as the indicator of AMR indicators for SDG goal. We have found 86% suspected ESBL (according to SDG definition) and 31% confirmed ESBL *E. coli* and 48% MRSA in blood.

We have analyzed together the susceptibility pattern of organisms from case based as well as the lab-based surveillance to represent a broad range of patients' sample from all over Bangladesh. We have found Linezolid, Doxycycline, Vancomycin and in case of urine sample Nitrofurantoin is more effective antibiotic for Gram positive organisms. On the other hand, for Gram negative organisms Carbapenem, Amikacin, Fosfomycin are better choice while for *Salmonella* and *Shigella* Ceftriaxone has high susceptibility.

We tried to identify the WHO critical priority pathogen in respect to resistance to Meropenem, *Acinetobacter, P. aeruginosa and* Enterobacteriaceae and found that to be 42%, for *ACB complex, 32% for P. aeruginosa* and 11% for Enterobacteriaceae. We also analyzed the WHO critical priority pathogen Enterobacteriaceae in respect to Ceftriaxone resistance. It was highest (64%) in *Proteus spp*. followed by *E. coli* (59%) and *K. pneumoniae* (48%).

Antibiotic usage in case-based surveillance site patients

In case-based surveillance the antibiotic use data is taken from every patient. So, we have a database of 20,868 antibiotics used over the period of six years from 2017 to 2023. Among this 61% was used in ward, 26 % in ICU and 13% in OPD patients. The highest used antibiotic was Ceftriaxone (31%) followed by Flucloxacillin (12%) and Meropenem (11%). Both in ward (34.6%) and ICU (33.1%) Ceftriaxone was the most used antibiotic. In OPD however Ciprofloxacin (19.1%) was the most used antibiotic. In this surveillance we include patients with wound infection, Urinary Tract Infection (UTI), blood stream infection, lower respiratory tract infection and diarrhea. We have found that other than diarrhoea and UTI Ceftriaxone was most

preferred antibiotic of choice. In case of diarrhoea it is Azithromycin and in UTI it is Ciprofloxacin. In site wise distribution we have found that Ceftriaxone is the most preferred antibiotic in ten out of thirteen sites ranging from 17.1% in DMCH to 51.55% in RpMCH. The three sites where Ceftriaxone was not the topmost used drug has secured the second position. Meropenem, a very useful drug for MDR pathogens in critically ill patients was also in the list of top ten used antibiotic where ICU is not available, or patients are not included from ICU patients. In RMCH two carbapenem group of drugs is in the top list Meropenem in 2nd position and doripenem in 10th position. Reserve group of drugs withing top ten used antibiotic is colistin and Tigecycline. In Dhaka Medical College hospital Colistin and in Khulna and Cox's Bazar Medical College hospital Tigecycline is the only reserve drug used in the top ten antibiotic. We tried to figure out the year wise trend of top five used antibiotics. Meropenem and Azithromycin showed an increasing trend of use since 2021 while Flucloxacillin showed a downward trend in the same time period. Other antibiotics showed no significant pattern.

Among the WHO reserve category drug used in different sites Linezolid (45%) was highest followed by Tigecycline (36%) and Colistin (15%). We tried to identify the relative use of reserve drugs in different departments and found the highest reserve drug was used in burn patients (12%) followed by ICU (4.7%) and surgery department (2.2%). In burn unit Colistin is the highest used (68.8%) antibiotic followed by Linezolid (20%). In ICU patients Tigecycline is the most used (67.9%) antibiotic followed by Linezolid (19.9%). In the surgery unit most of the reserve drug used is Linezolid (97.3%) followed by Colistin (2%). We have found that a little amount (4%) of reserve drug was used in OPD. Most of them are Linezolid (87%) followed by Tigecycline (9%).

Introduction

"Stop referring to a coming post-antibiotic era — it's already here."

The statement came from U.S. Centers for Disease Control and Prevention report (2019) nearly 75 years after Sir Alexander Fleming, the discoverer of one of the first antibiotics, Penicillin, cautioned about the antibiotic resistance in his speech while receiving The Noble Prize in 1945. (Lalchhandama, 2021)

Antimicrobial Resistance is now a significant threat to humanity. The discovery of antibiotic agents revolutionized medical practice as well as other sectors. Penicillin and streptomycin were responsible for saving many lives in the battles following D-Day and in the Japanese campaigns (Fleming Fund web page) Many other antibiotics were invented following this. The period between the 1940s and 1960s is considered the golden era of antibiotic discovery. Most of the antibiotic classes we use as medicines today were discovered and introduced to the market during this period. However, a marked decline in their efficacy has been observed over time because of antibiotic resistance (CDC, 2019) due to its widespread abuse. The development of resistance has outstripped the ability to develop drugs that can combat strains of resistant bacteria- a situation that might be named a "Silent Pandemic". So, the post-antibiotic era is a very real possibility for the 21st century. (Iskandar et al., 2022)

Antimicrobials – including antibiotics, antivirals, antifungals and antiparasitics – are medicines used to prevent and treat infections in humans, animals and plants. Antibiotics are a special category of antimicrobial drugs that underpin modern medicine as we know it:

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. As a result of drug resistance, antibiotics and other antimicrobial medicines become ineffective and infections become increasingly difficult or impossible to treat, key medical procedures (such as gut surgery, cesarean sections, joint replacements, and treatments that depress the immune system, such as chemotherapy for cancer) could become too dangerous to perform. Most of the direct and much of the indirect impact of AMR will fall on low and middle-income countries.

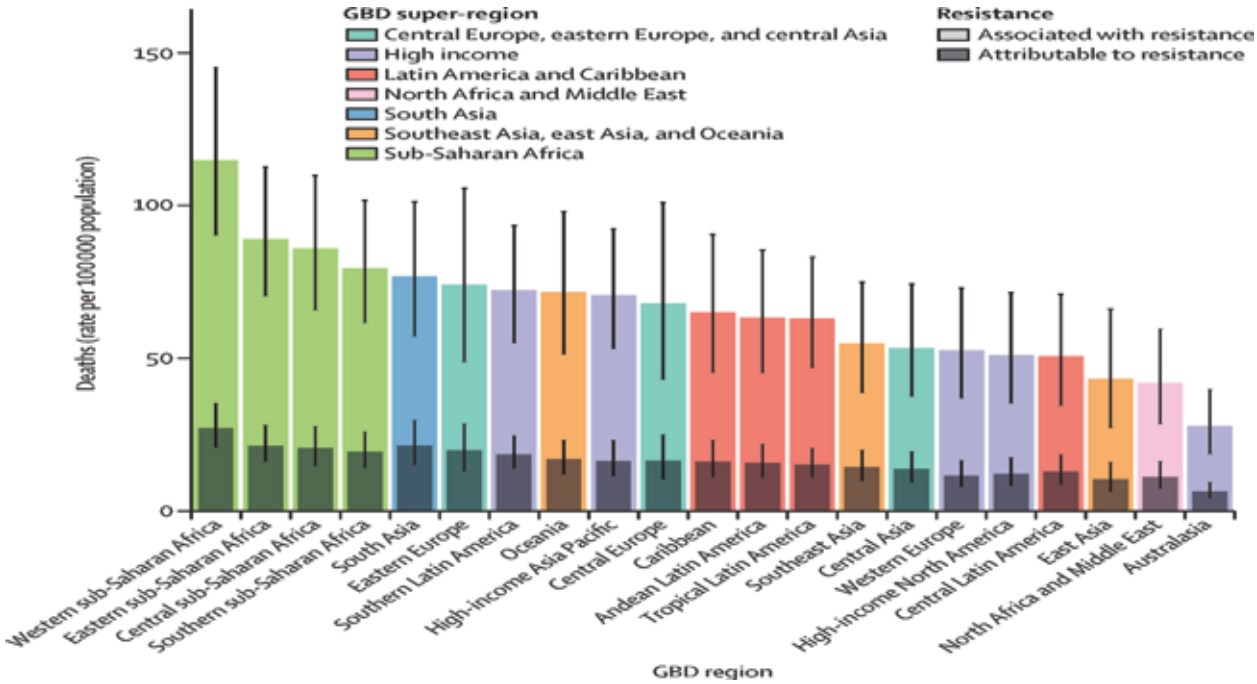
Current Global Scenario on AMR

AMR is a top global public health and development threat. Infections are becoming difficult to treat, resulting in increase of morbidity and mortality. Resistance occurs in bacteria, viruses, fungi, and parasites. Misuse and overuse of antimicrobials are the main drivers in the development of drug-resistant pathogens. Common infections show high rates of antibiotic resistance worldwide. Without immediate action, AMR infections could cause 10 million deaths annually by 2050 (UNICEF technical note on antimicrobial resistance, 2019)

In a recent study it was found that there were an estimated 4.95 million deaths associated with bacterial AMR in 2019, including 1.27 million deaths attributable to bacterial AMR (Murray et al., 2022).

One pathogen–drug combination, methicillin-resistant *S. aureus*, caused more than 100 000 deaths attributable to AMR in 2019, while six more each caused 50000–100000 deaths multidrug-resistant excluding extensively drug-resistant tuberculosis, third-generation cephalosporin-resistant *E coli*, carbapenem-resistant *A baumannii*, fluoroquinolone-resistant

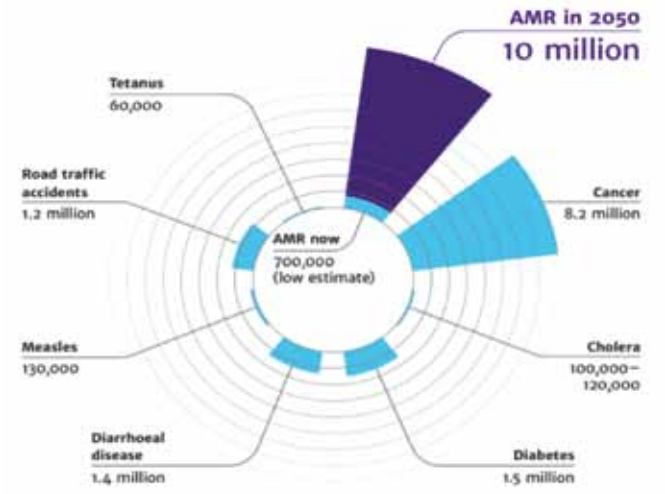
E. coli, carbapenem-resistant *K pneumoniae*, and third-generation cephalosporin-resistant *K pneumonia*. (Wagenlehner and Dittmar, 2022)



All age rate of deaths attributable to and associated with bacterial antimicrobial resistance by GBD region, 2019.

In Review of Antimicrobial Resistance final report 2016, it was stated that, by 2050, 10 million lives a year and a cumulative 100 trillion USD of economic output are at risk due to the rise of drug resistant infections if we do not find proactive solutions now to slow down the rise of drug resistance.

The cost of AMR to the economy is significant. In addition to death and disability, prolonged illness results in longer hospital stays, the need for more expensive medicines, and financial challenges for those impacted (Murray et al., 2022). Without effective antimicrobials, the success of modern medicine in treating infections, including during major surgery and cancer chemotherapy, would be at increased risk (Murray et al., 2022).



Deaths attributable to AMR every year (Review om antimicrobial resistance by Jioneinn, 2016)

Antibiotic pipeline is drying up

The current clinical antibacterial pipeline contains 43 antibiotics and combinations with a new therapeutic entity. Only 2 of these are active against the critical multidrug-resistant (MDR) Gram-negative bacteria.

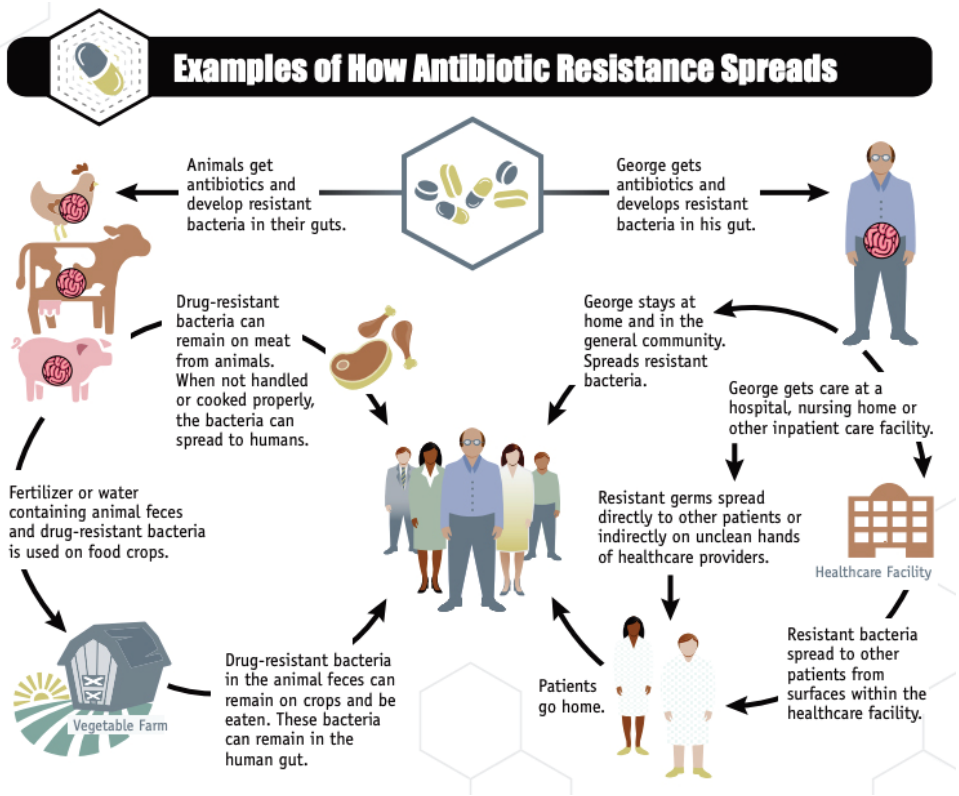
Overall, the clinical pipeline and recently approved antibiotics are insufficient to tackle the challenge of increasing the emergence and spread of antimicrobial resistance. (OMS, 2021)

Causes of AMR

AMR is a natural phenomenon accelerated by use of antimicrobial medicines. Resistance strains survive and aggregate. Misuse and overuse of antimicrobials are the main drivers in the development of drug-resistant pathogens. Medicines for treating infections loose effect because the microbe change – mutate, acquired genetic information from other microbes to develop resistance.

Lack of clean water and sanitation and inadequate infection prevention and control promotes the spread of microbes, some of which can be resistant to antimicrobial treatment (CDC, 2019)

Antimicrobial resistance (AMR) is a One Health issue. The drivers of AMR lie in humans, animals, agriculture (including crops and aquaculture), and in the environment. Though use in both human health and agriculture exists, use in human health is thought to be the greatest contributor to AMR. Both of which lead to antimicrobial environmental release, which itself is a contributor to resistance. They are also used in crop production, but only 0.2-0.4% of total agricultural antibiotic consumption is crop related. (WHO Website, 2023) https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance



A CDC infographic on how antibiotic resistance (a major type of antimicrobial resistance) happens and spreads

AMR and Global initiatives

World Health Organization has declared that AMR is one of the top 10 global public health threats. Urgent multisectoral actions are needed to address this condition and to achieve SDG (Sustainable Development Goals). A new SDG (Sustainable Development Goals) indicator for AMR (3.d.2) was approved 2019 for bloodstream infection due to specific drug-resistant pathogens.

The World health organization has been alarming on AMR since 1990s. It has acknowledged Antimicrobial Resistance as an upcoming public health concern in 1998. The World Health Assembly (WHA) Resolution of 1998 (1) urged Member States to develop measures to encourage appropriate and cost-effective use of antimicrobials, to prohibit the dispensing of antimicrobials without the prescription of a qualified health care professional, to improve practices to prevent the spread of infection. (World Health Organization, 2001)

In 2010, WHO issued a report warning that "many common infections will no longer have a cure and, once again, could kill unabated" if action was not taken to address AMR (CDC, 2019). The report called for a global response to the problem of AMR, since then, WHO has continued to work on AMR WHO has developed a Global Antimicrobial Resistance Surveillance System (GLASS) to support global surveillance and research on AMR (Fleming Fund Web Page). In addition, WHO has developed several guidelines and tools to support countries in their efforts to combat AMR. These include guidelines on infection prevention and control, antimicrobial stewardship, and the use of antibiotics in food-producing animals (Fleming Fund, Web page)

The Jaipur Declaration

Health Ministers of WHO South-East Asia Region convened in Jaipur, India, for the Twenty-ninth Health Ministers' Meeting in September 2011. Recognizing AMR as a major global public health issue the Jaipur Declaration on Antimicrobial Resistance (AMR) was adopted. The declaration underscores the impact of irrational antimicrobial use, especially in developing countries causing the emergence of AMR which jeopardizes achievements in disease prevention and threatens UN Millennium Development Goals. The ministers emphasized the need for a comprehensive, multidisciplinary approach with utmost priority to this hitherto neglected problem to preserve efficacy of the antimicrobial agents in fight against microbial diseases.

United Nations initiatives

On September 21, 2016, the United Nations General Assembly (UNGA) convened a high-level meeting on antimicrobial resistance – and adopted a political declaration on antimicrobial resistance (AMR). The declaration recognized AMR as a major global public health issue and called for a broad, coordinated approach that engages all sectors, including human, animal, plant, and environmental health (Lalchhandama, 2021). The declaration further recognized that while antimicrobial resistance is a global public health problem, its major brunt is being borne by people in developing countries. (UNICEF technical note on antimicrobial resistance, 2019)

The United Nations has recognized the importance of addressing AMR in achieving the SDGs. In 2021, a Call to Action on Antimicrobial Resistance was issued by the United Nations General Assembly (UNGA), which called for tackling AMR as an integral part of programmes addressing pandemic preparedness, health systems strengthening, universal health coverage, the environment, patient safety, infection prevention and control, promotion of sustainable food systems, food

safety and food security (Fleming Fund Web Page). The UNGA also adopted a resolution in March 2022 to establish a High-level Meeting on Antimicrobial Resistance (AMR) to be held in UNGA 2024 in collaboration with the Quadripartite organizations and the Global Leaders Group (GLG) (CDC, 2019).

Tripartite and Quadripartite

The Tripartite consisting of the Food and Agriculture Organization of the United Nations (FAO), the World Organization for Animal Health (WOAH, former OIE), and WHO have been working together for decades to address risks at the human, animal, plant, and environment interface. Since 2018, the three agencies joined forces as a Tripartite to strengthen their long-standing partnership with a renewed focus on tackling AMR from a One Health approach. The United Nations Environment Programme (UNEP) has also joined this work to support governments, civil society, and the private sector in addressing AMR risks related to the environmental sector. In 2022, the Tripartite became formally the Quadripartite as it welcomed UNEP in the alliance to accelerate coordinated strategy on human, animal and ecosystem health. The Quadripartite goal is to preserve antimicrobial efficacy and ensure sustainable and equitable access to antimicrobials for responsible and prudent use in human, animal and plant health contributing to achieving SDGs. (CDC, 2019).

The Fleming Fund initiative

It is a UK aid program that provides funding to partner with countries across Asia and Africa including Bangladesh to tackle antimicrobial resistance (AMR) and reduce the threat posed to the UK. The Fleming Fund is one of the largest investments in global AMR surveillance by any country, with up to £210 million of funding over three years. (Fleming Fund Web Page)

Global Action plan on AMR

In May 2015, at 68th World Health Assembly they adopted a Global Action Plan on AMR-Antimicrobial resistance. According to the Global Action Plan each country needed to

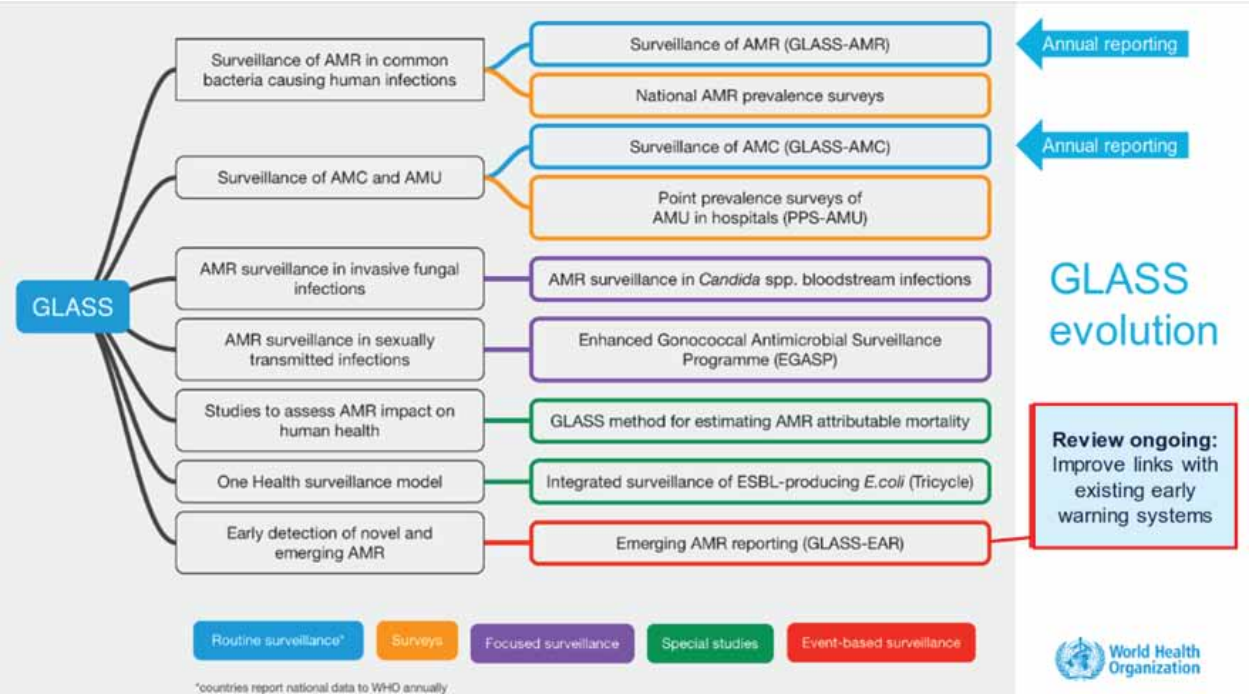
develop a National Action Plan regarding Antimicrobial Resistance. One of this Global Action Plan's key strategic plans and objectives is to strengthen the evidence base through surveillance and research. There were five action plans taken during the 68th World Health Assembly. They were,

1. To improve awareness and understanding of antimicrobial resistance through effective communication, education, and training.
2. To strengthen the knowledge and evidence base through surveillance and research.
3. To reduce the incidence of infection through adequate sanitation, hygiene, and infection prevention measures.
4. To optimize the use of antimicrobial medicines in human and animal health; and
5. To develop the economic case for sustainable investment that considers all countries' needs and to increase investment in new medicines, diagnostic tools, vaccines, and other interventions.

Global Antimicrobial Resistance and Use Surveillance System (GLASS)

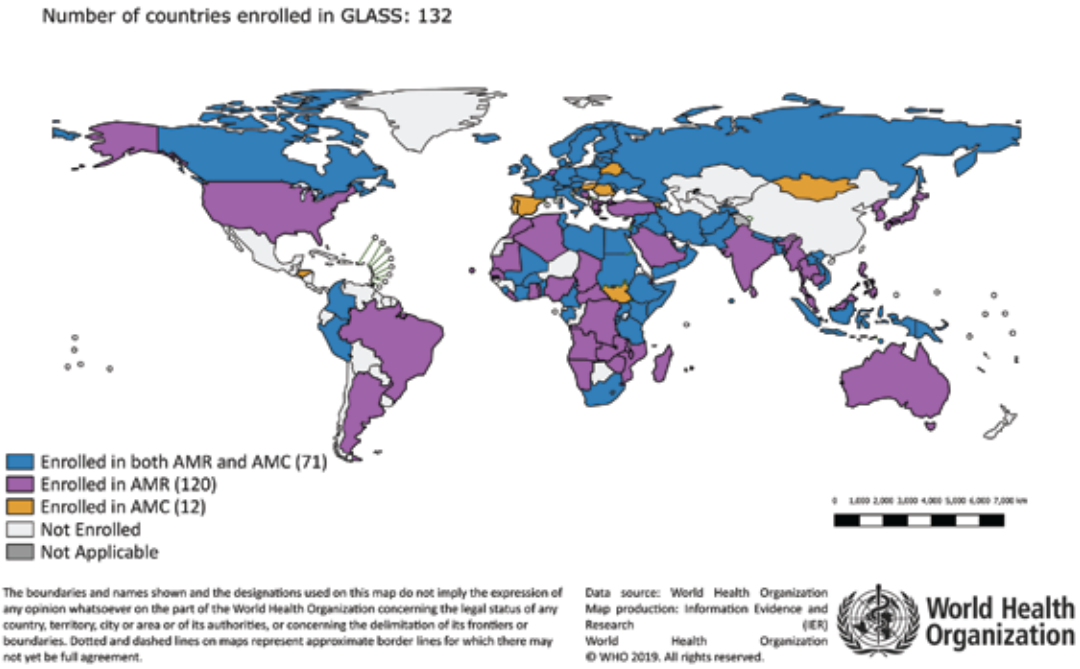
In 2015, the World health organization established the Global Antimicrobial Resistance and Use Surveillance System (GLASS). It was developed to monitor the situation and trend of antimicrobial resistance in Humans globally. GLASS was created to support the second objective of the GAP-AMR initiative to "strengthen knowledge through surveillance and research" and to continue filling knowledge gaps, to inform strategies at all levels. GLASS provides support, including evidence-based guidelines and technical documents, to assist countries and regions in building capacity and taking appropriate and timely corrective actions.

GLASS areas of work



By October 2023 a total of 132 countries were enrolled in GLASS. A total of 120 countries were enrolled in AMR only; 12 countries were enrolled in AMC only and 71 countries were enrolled in both AMR and AMC.

By the end of the 2021 data call, 99 countries, territories, and regions provided information on the status of AMR surveillance implementation, and 87 countries, territories, and regions on AMR rates during 2020. A new and more concise terminology has been introduced in the 2022 report. GLASS-AMC (Antimicrobial Consumption) and GLASS-AMR (Antimicrobial resistance) refer specifically to surveillance data related to AMC or AMR. The GLASS target by 2030 is that all countries, territories, and areas will apply globally harmonized standards to capture and share information on AMR and AMC with a global surveillance system to inform local, regional, and global strategies to contain AMR.



GLASS enrolment map

Bangladesh Perspective of AMR

Bangladesh is a country situated in southeast Asian region. It has a population of 163.05 million. Antimicrobial resistance (AMR) is a growing concern in Bangladesh. It is aggravated by irrational use of antimicrobials, widespread availability without prescription in the country, and consequent contamination of the environment. In a systematic review of Forty-six articles a high prevalence of resistance was detected in most tested pathogens, and many of the common first-line drugs were found mostly ineffective. Resistance to carbapenems was low in most cases. The presence of extended-spectrum beta-lactamase (ESBL)-producing organisms was indicated by the high resistance to beta-lactams. Methicillin-resistant *Staphylococcus aureus* (MRSA) was identified in four studies. (Ahmed, 2019)

National AMR surveillance in Bangladesh conducted by IEDCR throughout the country since 2017 found 8% of possible Pan Drug Resistant (PDR) among 6868 isolates which is truly alarming. Moreover, it showed that the resistance of most of the organisms over the period is increasing.

Capturing Data on AMR Patterns and Trends in Use in Regions of Asia (CAPTURA)

In 2019, an international consortium led by the International Vaccine Institute and with the help of The Fleming Fund the CAPTURA project was awarded with the specific objective of expanding the volume of historical data on antimicrobial resistance (AMR), consumption (AMC), and use (AMU) in the human health care sector across 12 countries in South and Southeast Asia, including Bangladesh.

Bangladesh shared microbiological culture records from 34 laboratories. Among this, one laboratory (IEDCR), shared a collated dataset obtained from nine sentinel sites across the country as a part of AMR surveillance network. Only five privately owned and operated pharmacies signed DTA with CAPTURA and shared AMU data included where the project has been successfully concluded and the result disseminated, and report already submitted.

There were 1,037,002 culture records from 2016 to 2020, of which 299,786 (28.90%) records reported bacterial growth and their AST results (in-case of clinically significant finding). The most common bacteria isolated in the dataset obtained is *'Escherichia coli'* (nearly 34.71% of positive records with pathogen identified) followed by *Klebsiella* species, *Pseudomonas species, Staphylococcus aureus* and *Enterococcus* species (approximately 14.51%, 10.14%, 8.83%, 6.86% respectively).

In general, high levels of resistance has been observed in the pathogens associated with HAI and *Salmonella Typhi* resistant to aminoglycosides and decreased susceptibility to Ciprofloxacin is also observed. Further, the Bangladesh data shows that there has not been major change in antimicrobial susceptibility trends in the country over the last four years.

Point Prevalence Survey (PPS) on antimicrobial use in 'One Health' approach

A PPS was conducted adapting the WHO PPS design in inpatients departments in 2021 with the objective of understanding antimicrobial use in humans (at hospitals, communities, and pharmacies), commercial chicken, and aquaculture in Bangladesh through the 'One Health' approach. The survey was conducted in four acute care government hospitals (two tertiary and two secondary level hospitals). It found Nearly 78% of patients received at least one antibiotic during the survey period. Third generation cephalosporins (44.6%), penicillins (12.3%), imidazoles (11.8%), aminoglycosides (7.2%), and macrolides (5.8%) were documented as highly used antibiotics. Overall, 64.0% of Watch, 35.6% of Access, and 0.1% of Reserve group antibiotics were used for treatment. The use of Watch group antibiotics was high in medicine wards (78.7%) and overall high use of Watch antibiotics was observed at secondary hospitals (71.5%) compared to tertiary hospitals (60.2%) (p value of 0.000).

National Antimicrobial Resistance Containment (ARC) Program

Antimicrobial Resistance Containment component has been introduced into Communicable Disease Control (CDC) Operation Plan (OP) of 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.

This is a national program under Communicable Disease Control (CDC), Disease Control Unit, DGHS. This program involves stakeholders from different sectors, namely- Health, Animal sector, Plant sector, Environments. Disease control unit of DGHS is the national focal point for ARC activities in Bangladesh. The activity of this program includes multisectoral coordination, antimicrobial stewardship, standard treatment guideline and other policy development, effective surveillance, enhancing infection prevention and control, necessary training, capacity building, monitoring and evaluation and Advocacy, Communication and Social Mobilization (ACSM) for ARC.

National Action Plan

After the adaptation of the Global Action Plan by WHO in 2015, Bangladesh took the initiative to make a National Action Plan. CDC has developed National Action Plan (NAP) in 2017 which included timeline of proposed activities along with implementing organizations. Further, in accordance with the global advancement and special emphasis of AMR in the SDG goal as an indicator as well as adherence of Prime Minister of Bangladesh with One Health Global Leaders Group on Antimicrobial Resistance, the Directorate General of Health Services (DGHS), 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 (2021-2026) for tackling AMR.

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 in accordance with the AMR Global Action Plan (WHO, FAO, WOAH).

Key Strategy 1: Strengthen multi-sectoral coordination for planning and implementation of ARC in one health approach.

Key Strategy 2: Increasing stakeholder awareness and engagement

Key Strategy 3: Establish integrated surveillance and strengthen laboratory capacity

Key Strategy 4: Enabling good practices

Key Strategy 5: Promoting responsible use of antimicrobials

Key Strategy 6: Promote innovation and research on AMR

Key Strategy 7: Reduce environmental spread of AMR

Key Strategy 8: Strengthen global collaboration and partnerships

National surveillance system and laboratory network

The national AMR surveillance strategy for 2020-2025 has been developed recently with support of The Fleming Fund country grant. IEDCR and DLS have been identified as the focal institute to monitor and coordinate AMR surveillance in the human health and animal health sector in the country.

Since 2016, the IEDCR has been conducting countrywide AMR surveillance, beginning with five sentinel sites, then scaling up to eleven. In the human health sector, IEDCR is hosting the National Reference Laboratory for AMR (NRL-AMR).

Director General of Drug Administration (DGDA)

Director General of Drug Administration under Ministry of Health and Family Welfare is assigned with antimicrobial consumption monitoring both in human and animal health. Report on AMC (antimicrobial consumption) from 2015-2020 has already been submitted to GLASS by DGDA. AMC surveillance report for 2021and 2022 will be submitted soon. The National Guideline on Dispensing, Use, and Disposal Management of Antimicrobial Drugs in Bangladesh and The Standard Operating Procedure (SOP) for AMC Surveillance in veterinary medicine been finalized. A Web-based GLASS AMC monitoring platform development is ongoing.

WHO Bangladesh launched a series of initiatives to combat Antimicrobial Resistance (AMR) comprehensively in collaboration with DGDA. These efforts began with training programs in July 2023 aimed at enhancing Antimicrobial Consumption (AMC) surveillance. Pharmaceutical industry representatives were educated on accurate data reporting to the WHO's Global Antimicrobial Resistance and Use Surveillance System (GLASS)-AMC portal, emphasizing the importance of data accuracy for well-informed policy decisions.

The Department of Livestock Services (DLS)

The Department of Livestock Services (DLS) plays the central and controlling rules for livestock development, production, disease control, disease surveillance, and preventive activities through its country-wide setup. DLS works under the supervision of The Ministry of Fisheries and Livestock (MoFL). DLS conducts surveillance through its Epidemiology unit and laboratory network.

CDIL started AMR activities for indicating bacteria *E. coli* from Live Bird market (LBM) in Dhaka city with the support from FAO science 2017. In 2022, the Ministry of Fisheries and Livestock, Government of The Peoples of Bangladesh, officially declared the Central Disease Investigation Laboratory (CDIL) as the National AMR reference laboratory (Surveillance) for Animal Health. This laboratory is now conducting AMR surveillance in *E. coli, Salmonella spp., Campylobacter spp., Enterobacter spp.,* and *Staphylococci spp*. Besides CDIL as a reference laboratory, there are four sentinel laboratories (Field disease investigation laboratory, Feni; Field disease investigation laboratory, Joypurhat of DLS, BLRI, and PRTC) for conducting AMR surveillance in the AMR surveillance network for Animal health.

The sentinel AMR laboratories also collect, collate, and analyze data on AMR test results and share data through BAHIS software.

The Bangladesh Livestock Research Institute (BLRI)

BLRI is a Key Point Institution (KPI) in livestock research in Bangladesh under the Ministry of Fisheries and Livestock the Bangladesh Livestock Research Institute (BLRI) has been conducting AMR surveillance in the livestock and poultry value chain system. 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 AqH sector and providing support to FIQCL.

Laboratory Facilities for Antimicrobial Resistance Reference Laboratory: The Animal Health Research Division (AHRD) of BLRI has Four BSL-2 enhance laboratories. Among these, the Antimicrobial Resistance Reference Laboratory (NRL) is the state of the art, fully operational laboratory under the AHRD since 2018.

Antimicrobial Resistance Surveillance in Bangladesh: 2016-2023

AMR Surveillance Sentinel Sites (Case Based)

Sectoral Coordination Center (Human Health) and
National Reference Laboratory (NRL) for AMR Surveillance

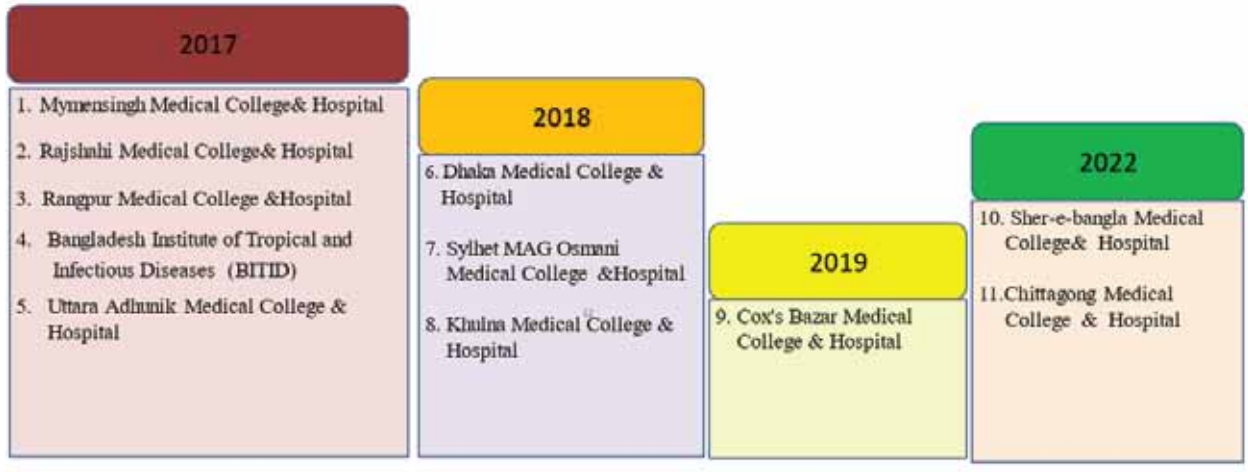
Surveillance is the foundation of infectious disease management. Surveillance of antimicrobial resistance (AMR) tracks changes in microbial populations, permits the early detection of resistant strains of public health importance, supports prompt notification and investigation of outbreaks. Surveillance findings are needed - to guide clinical therapy decisions, to generate evidence for policy recommendations, to assess the impact of resistance containment interventions. Finally, at

the global level, it provides early warnings of emerging threats and data to identify and act on long term trends.

In Global action plan of WHO on AMR containment as well as National Action plan of Bangladesh AMR surveillance has been identified as one of the main strategic actions. There was no systemic national surveillance conducted on AMR until 2016. In 2016 Antimicrobial Resistance Surveillance in Bangladesh project is initiated by Institute of Epidemiology, Disease Control & Research (IEDCR) with the support under the Global Health Security Agenda (GHSA) with cooperative agreement with US CDC. Initially the project duration was five years (2016-2020). The objective of the surveillance is to establish a surveillance system to find out the status of Antimicrobial Resistance among common pathogens in Bangladesh.

The site selection, setting up of Surveillance team (locally and centrally), Development of AMR Surveillance Protocol, development of Standard Operating Procedures (SOP), recruiting human resource, setting up system for data collection from sentinel sites and send to the central server, procurement of logistics and equipment etc. was done and the surveillance sites started functioning from March 2017. Surveillance sites were selected based on - country geographical representation, ability and willingness of the hospital to enroll cases, availability of standard microbiology laboratory which can perform culture and sensitivity testing. Initially five sites started surveillance activities in 2017.

Chronology of Inception of Case Based Surveillance Sites (Year Wise)



Objectives of the surveillance

The General Objective

To establish a surveillance system to determine the status of Antimicrobial Resistance among common pathogens in Bangladesh.

Specific Objectives

- To strengthen selected Microbiology laboratories for performing standard techniques of bacterial culture sensitivity testing.
- To isolate, identify, and perform Antimicrobial Sensitivity testing (AST) of the selected pathogens using uniform laboratory protocol.
- To develop an antibiogram periodically according to the observed sensitivity pattern.

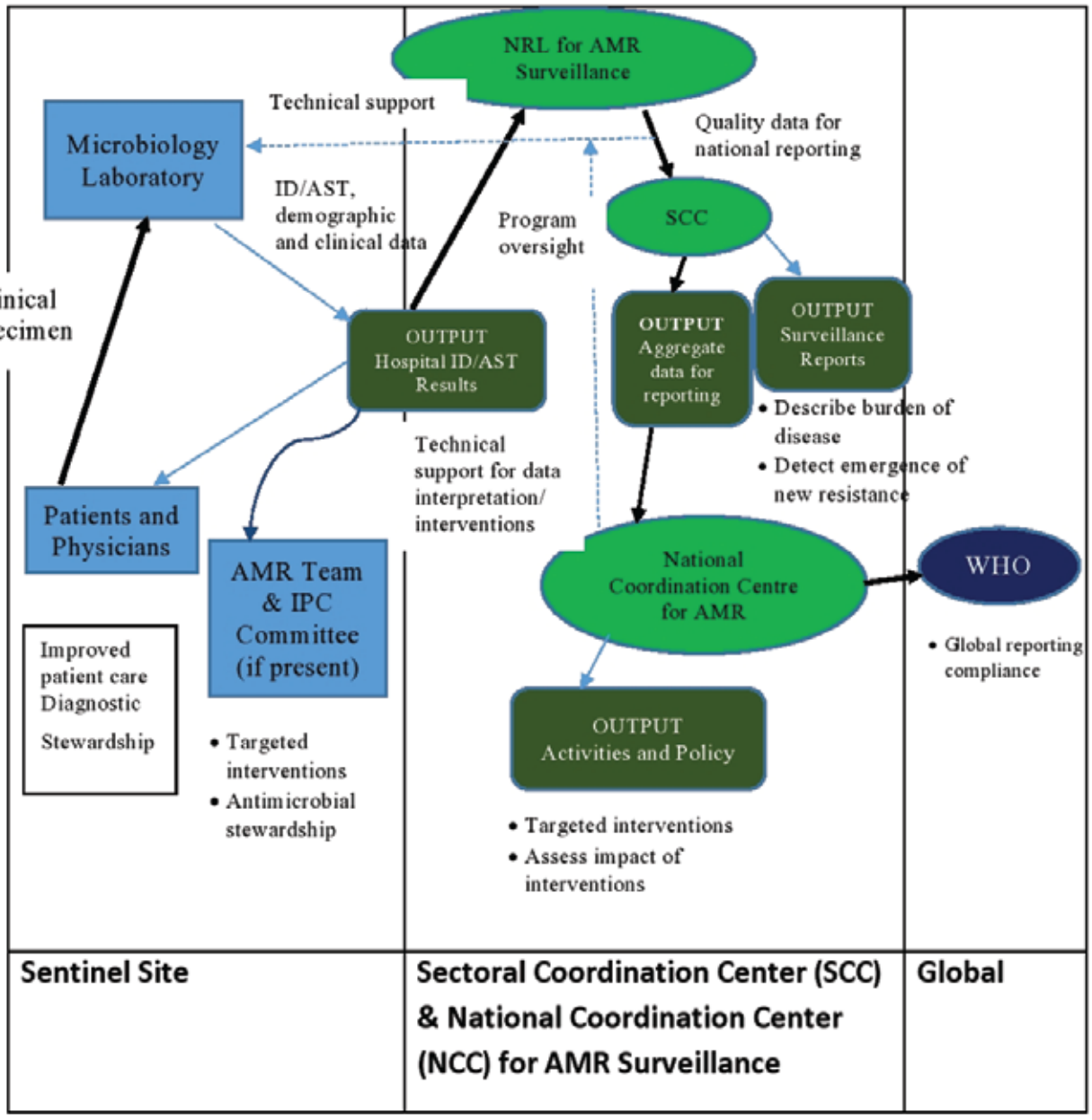
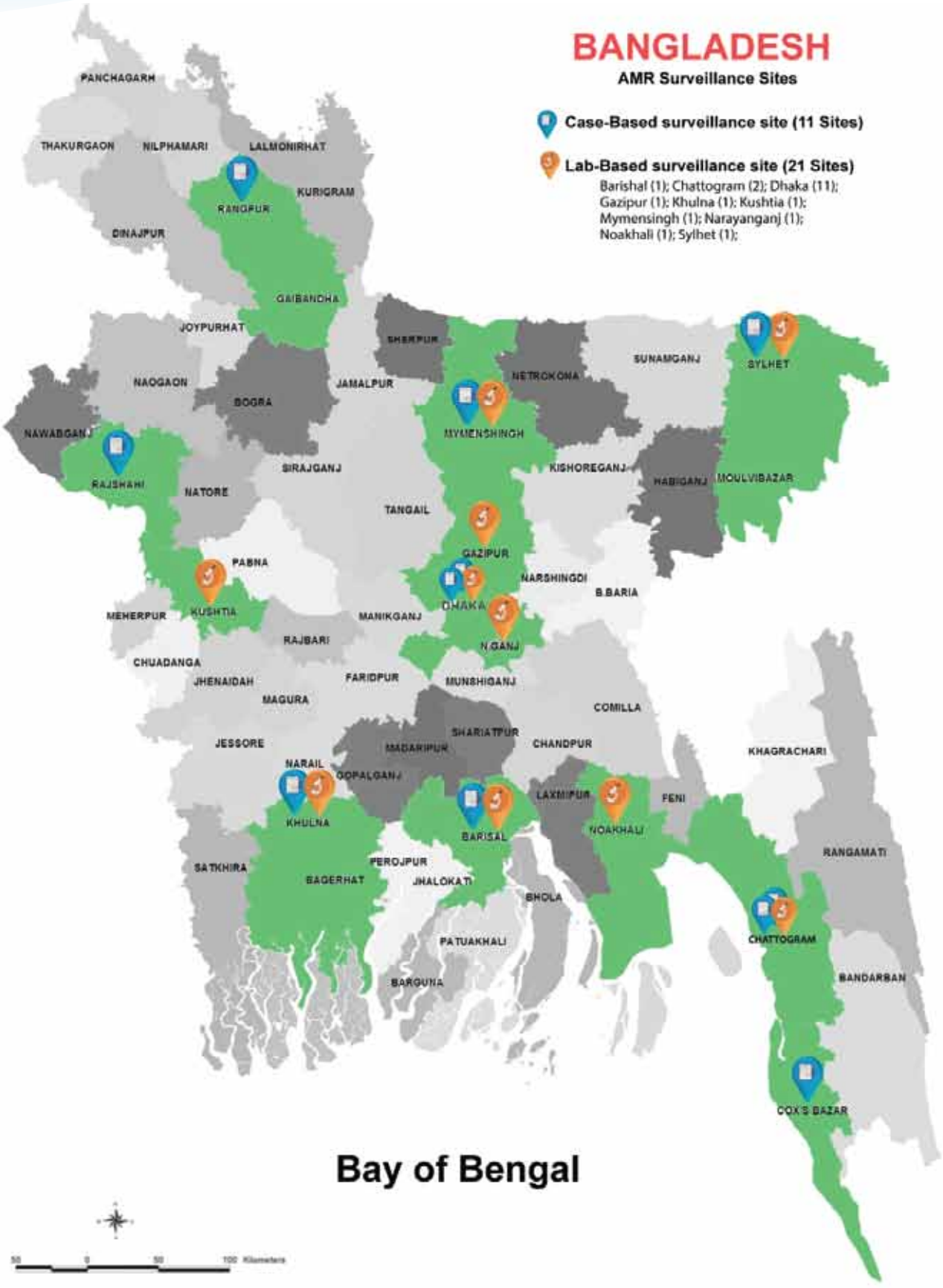
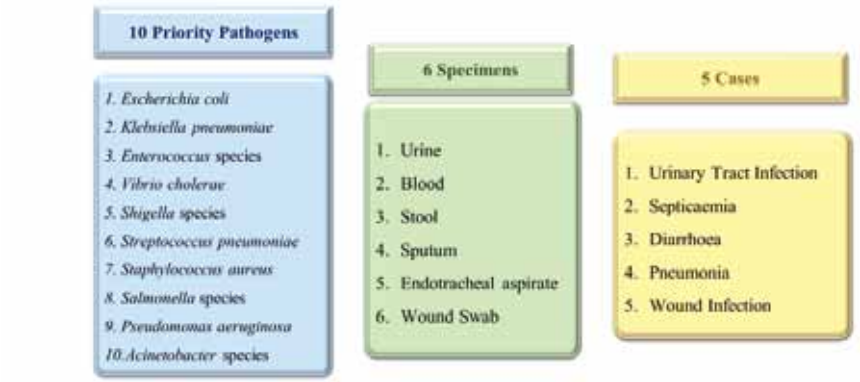


Figure 01: Overview of AMR Surveillance System



Geographic distribution of AMR surveillance sentinel sites

Priority pathogens, specimens, and cases



AMR surveillance co-ordination Committee

This committee is the administrative authority of AMR surveillance centrally. AMR surveillance co-ordination subcommittee consists of Epidemiologists, Laboratory personnel, AMR Surveillance Consultant, representative from CDC, DGHS and representatives from donor agency lead by Director IEDCR. This team is supported by IT experts, data management assistant and medical technologists and AMR surveillance lab consultant. The team meeting of this committee is held regularly.

Activities of Central Surveillance Team

The central team at IEDCR provides guidance and co-ordinates all the activities of the sentinel sites. They collaborate and communicate with national and international agencies. They arrange training and refresher training of the sentinel site physicians, nurses, microbiologists and technologists. They conduct monitoring and evaluation visits to the sites to assess their activities and progress. They give technical support to the sentinel site laboratories and maintain logistic supply chain. They perform data cleaning, analysis, review, and feedback.

Surveillance team at sentinel sites

Team lead: Head of Microbiology department

Members: Surveillance physicians and nurses, microbiologists and medical technologists, lab attendant and cleaner from the respective medical college and hospital and an IEDCR appointed coordinator, designated as Project Facilitator (PF).

AMR Surveillance Reference Laboratory (NRL)

With the recommendation of the National Technical Committee on AMR containment program and the Director General of Health Services (DGHS) IEDCR has been selected as the AMR surveillance Reference laboratory in 2020. It conducts supportive supervision of the sentinel sites. It provides logistics and equipment support to the sentinel sites. The reference laboratory prepares laboratory Standard Operating Procedure (SOP) and arrange hands on training of laboratory personnel on SOP as well as ensure its implementation. At present the 3rd version of SOP is ready for release. It also provides reference strain for internal quality control to the sites. Perform confirmatory testing for the characterization of AMR that cannot be performed at surveillance sites. It participates in different national and international research activities and gives support to

young researchers. Serve as the physical repository for microbial isolates. All the identified bacterial isolates from the sites are sent to the reference laboratory repository where it is preserved for retesting and further research. It collates and analyzes AMR data from respective sites and shares them with Sectoral and National coordination center as well as other stakeholders.

Quality control

The central surveillance team monitors and supervision the sentinel sites to assess their activities and do monthly online meetings with the laboratory personnel. To improve the capacity of the sentinel sites, NRL conduct Training for Doctors, nurses, microbiologists, medical technologists and project facilitators. The microbiologists and medical technologists provided hands on training and refresher training who are working at the sentinel sites.

All the laboratory activities at the sentinel sites are performed followed by SOPs. The SOPs provided by NRL at IEDCR. These SOPs are prepared by NRL with the support from renowned microbiologists of the country following the guidance of CLSI and other reference documents.

NRL participates in different international External Quality assurance program like CAP (College of American Pathologist), WHO collaborative center in Thailand. Recently it participated in six consecutive EQA programs organized by Fleming Fund Regional grant, EQAsia.

Bacterial isolates from the sentinel sites are regularly sent to the central repository at NRL, IEDCR. Quarterly, 5-10% of isolates are retested at NRL, and conduct root cause analysis discussed with the sites. Sentinel sites performing internal quality control. NRL also supports the sentinel laboratories to improve quality management systems. NRL also supports the sentinel site laboratory in participating in the EQA program. NRL is working to establish EQA service among all sentinel sites.

Data management

In case-based surveillance project facilitator takes patients epidemiological as well as laboratory data in prescribed format in both hard copy as well as in soft copy in tab. This data also includes clinical symptoms, comorbidity, antibiotic history data. The data is uploaded in software prepared by the IEDCR IT team. This data is readily visible to the central data management team as well as the AMR dashboard on the IEDCR website accessible to all. It helps a clinician to choose the right antibiotic when empirical antibiotic treatment is given to the patient.

At dashboard data can be filtered for site, specimen, or organism or to check their susceptibility pattern both overall and according to different case-based surveillance sites.

Data completeness and regular data upload are monitored centrally. In case of Lab based surveillance only the laboratory-based data from the respective laboratory is collected from them regularly and made visible for the public through the software. For yearly analysis this data is downloaded and analyzed using WHONET software. Recently from 2022 lab-based surveillance is included where only lab data is included from renowned and specialized govt. & private laboratories. These Laboratories are assessed before including in lab-based surveillance to provide their laboratory data for the dashboard. Till now we have 21 private laboratory data. Unlike case base surveillance data cannot be filtered site wise, in lab base surveillance.

Beside that to achieve one health true approach the AMR dashboard is recently updated with AMR data from animal health sectors. Data from different animal health laboratories shows the resistance in poultry, cattle, and other species.

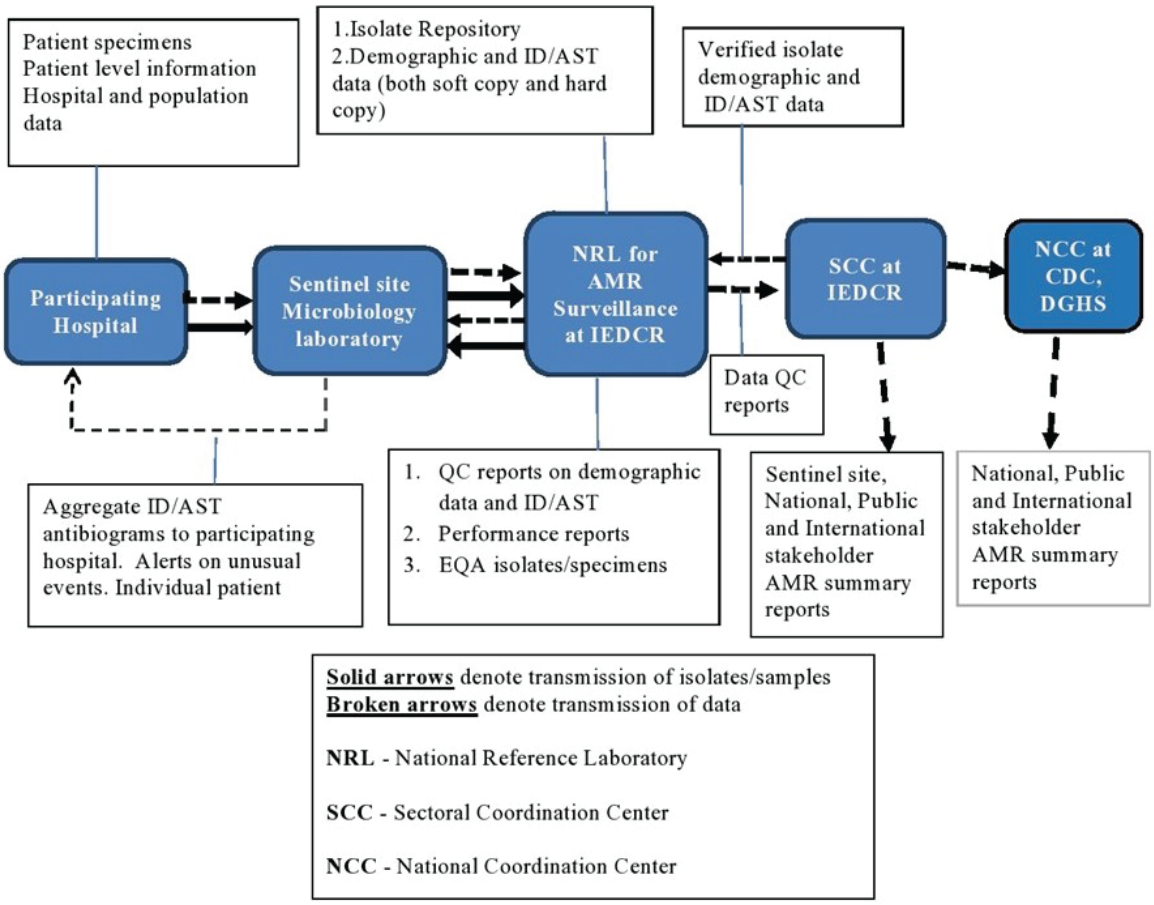


Figure 02: Diagram of antimicrobial susceptibility testing data sharing and isolate/sample transfer in antimicrobial surveillance system

Web based activities including data visualization in the official IEDCR website

IEDCR has a designated online Dashboard for visualization of the AMR related data. This is public in nature, and anyone can view it. Sentinel site-specific or organism-specific data is also available and has been updated regularly.

The dashboard link is- https://dashboard.iedcr.gov.bd/amr/

AMR Surveillance in Private Laboratories (Lab-based surveillance)

National AMR Surveillance is initiated as a case-based surveillance and includes mainly the public medical colleges and Institute. At present, the majority of microbiological laboratory data is generated from private laboratories of Bangladesh and the performance and standard of many of them are up to the mark and some of them are even accredited.

So, with the support of Fleming fund country grant in Bangladesh IEDCR took initiative to include the private laboratories in the surveillance system. CDC DGHS also supported the initiative. Two consecutive meetings in Dhaka and Chattogram division was conducted with the stakeholders of different private laboratories in 2022 where they were informed regarding the issue and their queries, suggestions and apprehensions were addressed. This was followed by successive laboratory assessment visits. Consequently, the quality laboratories were identified and were

included in the National surveillance system. These laboratories were included in Lab based surveillance – another type of surveillance mentioned in the WHO GLASS platform where mainly laboratory data is taken to know the existing susceptibility pattern of organisms isolated from various kinds of samples. The process of inclusion of new laboratories in the system is ongoing. At present A total 21 branches of 5 labs are included in this surveillance and evaluation process of others is ongoing. Here only laboratory data is provided from this designated laboratory. Through this surveillance system private laboratories are brought into national platform and improve their laboratory through the technical support from NRL at IEDCR.

Introduction of surveillance sites

Table 1: Hospitals of Case-based AMR Surveillance

Sl. No	Name	Established	Total Bed	ICU Bed Number	Other Special Units
1	Dhaka Medical College and Hospital (DMCH)	1946	2300	115	SCANU CCU Burn Unit
2	Uttara Adhunik Medical College and Hospital (UAMCH)	2007	250	17	CCU
3	Mymensingh Medical College and Hospital (MMCH)	1962	1000	10	SCANU CCU
4	Rajshahi Medical College and Hospital (RMCH)	1958	1200	30	Burn Unit
5	Rangpur Medical College and Hospital (RpMCH)	1970	1000	10	Burn Unit
6	Bangladesh Institute of Tropical and Infectious Diseases (BITID)	2013	170	-	-
7	Khulna Medical College and Hospital (KMCH)	1992	500	20	SCANU CCU Burn Unit
8	Sylhet MAG Osmani Medical College and Hospital (SOMCH)	1962	900	30	Burn Unit
9	Cox's Bazar Medical College and Hospital (CoxMCH)	2008	250	08	Burn Unit
10	Sher-e-Bangla Medical College and Hospital, Barisal (SBMCH)	1968	1000	10	
11	Chittagong Medical College and Hospital (CMCH)	1957	2200	25	SCANU CCU Burn Unit

Mymensingh Medical College and Hospital (MMCH)

AMR surveillance team of MMCH

Mymensingh Medical College was established in 1962 to run a 5-years MBBS course under the affiliation of Dhaka University. The college has a 1000 bedded hospital. Moreover, it has a 10 bedded intensive care unit (ICU), Sheikh Rasel SCANU-50 beds, CCU-50 beds. SK Hospital is the infectious disease hospital which has 60 beds (Infectious-40, TB-10, Kala-Azar-10) and attached to this hospital. MMCH has an active IPC and Stewardship committee for effective infection prevention & control and for antimicrobial stewardship respectively. The college runs post-graduation courses like M.Phil (Microbiology)/ MD (Microbiology). Several research works are currently ongoing in the departments. Training like BCPs and training of medical technologist are regularly performed here. The Microbiology laboratory has a modern infrastructure where culture and sensitivity tests are done regularly. It performs approximately 300 cultures & sensitivity of different pathological samples/week. The culture sensitivity testing is done by automated method for blood sample and conventional method for other samples. It has got a BSL 2 laboratory establishment and has got molecular testing capacity.

The laboratory has done 22,0751 COVID tests from 1st April 2020 to 19th September 2022. The Microbiology laboratory has been included in the National AMR surveillance system since 2017 as a sentinel site for AMR hospital based/lab-based data.

Rajshahi Medical College and Hospital (RMCH)

AMR surveillance team of RMCH

Rajshahi Medical College was established in 1958 to run a five-year MBBS course under the affiliation of Rajshahi Medical University. The college has a 1200 bedded hospital. It has a 30 bedded intensive care unit (ICU) and 25 bedded burn unit too. The average bed occupancy is >1200/day (as per last year's hospital data). The college runs post-graduation course on Microbiology (M.Phil.). The microbiology laboratory currently performs approximately 220 culture and sensitivity test of different samples. The culture sensitivity testing is done by both conventional methods and automated methods. It has an BSL 2 laboratory establishment and has molecular testing capacity. The laboratory has done 1,61,226 COVID tests during 2020-2022. The microbiology laboratory has been included in the National AMR surveillance system since 2017 as a sentinel site for AMR hospital-based data.

Rangpur Medical College and Hospital

AMR surveillance team of RpMCH

Rangpur Medical College was established in 1970 to run a five-year MBBS course under the affiliation of Rajshahi Medical University. The college has a 1000 bedded hospital. It has a 10 bedded intensive care unit (ICU) and a 40 bedded burn unit too. The total number of admitted patients in IPD last year was 1,73375 and 2000/day patients are treated in the different OPDs. The microbiology laboratory currently performs approximately 120 cultures of different pathological samples/week; among these 25 blood cultures, 70 urine, and 25 other samples are tested for culture sensitivity. The culture sensitivity testing is done by conventional methods and automated methods. It has a BSL 2 laboratory establishment and has molecular testing capacity.

The laboratory has done 9, 86, 90 COVID tests during 2020-2022. The microbiology laboratory has been included in the National AMR surveillance system since 2017 as a sentinel site for AMR hospital-based/lab-based data.

Bangladesh Institute of Tropical and Infectious Diseases (BITID)

AMR surveillance team of BITID

Bangladesh Institute of Tropical and Infectious Diseases (BITID) in Chattogram was established in 2013 with the objective of creating a multidisciplinary center of excellence for academia, collaborative research, clinical services and capacity development. The Institute has a 170 bedded hospital with an intensive care unit of 05 beds. The average bed occupancy is 2.56/day (as per last year's hospital data). The Institute has an actively functioning IPC committee and a Biosafety and Biosecurity committee. BITID also has a proper Waste management system. The institute runs post-graduation courses on MD Infectious Diseases and Tropical Medicine. The microbiology laboratory currently performs approximately 40 cultures of different pathological samples/week. The culture sensitivity testing is done by both conventional method and automated method. It has got a BSL 2+ and BSL 3 laboratory establishment and has got molecular testing capacity.

The laboratory has done 3, 08, 634 COVID tests during 2020-2022. The microbiology laboratory has been included in the National AMR surveillance system since 2017 as a sentinel site for AMR hospital-based data.

Uttara Adhunik Medical College and Hospital (UAMCH)

AMR surveillance team of UAMCH

Uttara Adhunik Medical College, Dhaka was established in 2007 to run a five-year MBBS course under the affiliation of Dhaka University. The college has a 250-bedded hospital which has a 17-bedded intensive care unit (ICU). The average bed occupancy is 54.68/day (as per last year's hospital data). The Hospital active Infection prevention and control program and a waste management system. The Microbiology Department is taking the initiative to form an antimicrobial stewardship committee at UAMCH. The microbiology laboratory is a BSL 2 laboratory having molecular testing capacity. It performs approximately 455 culture and sensitivity testing of different pathological samples/week. The culture sensitivity testing is done by conventional method, as well as automated method.

The laboratory has done 3630 COVID-19 Antigen tests during 2020-2022.

The microbiology laboratory has been included in the National AMR surveillance system since 2017 as a sentinel site for AMR hospital-based data.

Dhaka Medical College and Hospital (DMCH)

Dhaka Medical College and Hospital (DMCH)

AMR surveillance team of DMCH

Dhaka Medical College was established in 1946 to run a five-year MBBS course under the affiliation of Dhaka University. The college has a 2300-bedded hospital which has a 115-bed intensive care unit (ICU) and 300-bed burn unit too. The average bed occupancy is 121.34/day (as per last year's hospital data. The college runs post-graduation (M. Phil) course on Microbiology since 2001. In next year (2024) it will be an MD course on Microbiology. This College Hospital has an actively functioning IPC Committee led by Director of the hospital. Which has successfully reduced wound infection rate from over 40% to around 10% or even less in some wards over the last 2 years. The microbiology laboratory currently performs culture sensitivity tests. It performs approximately 600 cultures of different pathological samples/week. The culture sensitivity testing is done by conventional method as well as automated method. It has got a BSL-2 laboratory establishment and has got molecular testing capacity. The Microbiology laboratory of Dhaka Medical College follows the standard procedure for laboratory waste management.

The laboratory has done 85659 COVID tests during 2020-2022. The microbiology laboratory has been included in the National AMR surveillance system since July 2018 as a sentinel site for AMR hospital-based data.

Sylhet MAG Osmani Medical College and Hospital (SOMCH)

AMR surveillance team of SOMCH

Sylhet MAG Osmani Medical College was established in 1962 to run a five-year MBBS course under the affiliation of Sylhet Medical University, Sylhet. The college has a 900-bedded hospital which has 30-bed intensive care units (ICU) and a 16-bed burn unit too. The college runs post-graduation courses on M. Phil (Microbiology). The microbiology laboratory currently performs culture sensitivity tests. It performs approximately 100 cultures of different pathological samples/week. The culture sensitivity testing is done by conventional method and automated method. It has a BSL 2 laboratory establishment and has molecular testing capacity.

The laboratory has done 1, 56, 323 COVID tests during 2020-2022. The microbiology laboratory has been included in the National AMR surveillance system since August/2018 as a sentinel site for AMR hospital-based data. An active IPC committee is present consisting of both clinicians and microbiologists.

Khulna Medical College and Hospital (KMCH)

AMR surveillance team of KMCH

Khulna Medical College was established in 1992 to run a five-year MBBS course under the affiliation of Rajshahi University. Since 2021 it is under Sheikh Hasina Medical University, Khulna. The college has a 500 bedded hospital which has a 20 bedded intensive care unit (ICU) and 37 bedded burn unit and 44 bedded SCANNU too. The average bed occupancy is 1500/day (as per last month's hospital data). The laboratory is working with the antimicrobial stewardship committee. The microbiology laboratory currently performs culture sensitivity tests for urine, stool, blood, pus, wound swab, and endotracheal aspirate (ETA) samples. It performs approximately 50-60 cultures of different pathological samples/week. The culture sensitivity testing is done by conventional method and automated method. It has got a BSL 2 laboratory establishment and has got molecular testing capacity.

The laboratory has done 2, 07,911 COVID tests during 2020-2022. The microbiology laboratory has been included in the National AMR surveillance system since 2018 as a sentinel site for AMR hospital-based data.

Cox's Bazar Medical College and Hospital (CoxMCH)

AMR surveillance team of CoxMCH

Cox’s Bazar Medical College was established in 2008 to run a five-year MBBS course under the affiliation of Chittagong University. The college is attached with a 250 bedded Cox’s Bazar Sadar hospital which has an 8 bedded intensive care unit (ICU) and 12 bedded HDU. The average bed occupancy is 250/day (as per last year's hospital data). Cox’s Bazar Medical College has an active IPC committee presided by hospital superintendent with 26 members which was updated in 2023. The waste management system is also very organized which is coordinated and supervised by the College Principal and HOD, Microbiology. The microbiology laboratory currently performs culture sensitivity tests for urine, stool, blood, wound swab. It performs approximately 25 cultures of different pathological samples/week. The culture sensitivity testing is done by conventional methods. It has got a BSL 2 laboratory establishment and has got molecular testing capacity.

The laboratory has done 3, 58, 148 COVID tests during 2020-2022.

Sher-e-Bangla Medical College and Hospital, Barisal (SBMCH)

AMR surveillance team of SBMCH

Sher-e-Bangla Medical College was established in 1968 to run a five-year MBBS course under the affiliation of Dhaka University. The college has a 1000 bedded hospital which has a 10 bedded intensive care unit (ICU) and 30 bedded burn unit too. The average bed occupancy is 570 /day (as per last year's hospital data). The microbiology laboratory currently performs culture sensitivity tests for approximately 100 Cultures of different pathological samples/week. The culture sensitivity testing is done by conventional method/ automated method. It has a BSL 2 laboratory establishment and has molecular testing capacity.

The laboratory has done 124423 COVID tests during 2020-2022.

Chittagong Medical College and Hospital (CMCH)

AMR surveillance team of CMCH

Chittagong Medical College was established in 1957 to run a five-year MBBS course under the affiliation of University of Chittagong. Now it is affiliated under Chittagong Medical University, Chattogram. The college has a 2200 bedded hospital known as Chittagong Medical College Hospital which has 50 bedded intensive care unit (ICU) which consists of 25 bedded general ICU, 10 bedded PICU, 15 bedded cardiac ICU; 50 bedded burn unit too. The average bed occupancy is 3000+/day. The Institute has an actively functioning IPC committee and a Biosafety and Biosecurity committee. The College runs post-graduation courses (M. Phil and FCPS) on Microbiology. The Microbiology laboratory currently performs culture sensitivity tests. It performs approximately 130 cultures of different pathological samples/week. The culture sensitivity testing is done by conventional method as well as automated method. It has got a BSL-2 laboratory establishment and has got molecular testing capacity.

The laboratory has done 200,000 (two lacs) RT-PCR tests for COVID-19 during 2020-2O22. The Microbiology laboratory has been included in the National AMR surveillance system of Bangladesh since 12/12/2022 as a sentinel site for AMR hospital-based data.

Laboratories of Lab-based AMR Surveillance

Popular Diagnostic Centre Ltd.

Founded in 1983, Popular group started with high tech diagnostic facilities. The microbiology department of Popular diagnostic center is composed of fully automated Vitech instruments for identification and sensitivity of bacterial pathogens and operated by qualified laboratory personal. As diagnostic center of high professional precision, Popular aim is to serve both hospital inpatients and referrals from the learned private practitioners to get their clinical and other available screenings with utmost care and dedication. At present 13 branches of this diagnostic center are contributing data in National Surveillance system from all over the country since 7 July 2022.

Epic Health Care Ltd.

Epic Health Care is the 1st and only ISO 15189 accredited laboratory in Chattogram, crossing a journey of 9 years from 2015. 1st lab in Chattogram since 2017, Epic Health Care regularly participates in the External Quality Assurance Program with Bio-rad USA and Randox-UK to ensure quality standards comparable to the advanced laboratories in the world. As per academic curriculum, students of Chittagong University, USTC and many other universities are given the special opportunity for hands on medical laboratory education and training at Epic Health Care. The laboratory is contributing data to National AMR Surveillance System since 11 October 2022.

Square Hospitals Ltd.

Square Hospitals Limited, Dhaka is a 500 bedded tertiary care hospital and the leading contributor of private healthcare services in Bangladesh since its inception on 16th December 2006. The Microbiology laboratory of the hospital currently performs about 200 tests per day. This includes. Routine culture sensitivity tests using automated and manual identification system: urine, stool, blood, sputum, pus, wound swab, plural fluid, cerebrospinal fluid, ascitic fluid etc. Fungus: Culture and sensitivity; *Mycobacterium tuberculosis/NTM* (Non-Tubercular *Mycobacterium*) Culture and sensitivity; Anaerobic culture. This laboratory is included in the National AMR surveillance system since as a sentinel site for AMR hospital based/lab-based data of 5 branches since 12 March 2023.

The Ibn Sina Trust

The Ibn Sina Trust started its journey in June 1980 with a noble vision: “To serve the humanity.” The trust has agreed to provide healthcare services to the people of Bangladesh at affordable cost.

Besides, the Ibn Sina Trust is more famous in the sector of diagnosis and investigation. The laboratory reports of Ibn Sina Diagnostic centers are well accepted in Singapore General Hospital, Mount Elizabeth Hospital Singapore, Bumrungrad International Hospital Thailand, and other reputed hospitals in Asia. It has been contributing to National AMR surveillance system since 9 February 2023.

National Institute of Neurosciences and Hospital (NINS)

This 450 Bedded National Institute of Neurosciences and Hospital, Dhaka is a Government Organization which started its journey from September 2012. It is the only referral neuroscience hospital in Bangladesh having department of Neurology, Neurosurgery, Paediatric Neurology, Paediatric Neurosurgery, Neurophysiology, Neuro intervention, Neuro rehabilitation, Neuro radiology, Neuropathology, Transfusion Medicine, Critical Care Medicine & so others. It has 100 bedded comprehensive stroke unit. The institute achieved best performance Health Minister Award 2017, 2018, 2019 and 2020 for its outstanding contribution in National Health Service. The microbiology laboratory of the hospital performs the culture sensitivity of CSF, blood, urine and other specimens. Furthermore, it performs the culture sensitivity testing of tracheal aspirate, bone tissue, shunt tube, CV-line catheter tip and so on. This is a Biosafety Level II lab. Everyday more than 25 specimens are processing for culture sensitivity testing which are mostly CSF and urine. The institute has been included in National AMR Surveillance since 17 August 2022

Role of development partners in AMR containment of Bangladesh

The Centers for Disease Control and Prevention, Atlanta, USA (US-CDC)

Through the Cooperative Agreement with GHSA Action Packages (2016-2020) supported by US-CDC, The AMR surveillance in Bangladesh started in 2016. Site selection, SOP development, procurement of logistics and equipment, human resources and all other technical support was provided by this Co- agreement. The project was extended till September 2021 as NOC (No Cost Extension). US-CDC continued supporting National AMR surveillance through SafetyNet including human resources and some other activities.

World Health Organization (WHO)

WHO Bangladesh has been supporting implementing a comprehensive strategy to prevent, detect, and respond to AMR. Outputs include strengthening surveillance, updating guidance documents, enhancing national policy, and monitoring antimicrobial consumption. National AMR Technical Group meetings and guidelines development are part of governance strengthening.

WHO has been supporting National AMR Surveillance system of Bangladesh to:

- Improve and standardize AMR surveillance systems.
- Periodic dissemination of surveillance data at national and subnational levels.
- Develop antibiograms for local and national levels.
- Establish sentinel sites as models for comprehensive AMR containment.

As part of containment efforts, the World Health Organization (WHO) extends its assistance to CDC, DGHS and DGDA in their initiatives to address antimicrobial resistance (AMR). In this context, updated guidance documents and informational resources are accessible for clinicians, laboratories, drug vendors, consumers, as well as animal and agricultural farmers, aiding in the prevention and management of AMR. The strengthening of national policies and governance related to antimicrobial resistance is prioritized, including advocacy for more effective strategies in containing AMR. Additionally, WHO supports activities aimed at enhancing the country's capacity to monitor antimicrobial consumption.

Fleming Fund Country Grant to Bangladesh (FFCGB)

FFCGB along with the consortium partners has been working on establishing AMR surveillance systems in the human, livestock, and fisheries sectors in Bangladesh. It is also focusing on strengthening surveillance of antimicrobial consumption.

FFCGB provided technical support to develop the first national One Health AMR surveillance strategy entitled "The National Antimicrobial Resistance Surveillance Strategy of Bangladesh 2020-2025". For capacity building, out of the twelve laboratories selected for AMR surveillance (six from human health, five from animal health and one from Aquaculture sectors) FFCGB has refurbished two national reference laboratories of animal health and eight sentinel site laboratories (five from human health and three from animal health sectors) to upgrade the standards equivalent to BSL 2 and provided essential modern equipment, furniture and reagents to all the twelve laboratories.

It has also facilitated building of AMR Data management System with One Health Approach. FFCGB has been supporting the laboratory-based AMR surveillance conducted by IEDCR. It has conducted two rounds of Point Prevalence Survey (PPS) in selected hospitals to find out the prevailing picture of antimicrobial use in large hospitals of Bangladesh. FFCGB has initiated and has been supporting the preparation and publication of Quarterly AMR Newsletter.

USAID MTaPS Contribution to Antimicrobial Resistance Containment (ARC) in Bangladesh

USAID MTaPS Bangladesh has been providing technical assistance to the Government of Bangladesh to improve the Antimicrobial Resistance (AMR) Containment (ARC) by strengthening international Health Regulation (IHR) capacity of stakeholders and institutions on AMR. MTaPS areas of focus are effective Multisectoral Coordination (MSC), Infection Prevention and Control (IPC), and optimizing Antimicrobial Stewardship (AMS) to help the country progress to the next higher Joint External Evaluation (JEE) capacity level. MTaPS has so far supported the government and stakeholders to complete 20 out of the 62 (32%) global benchmark actions required to attain sustainable capacity level in the MSC, IPC, and AMS components of the AMR technical area under the global health security agenda.

Results

Results

Case-based surveillance

This surveillance system gathers comprehensive patient information in addition to laboratory data.

Since 2017 to June 2023 the surveillance has accumulated data from 34,340 patients attending the indoor and outdoor. Among them 51% were indoor and 49% were outdoor (OPD patients). A total of 12% of indoor patients were from ICU. Within the indoor patient category, the surgery unit contributed the highest proportion (30%), while a minor percentage (4%) originated from the burn unit, demonstrating a notable resistance profile.

There is no significant difference in male and female patients. The highest number of patients were from the 20-30 age group. Urine samples were the topmost (47%) among other while endotracheal aspirate sample was the lowest (4%). Culture produced a total (25%) of growth among which wound swab was the highest (57%) and stool sample produced lowest (9%) positive result. It should be mentioned that in stool sample growth of *E. coli* is ignored as the pathogenic strain could not be confirmed. *E. coli* was the highest (31%) isolated bacteria followed by *P. aeruginosa* (19%) and *K. pneumoniae* (15%). E. coli is the highest isolated organism in urine (61%) while *K. pneumoniae* was the highest in endotracheal aspirate (32%) and sputum (48%). In case of wound swab, the most isolated pathogen was *Pseudomonas aeruginosa* (38%). In the case of blood sample *Salmonella spp*. was most isolated (43%) and in stool sample *V. cholerae* was the highest (65%) isolated bacteria. In most of the antibiotic significant difference of susceptibility was found among OPD, ward and ICU patients irrespective of specimen. Antibiotic susceptibility was found lowest is ICU followed by ward and OPD. In case of blood and urine sample also this type of susceptibility pattern was evident.

In yearly trend, most of the antibiotic showed gradual decreased susceptibility. However, most of these have no steady pattern. Although clindamycin showed increase susceptibility.

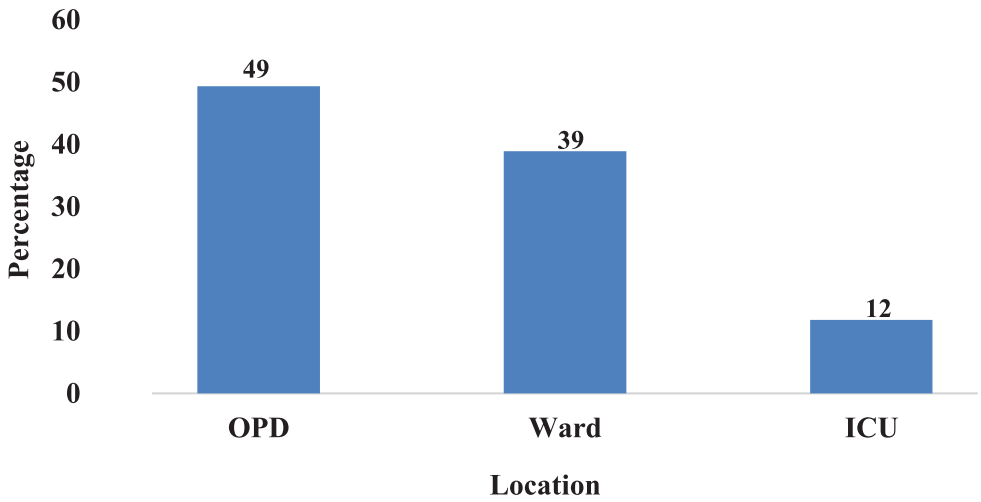


Figure 03: Distribution of patients (n=34,340)

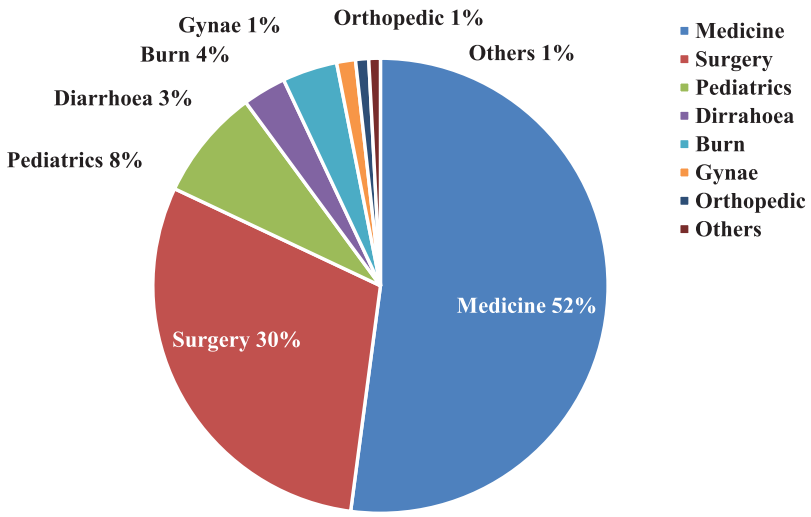


Figure 04: Distribution of Patients in Ward (n=13,453)

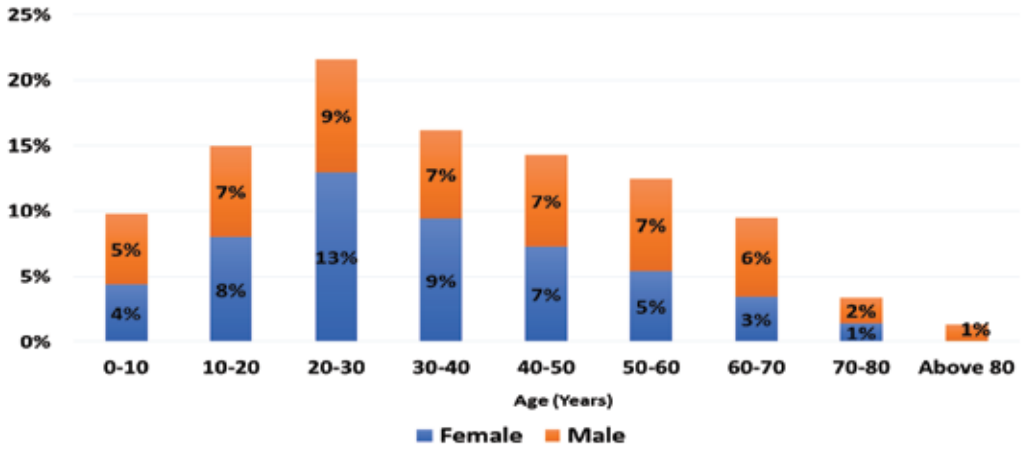


Figure 05: Distribution of patients according to age and sex (n=34,340)

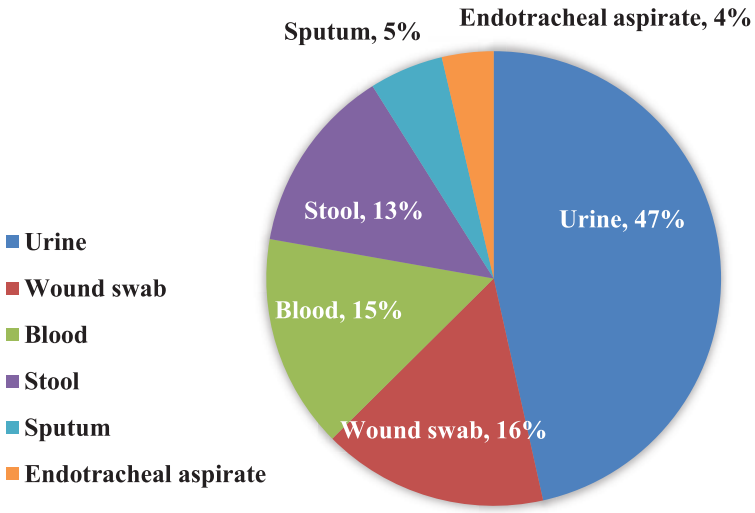


Figure 06: Distribution of Sample (n=34,340)

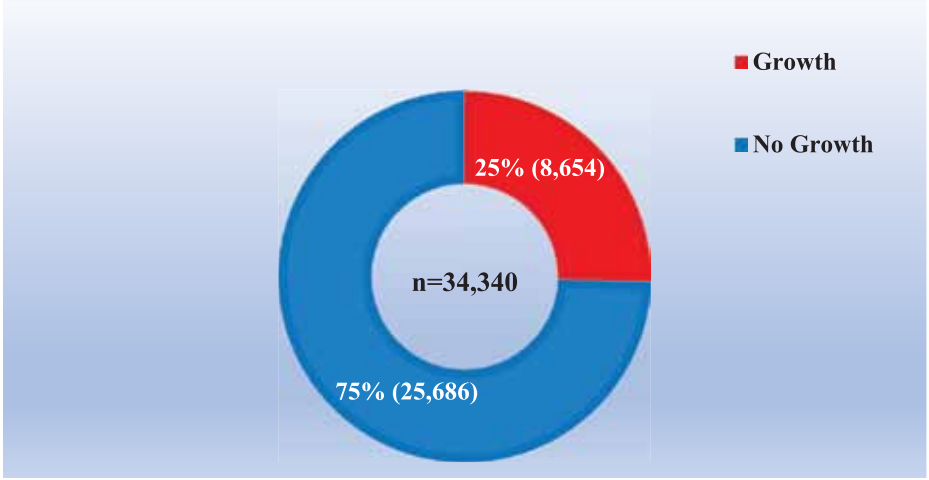


Figure 07: Distribution of yield of Culture

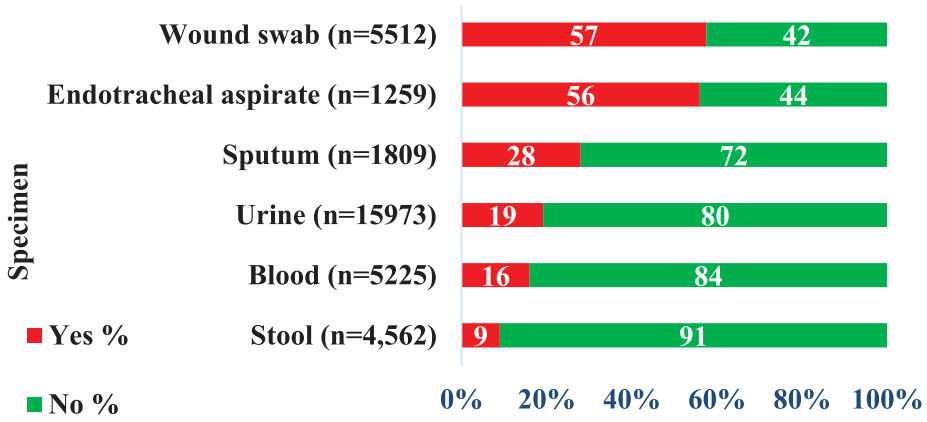


Figure 08: Distribution of growth in cultured specimens

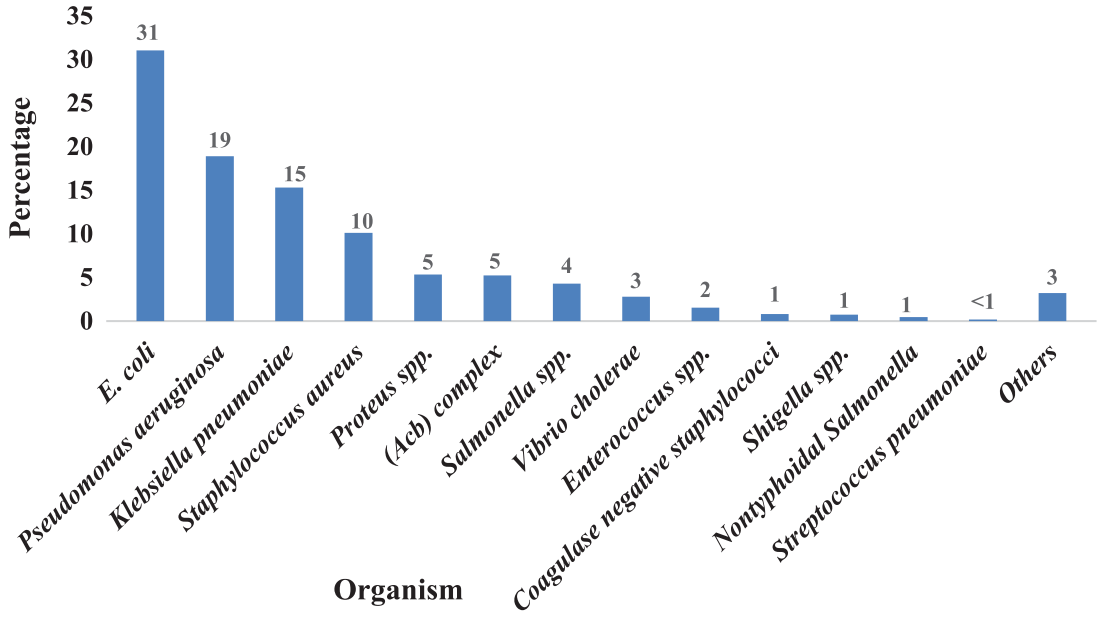


Figure 09: Distribution of bacterial growth in cultured specimen (n=8,654)

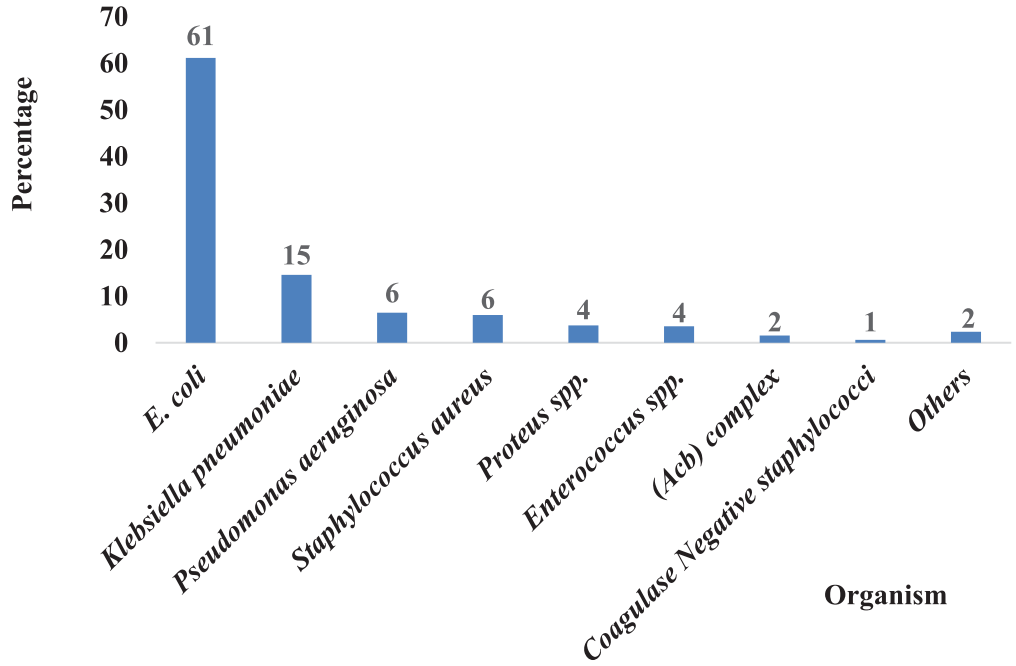


Figure 10: Distribution of bacterial growth in Urine (n=3080)

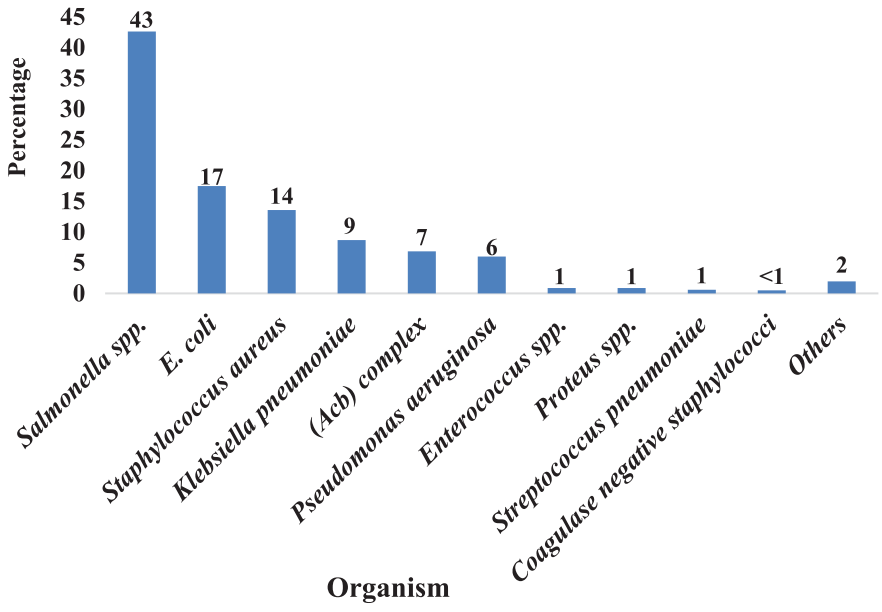


Figure 11: Distribution of bacteria in Blood (n=819)

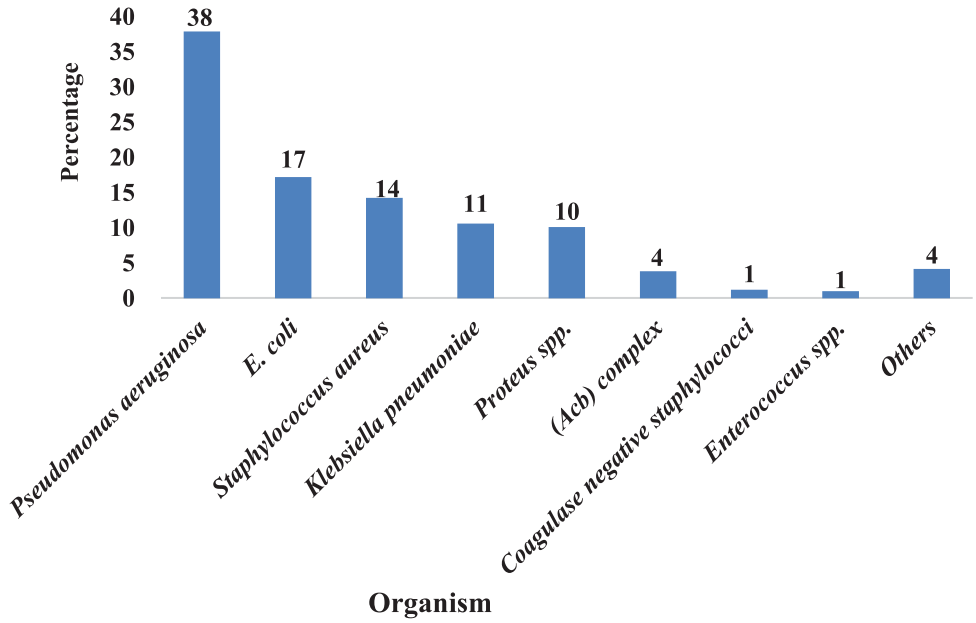


Figure 12: Distribution of bacterial growth in wound swab (n=3,153)

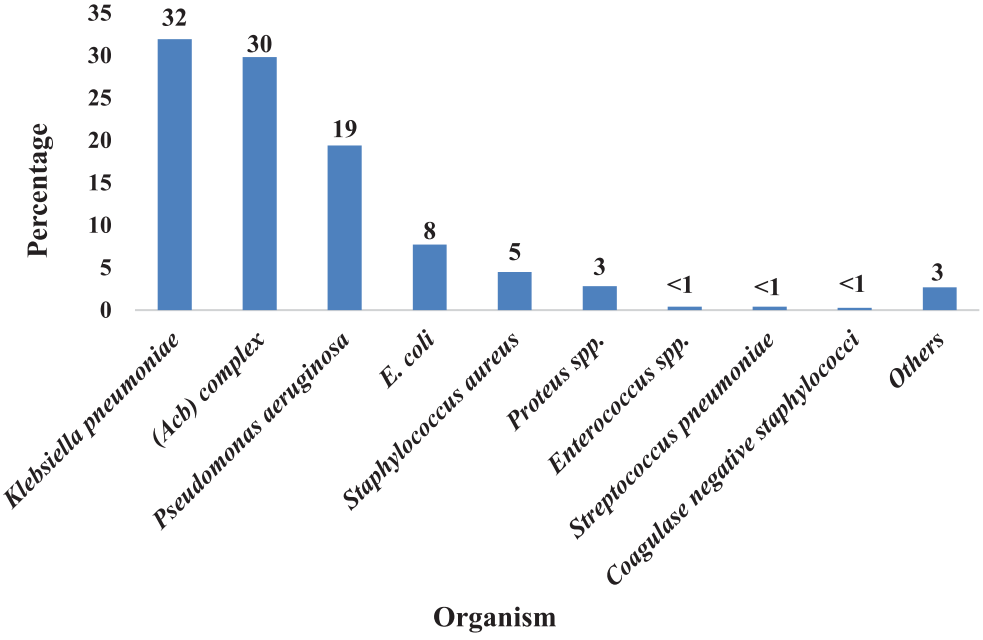


Figure 13: Distribution of bacterial growth in Endotracheal aspirate (n=711)

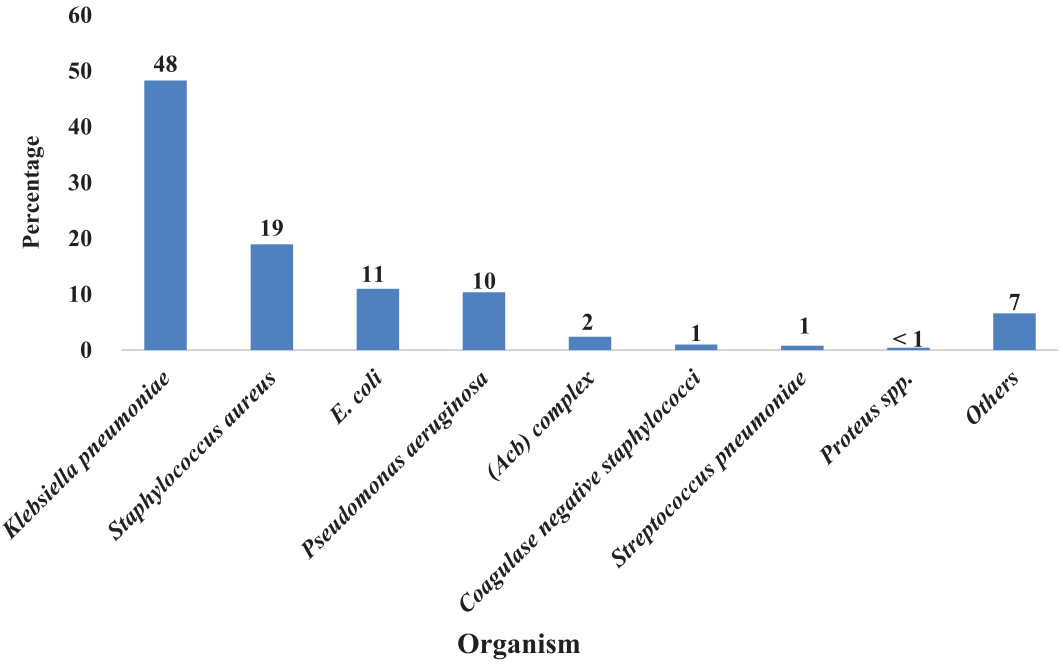


Figure 14: Distribution of bacterial growth in Sputum (n=501)

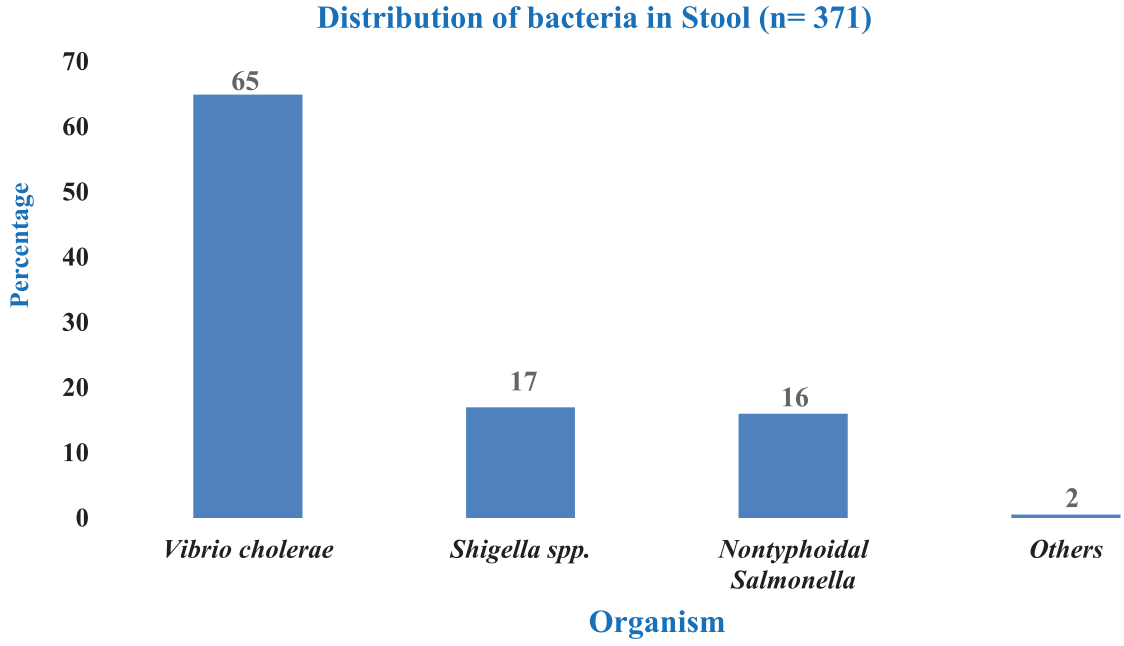


Figure 15: Distribution of bacteria in Stool (n=371)

Distribution of antibiotic Susceptibility among ICU, Ward and Outdoor patients

Table 2: Overall distribution of antibiotic susceptibility among ICU, Ward and Outdoor patients (OPD)

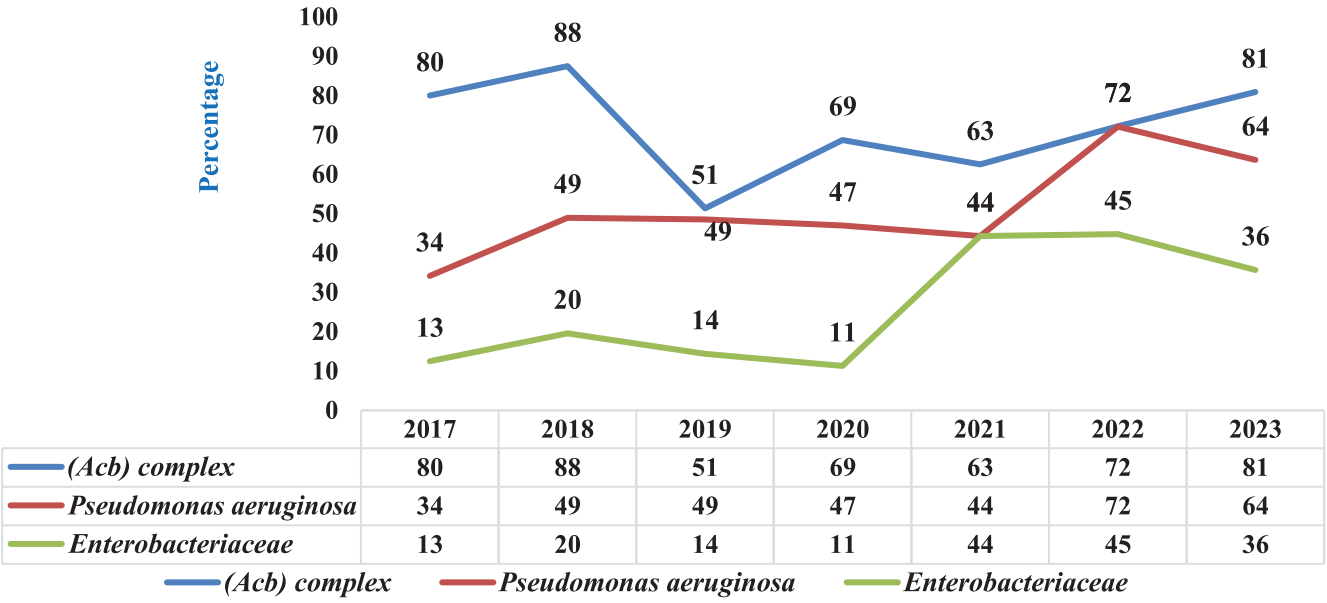
Antibiotic name	Antibiotic Susceptibility		
	ICU	Ward	OPD
	%	%	%
Penicillin G	9	33	40
Cefuroxime	8	16	33
Ceftriaxone	8	26	50
Ampicillin	9	12	16
Aztreonam	14	26	46
Ceftazidime	9	22	42
Cefepime	9	26	50
Cefixime	12	24	30
Azithromycin	12	41	23
Amoxicillin-Clavulanate	14	20	37
Ciprofloxacin	14	33	42
Piperacillin-Tazobactam	17	46	61
Clindamycin	20	43	56
Nitrofurantoin	23	58	75
Trimethoprim-sulfamethoxazole	24	33	49
Gentamicin	27	49	76
Amikacin	28	54	81
Carbapenem	30	66	84
Tetracycline	32	44	52
Ofloxacin	29	19	45
Linezolid	70	75	82

Table 3: Distribution of Blood sample antibiotic Susceptibility among ICU, Ward and Outdoor patients (OPD)

Antibiotic name	Antibiotic Susceptibility		
	ICU	Ward	OPD
	%	%	%
Amikacin	36	66	-
Amoxicillin-Clavulanate	25	58	86
Ampicillin	20	48	77
Azithromycin	19	45	87
Aztreonam	28	59	89
Ceftazidime	23	61	92
Clindamycin	30	63	71
Cefixime	13	65	85
Ciprofloxacin	24	24	8
Cefepime	26	63	90
Ceftriaxone	23	69	93
Cefuroxime	20	61	91
Carbapenem	43	89	99
Tetracycline	53	64	86
Gentamicin	37	77	98
Linezolid	77	89	-
Penicillin G	14	50	-
Piperacillin-Tazobactam	27	67	81
Trimethoprim-sulfamethoxazole	41	56	81

Table 4: Distribution of urine sample antibiotic Susceptibility among ICU, Ward & Outdoor patients (OPD)

Antibiotic name	Antibiotic Susceptibility		
	ICU	Ward	OPD
	%	%	%
Amikacin	25	80	82
Ampicillin	14	11	11
Aztreonam	-	41	42
Cefixime	-	17	23
Cefuroxime	-	22	24
Amoxicillin-Clavulanate	-	32	34
Ceftazidime	-	32	38
Ceftriaxone	-	39	45
Carbapenem	45	86	83
Trimethoprim-sulfamethoxazole	15	46	46
Cefepime	-	47	47
Tetracycline	-	48	49
Ciprofloxacin	12	48	44
Piperacillin-Tazobactam	-	61	60
Gentamicin	23	73	75
Nitrofurantoin	17	76	75
Ofloxacin	-	-	45



	2017	2018	2019	2020	2021	2022	2023
(Acb) complex	80	88	51	69	63	72	81
Pseudomonas aeruginosa	34	49	49	47	44	72	64
Enterobacteriaceae	13	20	14	11	44	45	36

Figure 16: Yearly Trend of Resistance Pattern of WHO Critical Priority Pathogens to Carbapenem

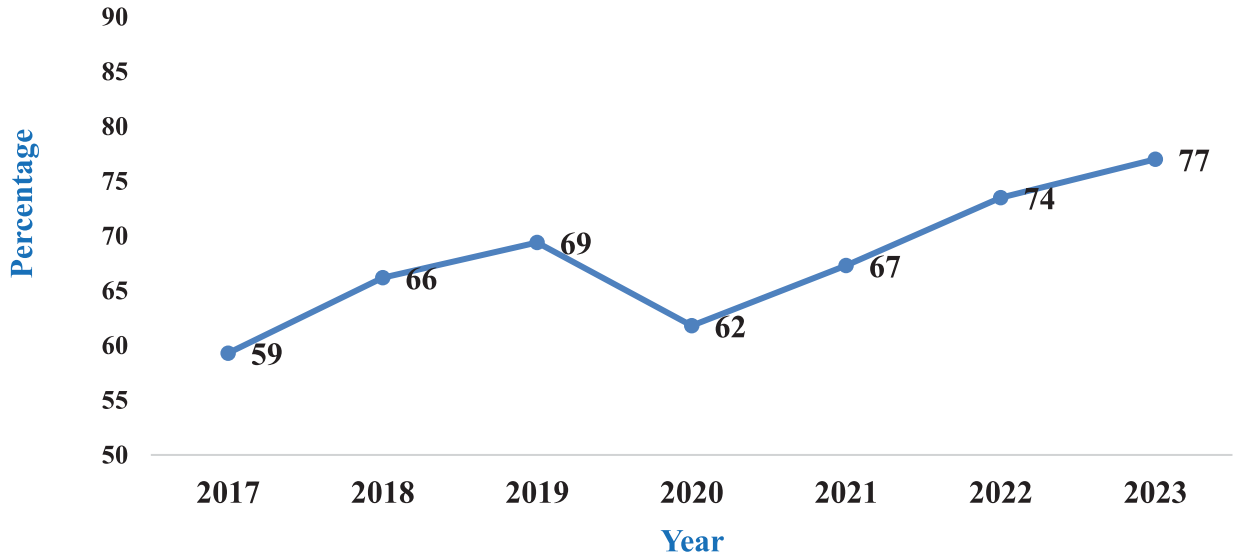


Figure 17: Yearly Trend of Resistance pattern of
WHO Critical PriorityPathogens (Enterobacteriaceae) to Ceftriaxone

Table 5: Yearly Trend of Antibiotic Susceptibility

Antibiotic name	Year						
	2017	2018	2019	2020	2021	2022	2023
Ampicillin	27%	17%	13%	17%	13%	10%	7%
Ceftazidime	38%	33%	33%	39%	25%	18%	15%
Clindamycin	39%	40%	39%	40%	55%	47%	52%
Ceftriaxone	48%	40%	36%	43%	38%	29%	20%
Cefuroxime	39%	35%	34%	32%	15%	12%	10%
Carbapenem	80%	71%	76%	78%	55%	47%	51%
Linezolid	70%	73%	74%	82%	83%	81%	88%
Norfloxacin	47%	45%	49%	62%	55%	68%	58%
Ofloxacin	43%	51%	45%	34%	32%	17%	-
Piperacillin	38%	22%	27%	33%	25%	18%	12%

Lab-based surveillance:

In lab-based surveillance only limited laboratory related data is collected from the culture positive patients from different private laboratories and one public laboratory situated in different geographical locations in the country. Here data of total 35,662 isolates from different sample is analyzed. Among them urine sample constitutes the highest (70%) sample followed by blood (10%). E. coli is the highest (27%) isolated bacteria from all the samples. It constitutes the highest number in stool (83%) and urine (55%) high vaginal swab (36%). *Salmonella spp*. is the highest (68%) isolated bacteria in blood while *S. aureus* is highest (27%) in wound swab and nipple discharge (49%) and *K. pneumoniae* from throat swab (38%) sample.

Only fungal pathogen Candida spp. isolated from different samples shows more than 90% susceptibility of Flucytosine (97%), Voriconazole (92%) and micafungin (92%).

The susceptibility of *E. coli* from urine and non-urine sample did not show much difference. Fosfomycin (for urine only), Imipenem, Meropenem showed more than 90% susceptibility. In urine sample Amikacin (92%), Imipenem (91%) and Fosfomycin (90%) were found to be the most effective antibiotic. Whereas the nitrofurantoin susceptibility is (72%). In blood sample among 3,620 isolates tested Moxifloxacin is found to be highest (94%) susceptible.

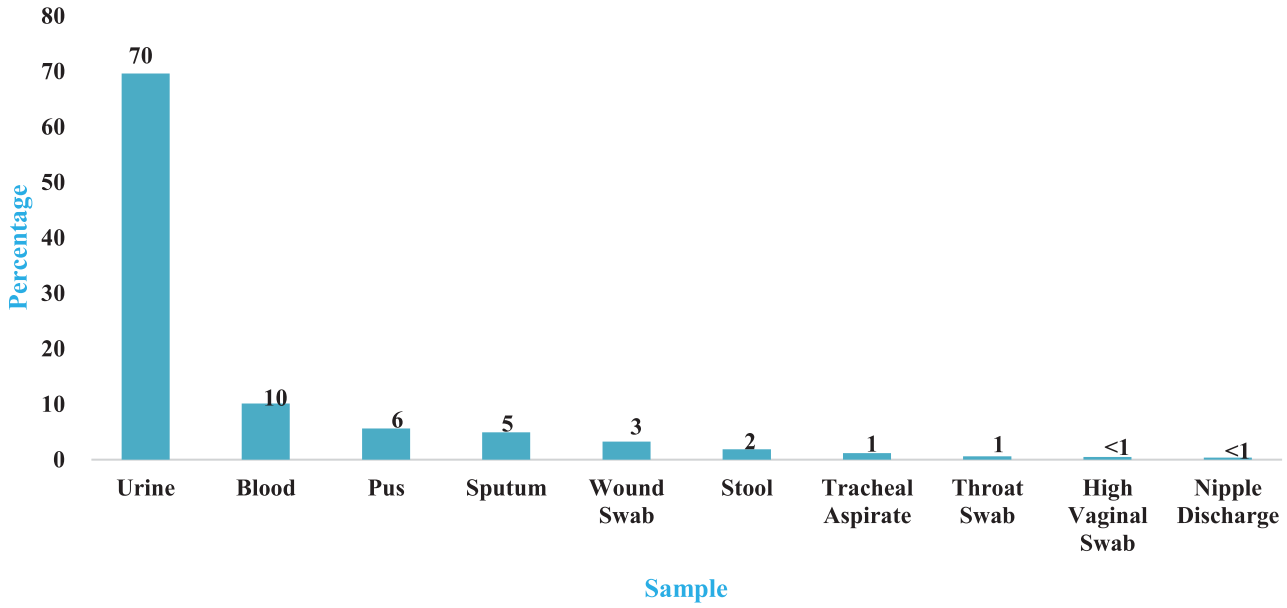


Figure 18: Most frequent positive samples (n=35,662)

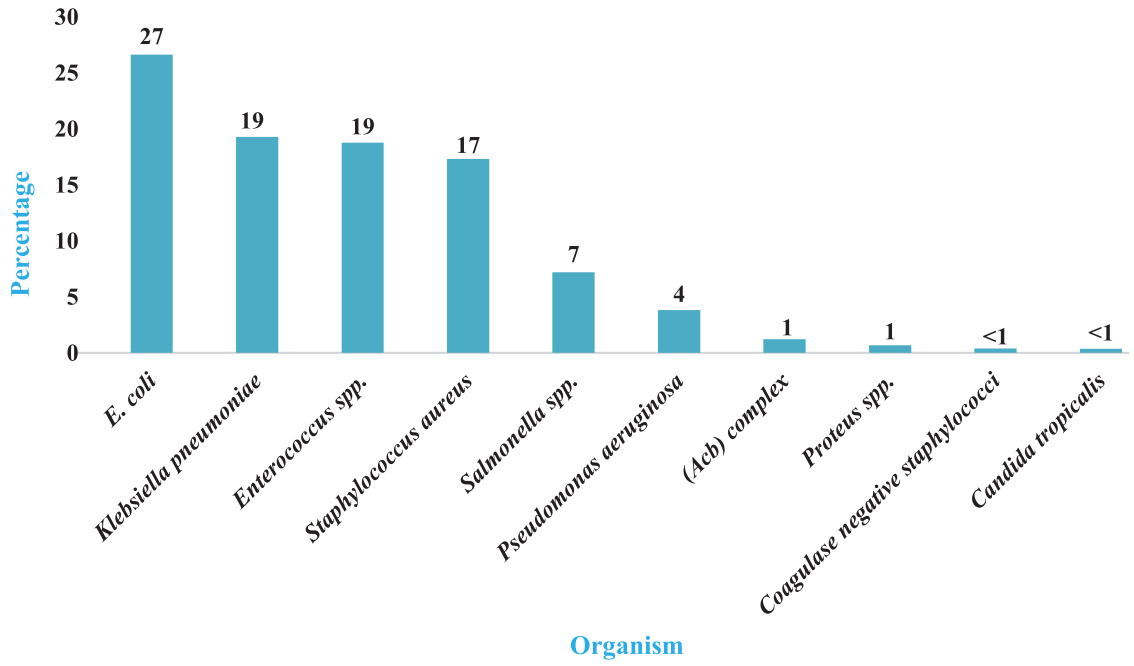


Figure 19: Most frequent isolated organism (n=35,662)

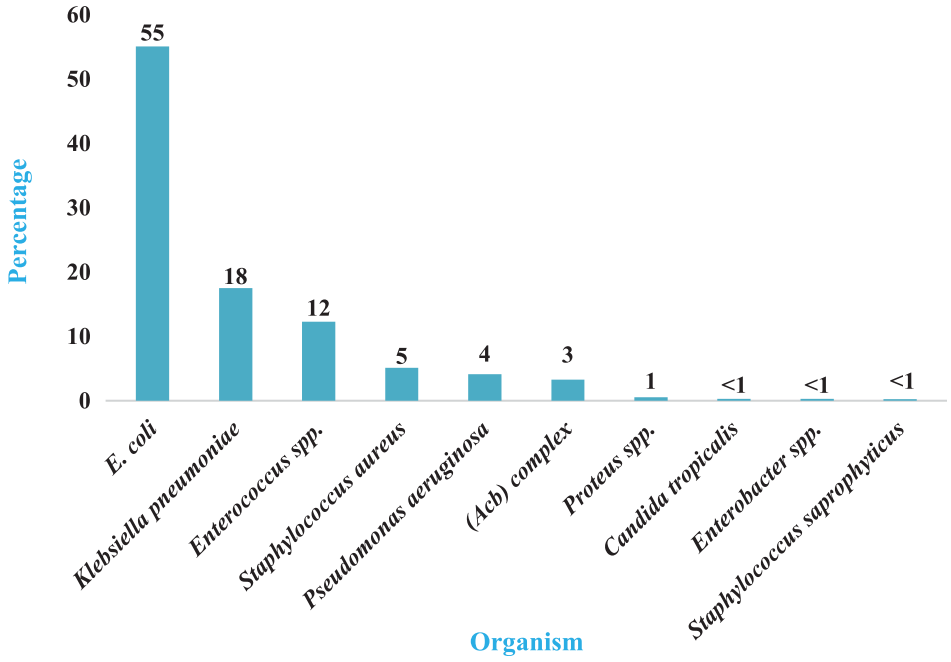


Figure 20: Ten most predominant organisms in Urine (n=24,837)

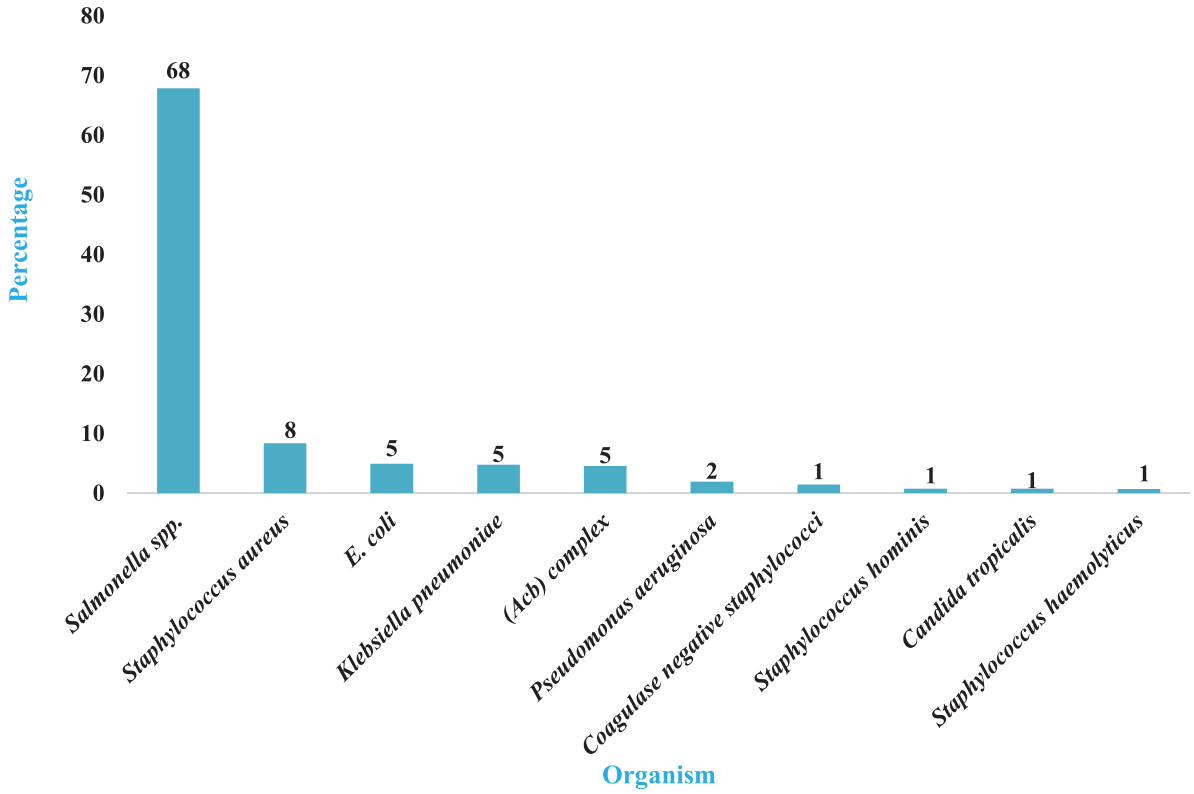


Figure 21: Ten most predominant organisms in Blood (n=3,620)

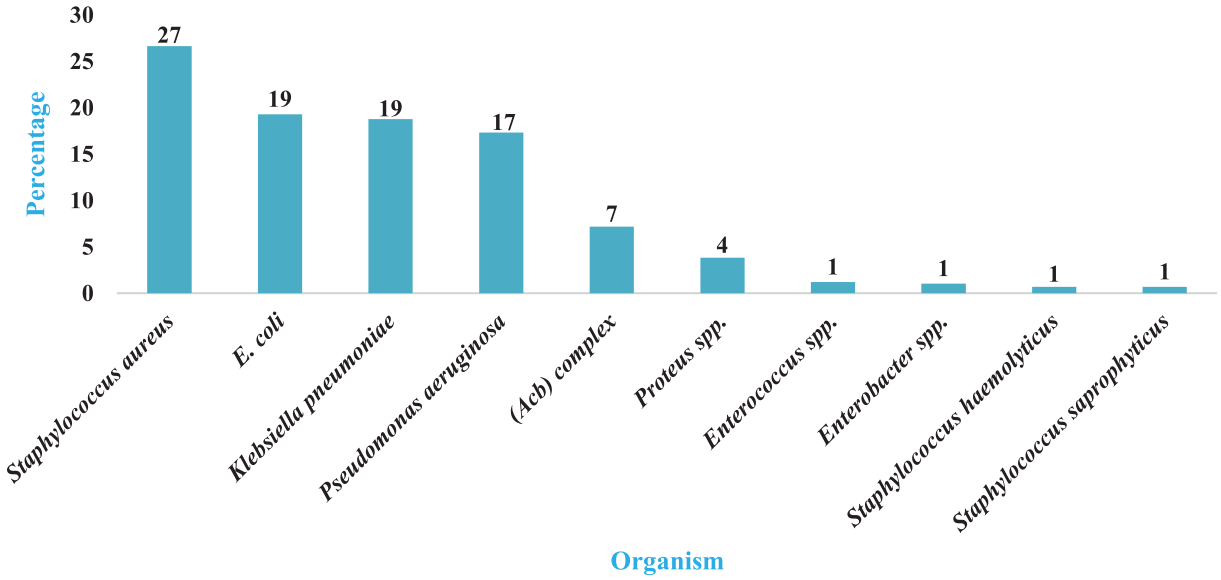


Figure 22: Ten most predominant organisms in Wound swab (n=1,156)

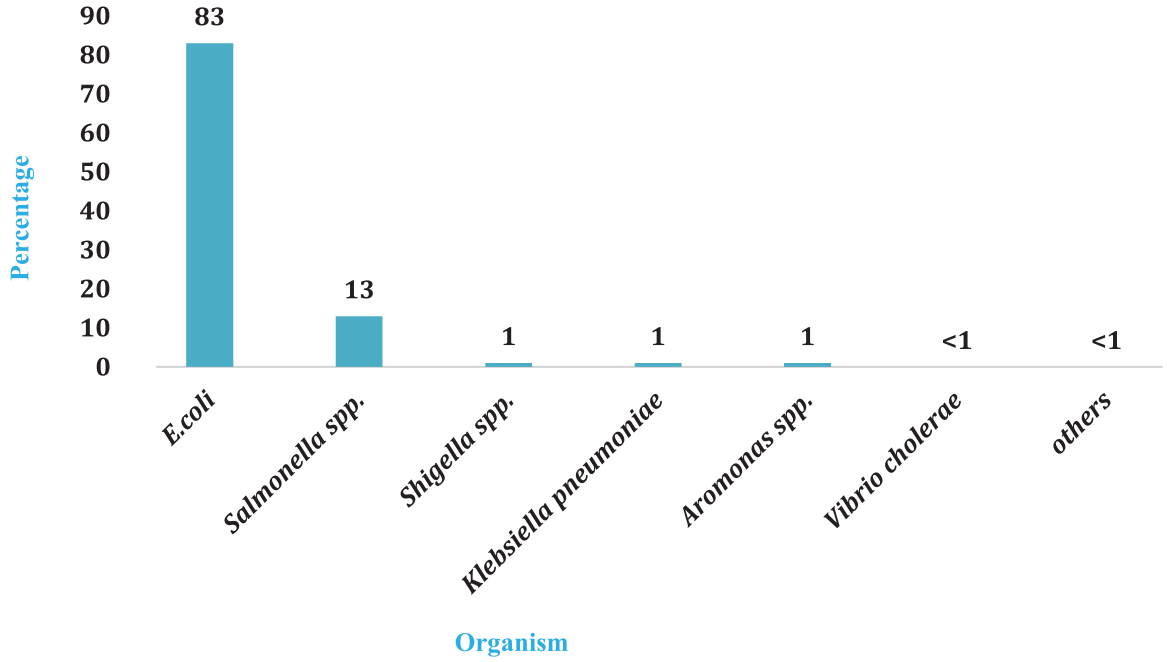


Figure 23: Ten most predominant organisms in Stool (n=657)

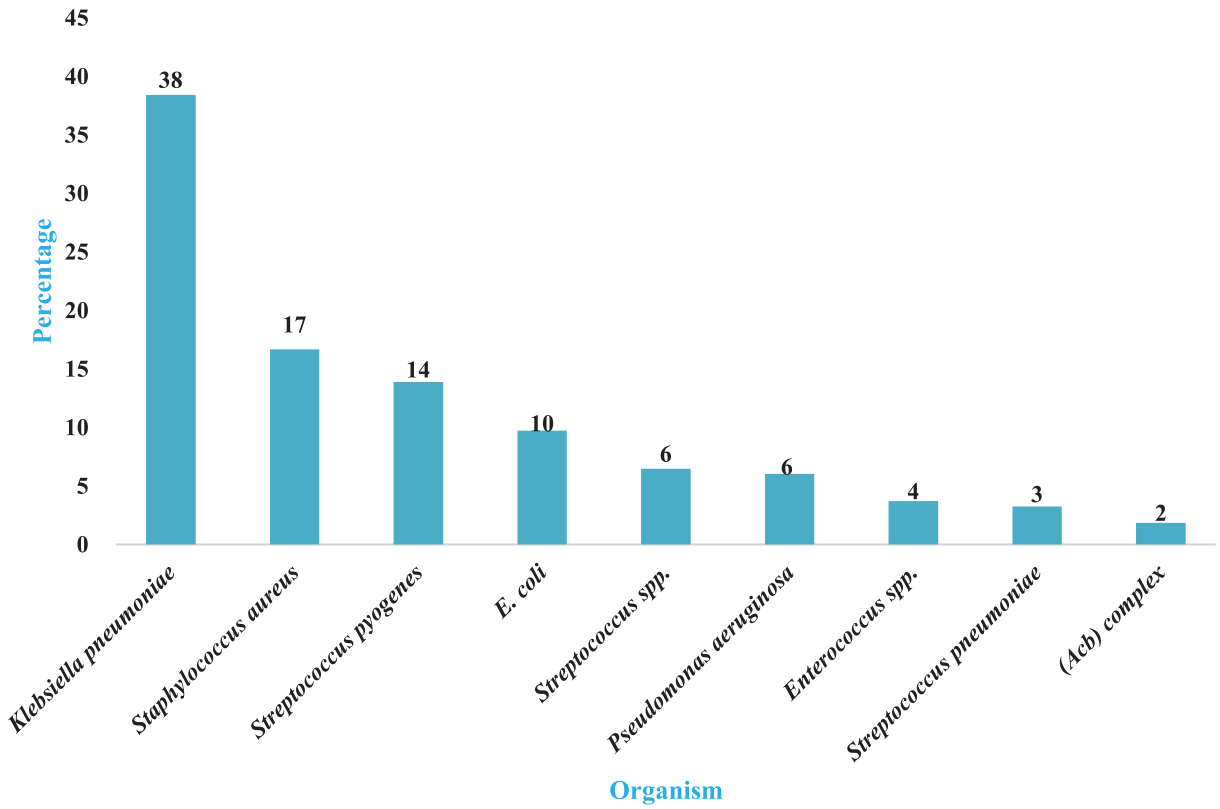


Figure 24: Distribution of microbial growth in Throat swab (n=216)

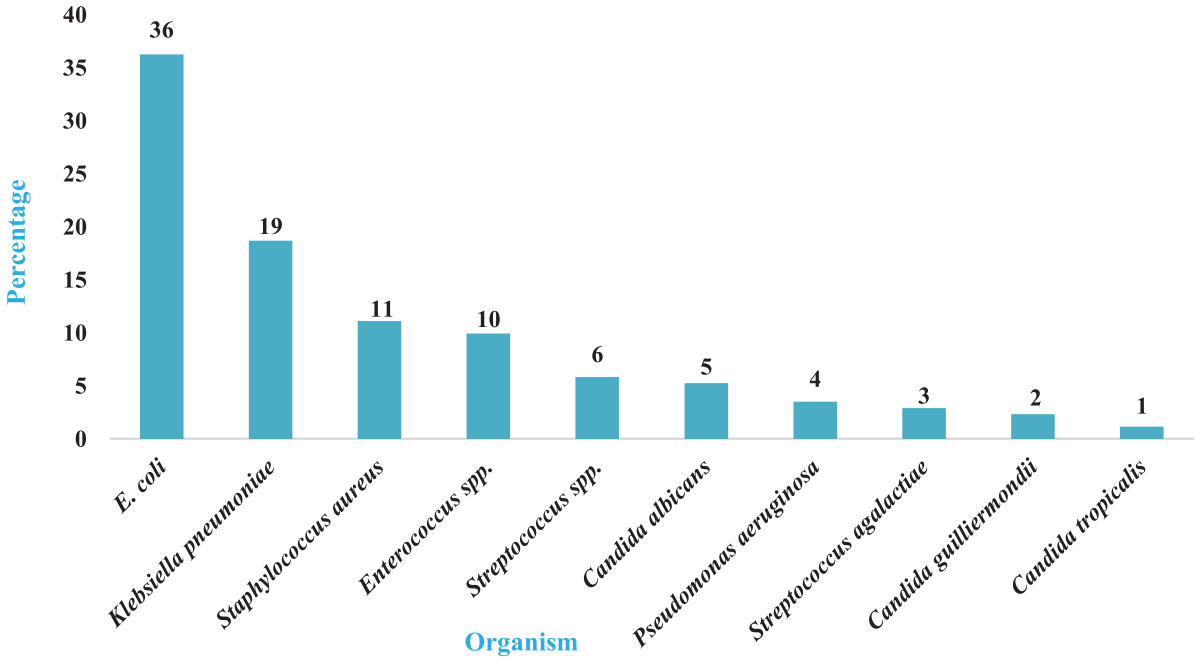


Figure 25: Ten most Predominant organisms in High Vaginal Swab (n=171)

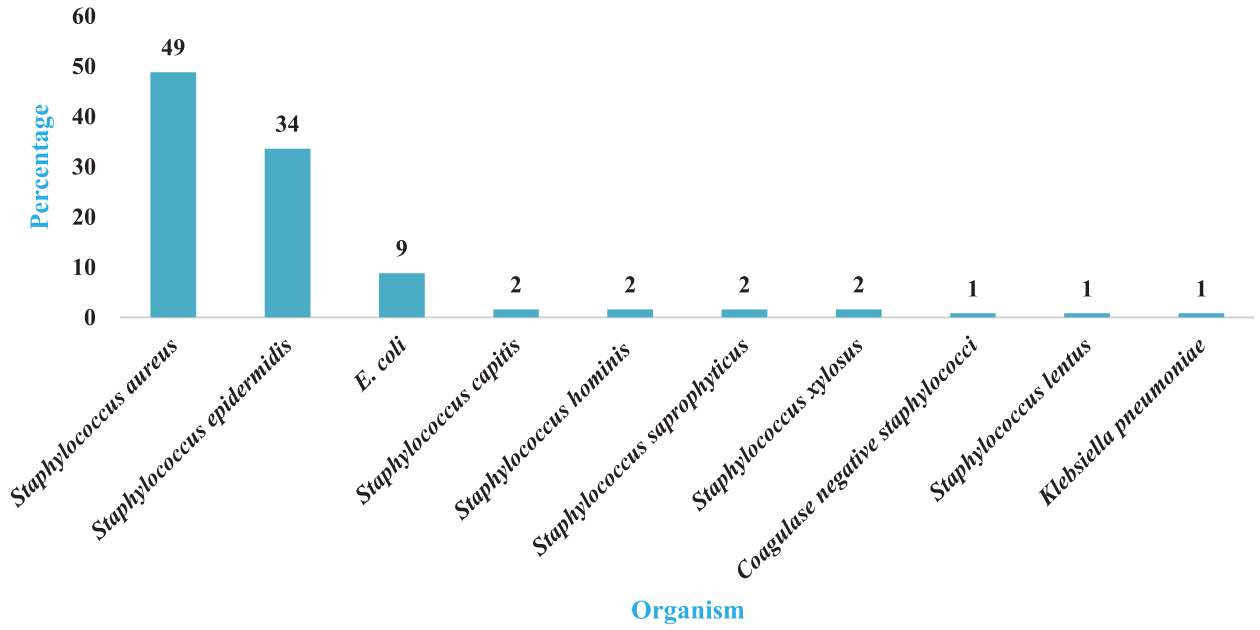


Figure 26: Distribution of microbial growth on Nipple discharge (n=125)

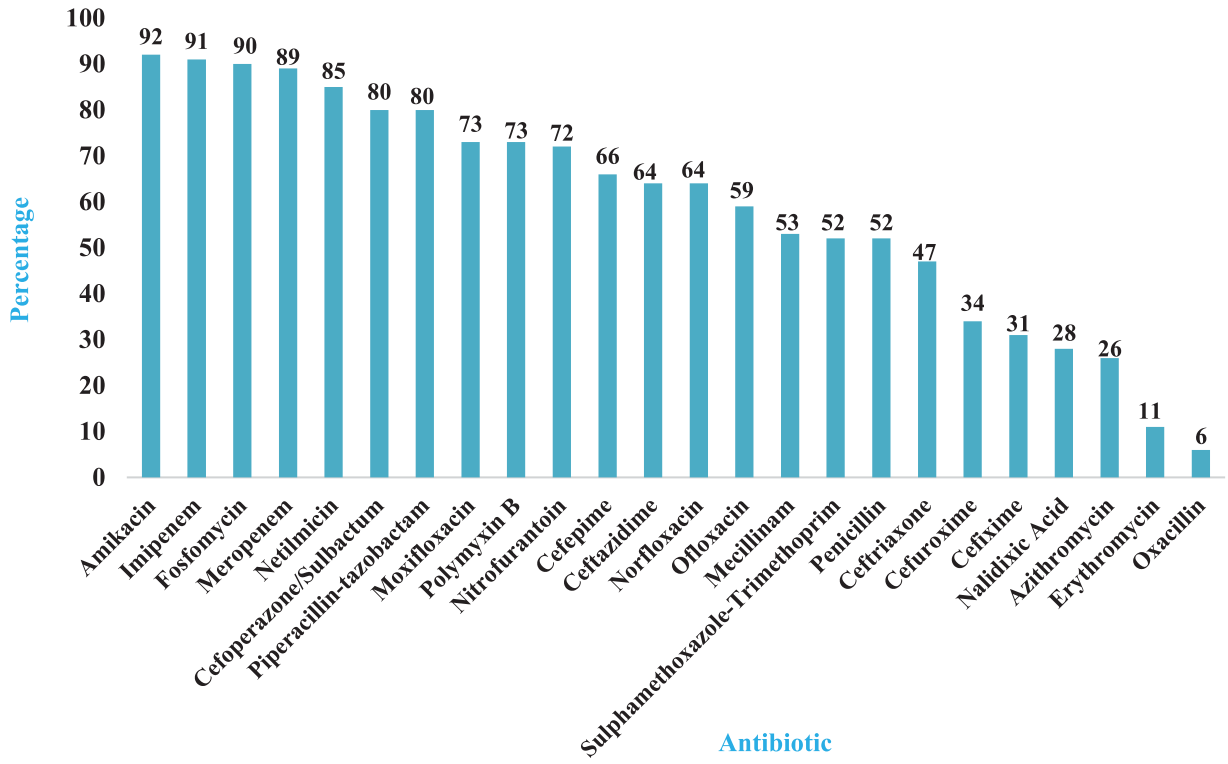


Figure 27: Susceptibility pattern of bacterial growth from urine sample (n=24,837)

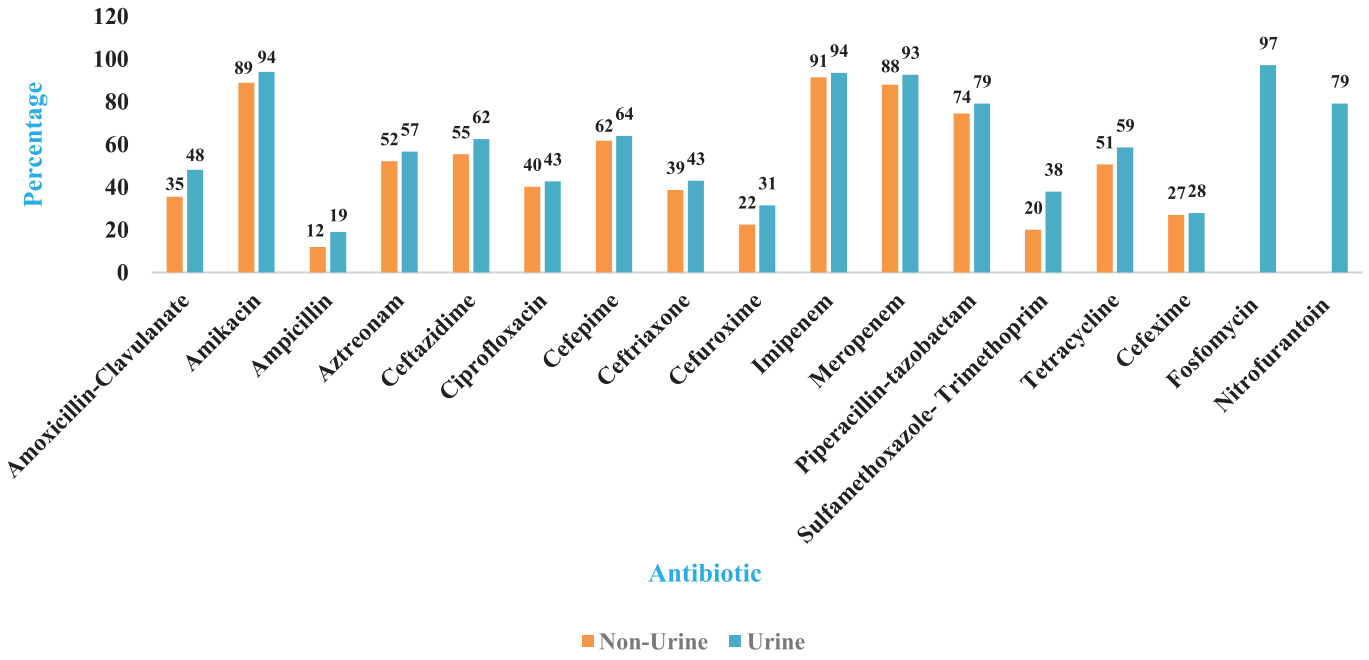


Figure 28: Susceptibility pattern of *E. coli* from non-urine (n=1,715) and urine sample(n=13,672)

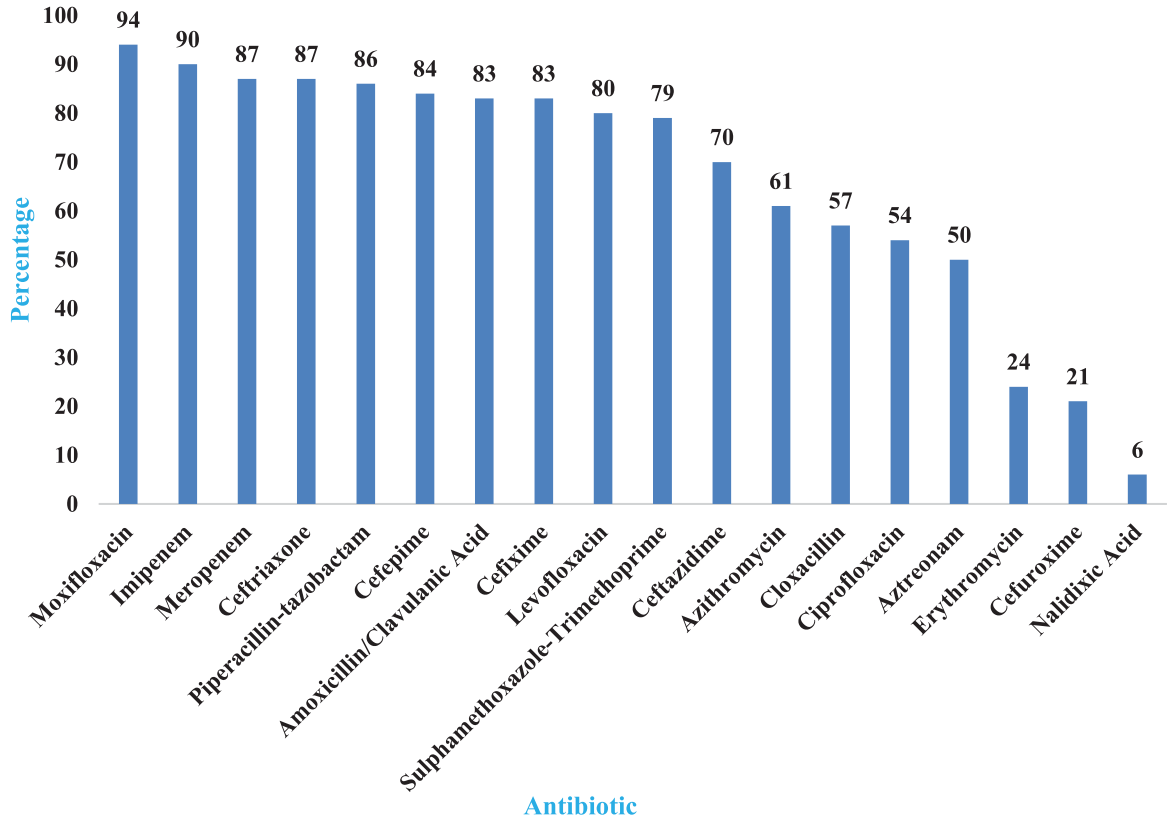


Figure 29: Susceptibility pattern of bacterial growth from blood sample (n=3,620)

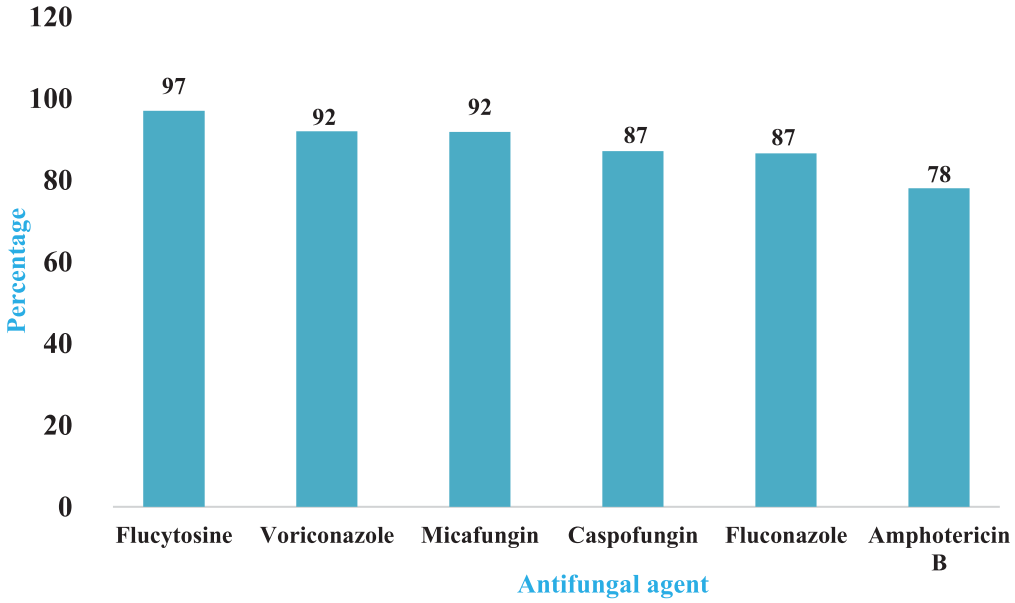


Figure 30: Susceptibility pattern of Candida spp. (n=307)

Overall

Antibiogram of Gram-positive bacteria

We have made antibiogram with combined data from case-based surveillance and lab-based surveillance to make it more representative for the country. We got Linezolid as most susceptible for gram-positive organisms. In case of *S. aureus, Enterococcus* and *CoNS* we have found Linezolid to be highest sensitive and in case of urine sample Nitrofurantoin is second highest susceptible antibiotic for all. We did not include Vancomycin in this list as it require MIC result. *S. pneumoniae* is also the most susceptible to Linezolid.

In the case of Gram-negative organism *E. coli, K. pneumoniae* and *Pseudomonas* and *Proteus spp*. Fosfomycin (in case of urine sample), Imipenem, Meropenem and Amikacin are the topmost susceptible antibiotics. In case of overall *Salmonella* spp. and *Salmonella Typhi* and *Non-typhoidal salmonella* Imipenem, Meropenem and Ceftriaxone showed the highest susceptibility. In case of Shigella spp. Ceftriaxone showed highest susceptibility. In case of *ACB complex* the susceptibility is less for most of the antibiotics. The highest susceptible antibiotic is Imipenem followed by Amikacin and Meropenem.

Blood stream infection of ESBL producing *E. coli* is an AMR indicator for SDG. According to SDG definition we have found it to be 86% and with lab confirmation we have found it to be 31%.

Another SDG indicator is MRSA in blood. We found it to be 70%.

We have found highest carbapenem resistance in *ACB complex* (42%) and according to WHO these are regarded as critical priority pathogen. This is followed by *P. aeruginosa* (32%) and Enterobacteriaceae (11%). *Proteus spp*. showed the highest resistance to ceftriaxone (64%) followed by *E. coli* (59%) and *K. pneumoniae* (48%) and According to WHO these are also the critical priority pathogen.

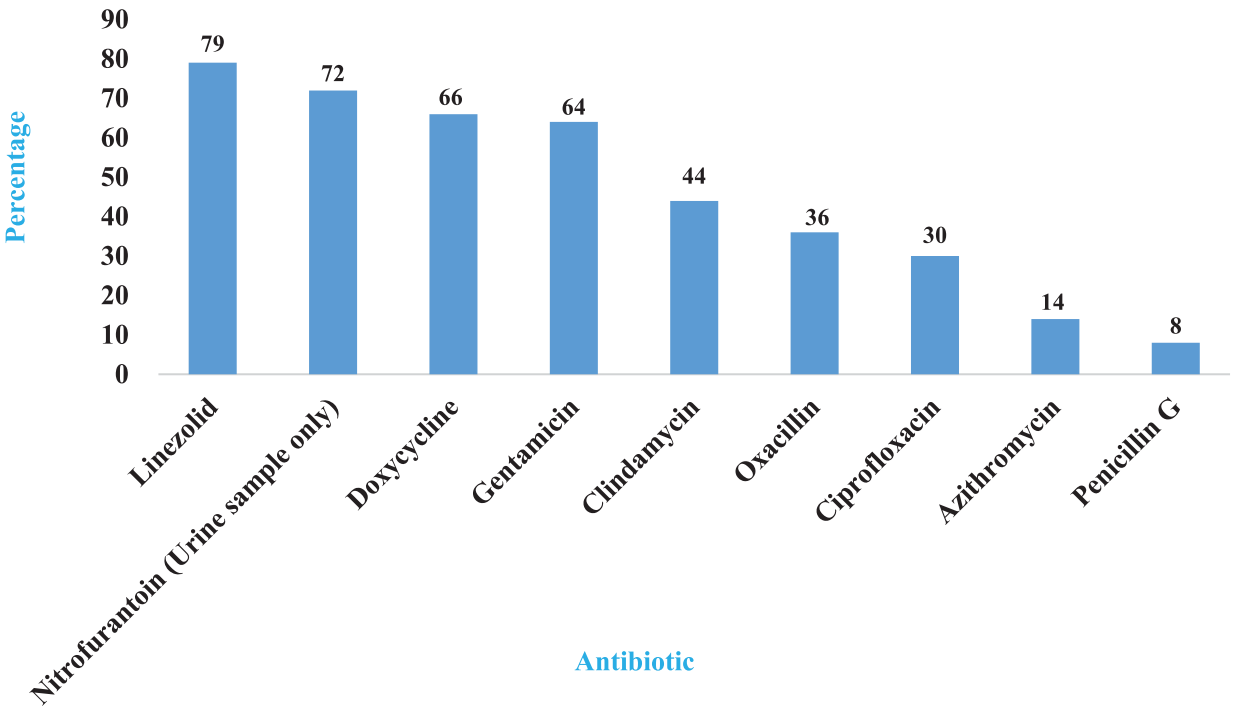


Figure 31: Susceptibility pattern of *Staphylococcus aureus* (n=4,030)

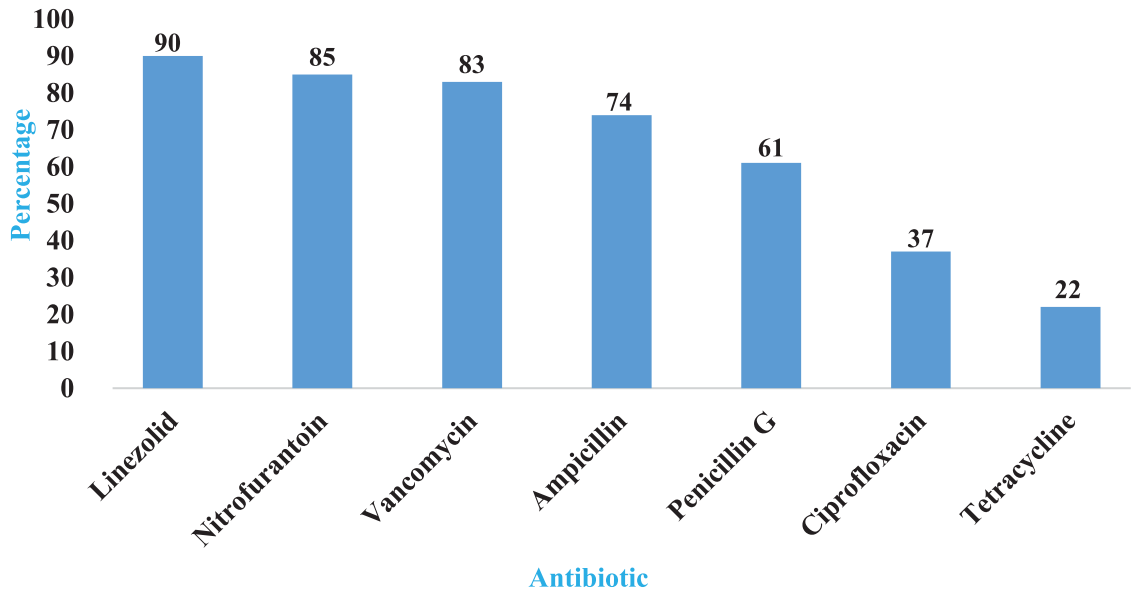


Figure 32: Susceptibility pattern of *Enterococcus spp.* (n=3,381)

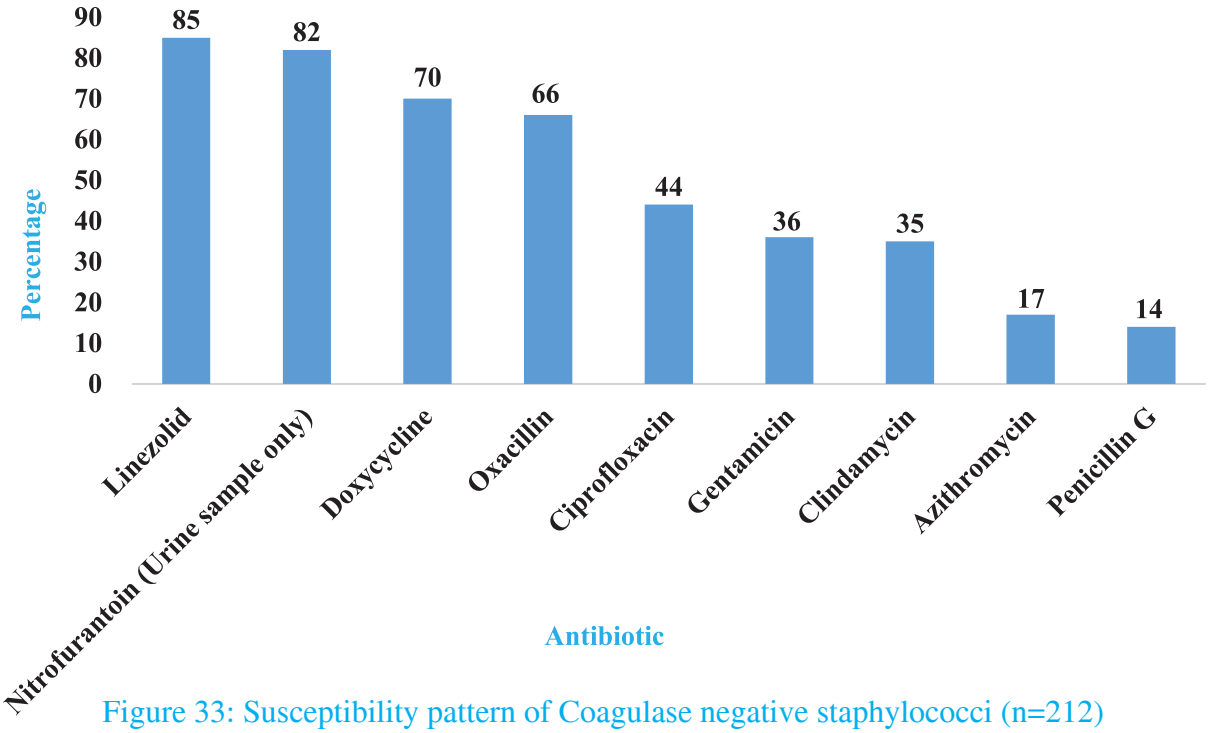


Figure 33: Susceptibility pattern of Coagulase negative staphylococci (n=212)

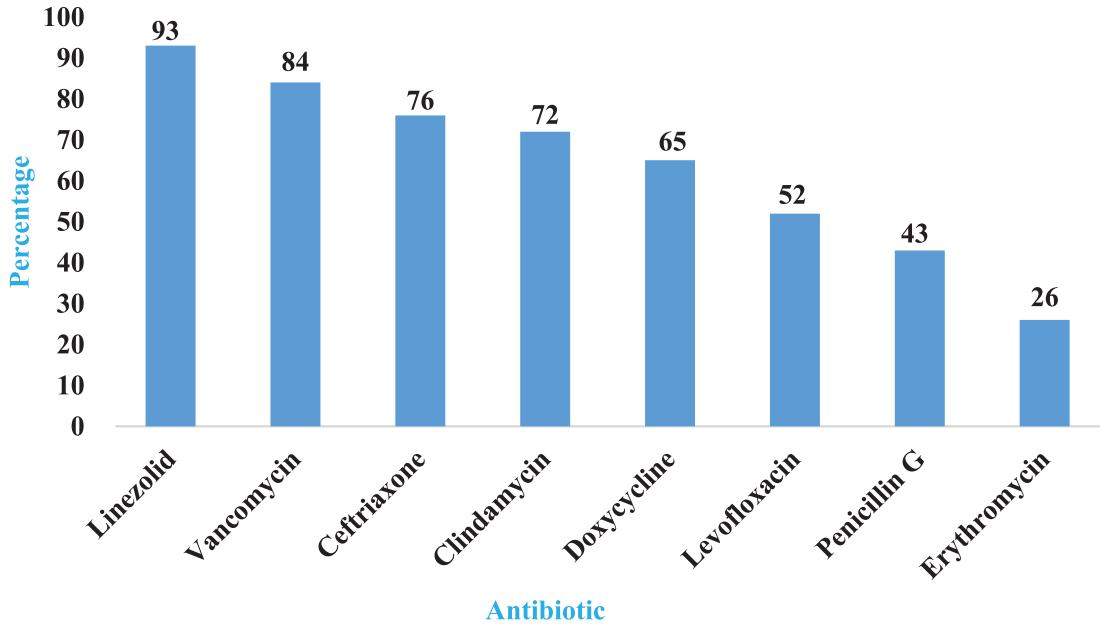


Figure 34: Susceptibility pattern of Streptococcus *pneumoniae* (n=81)

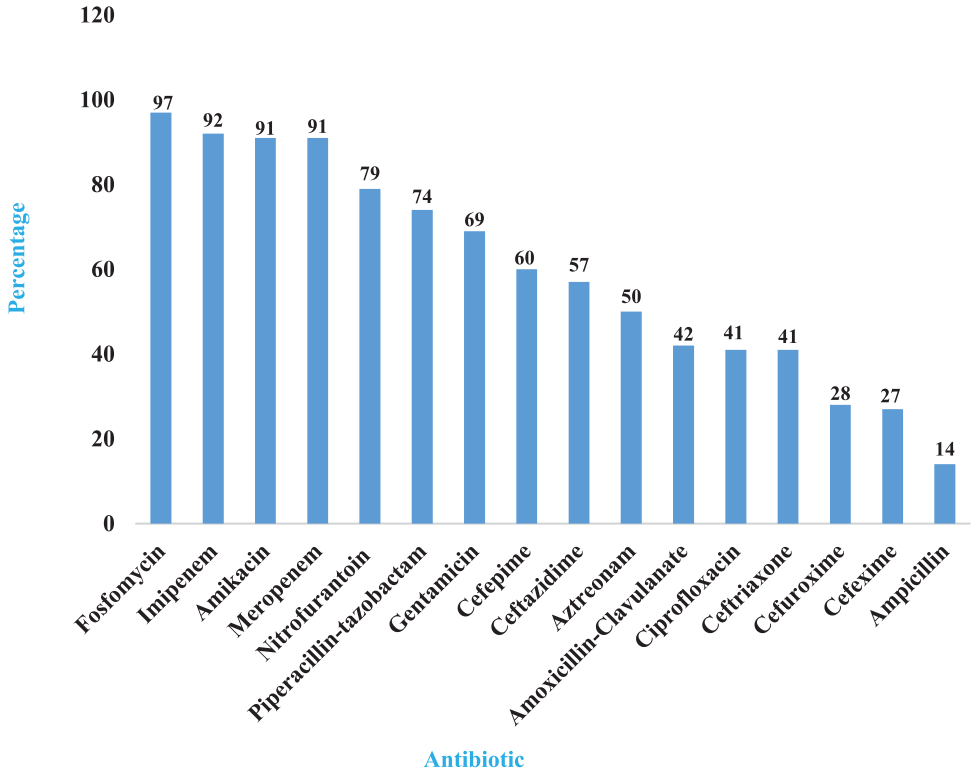


Figure 35: Susceptibility pattern of *E. coli*. (n=18,067)

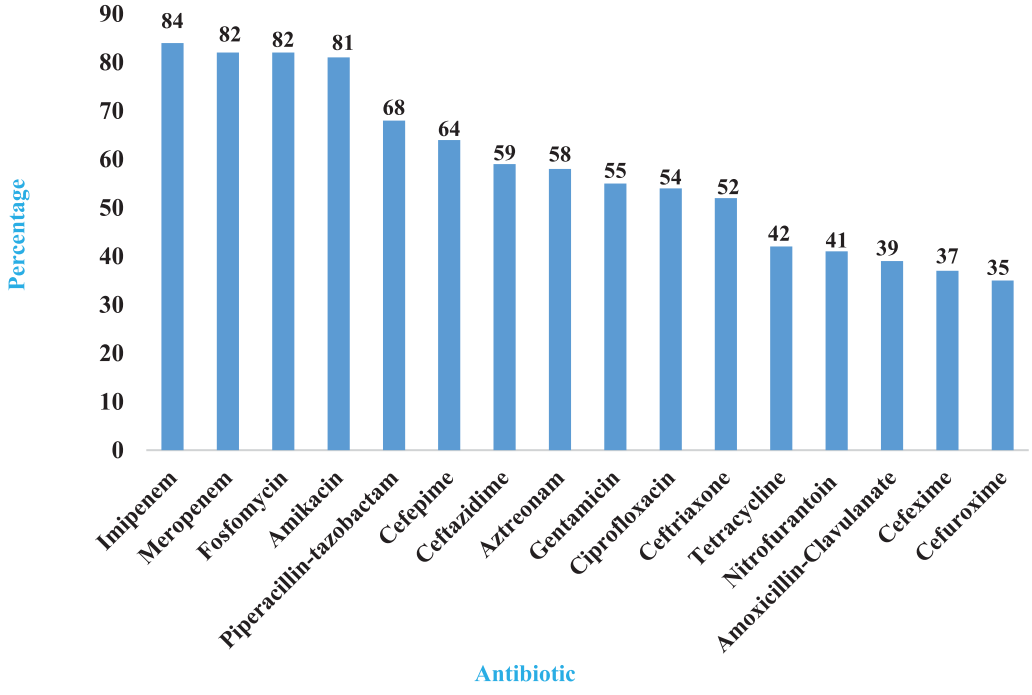


Figure 36: Susceptibility pattern of *K. pneumoniae* (n=7,525)

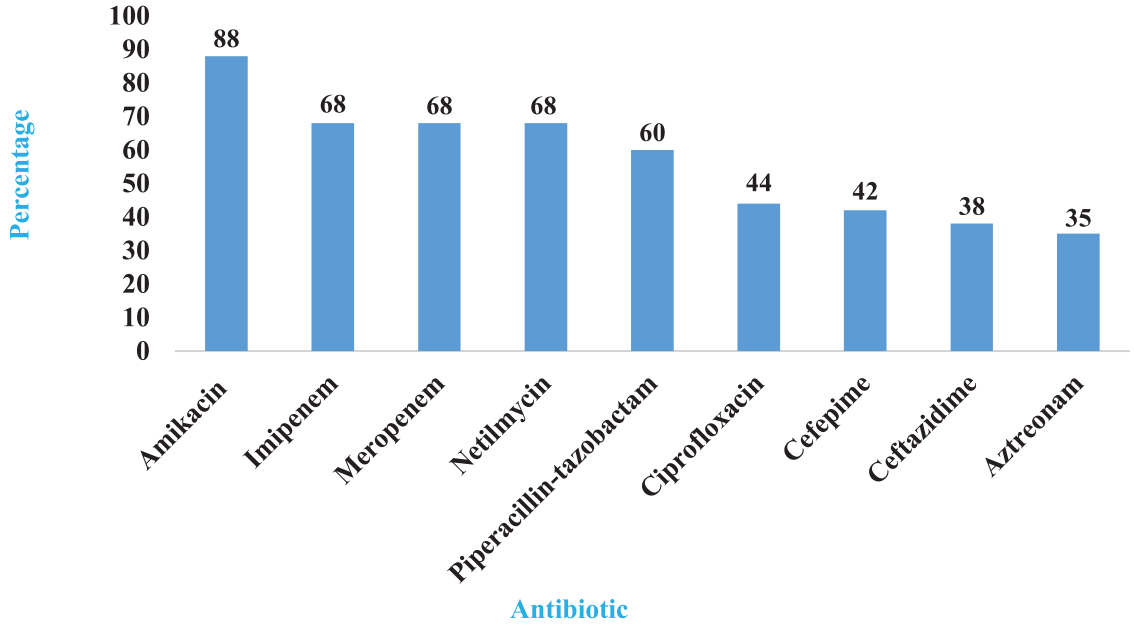


Figure 37: Susceptibility pattern of *Pseudomonas aeruginosa* (n=3,491)

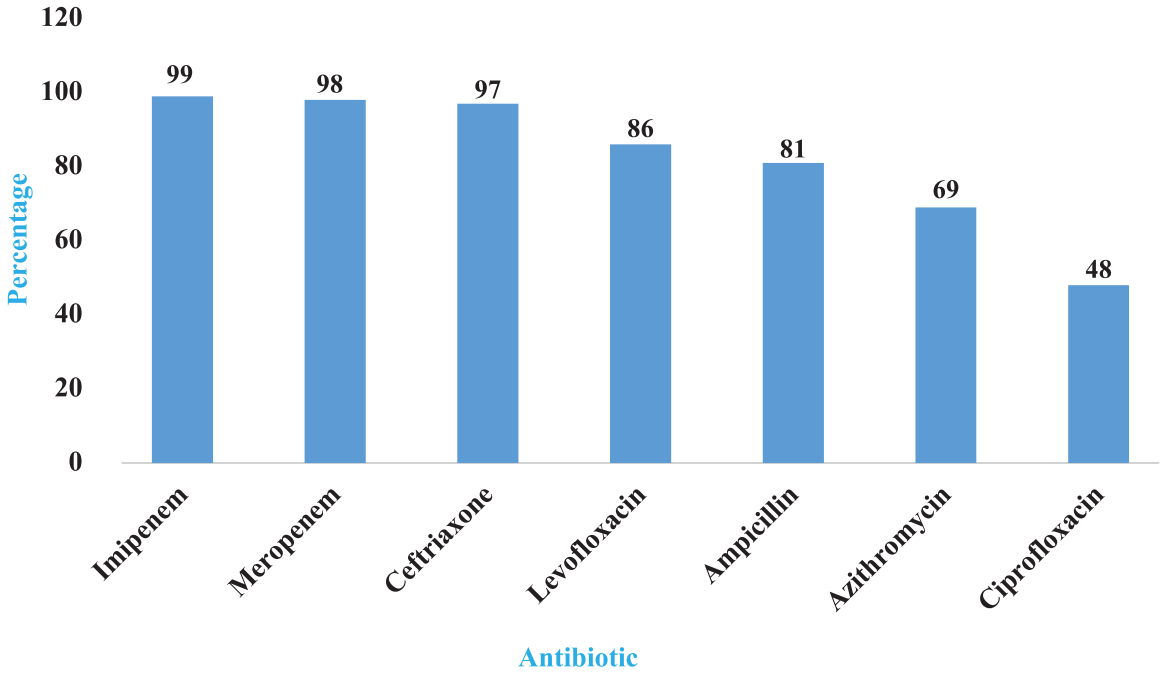


Figure 38: Susceptibility pattern of *Salmonella spp*. (n=2,916)

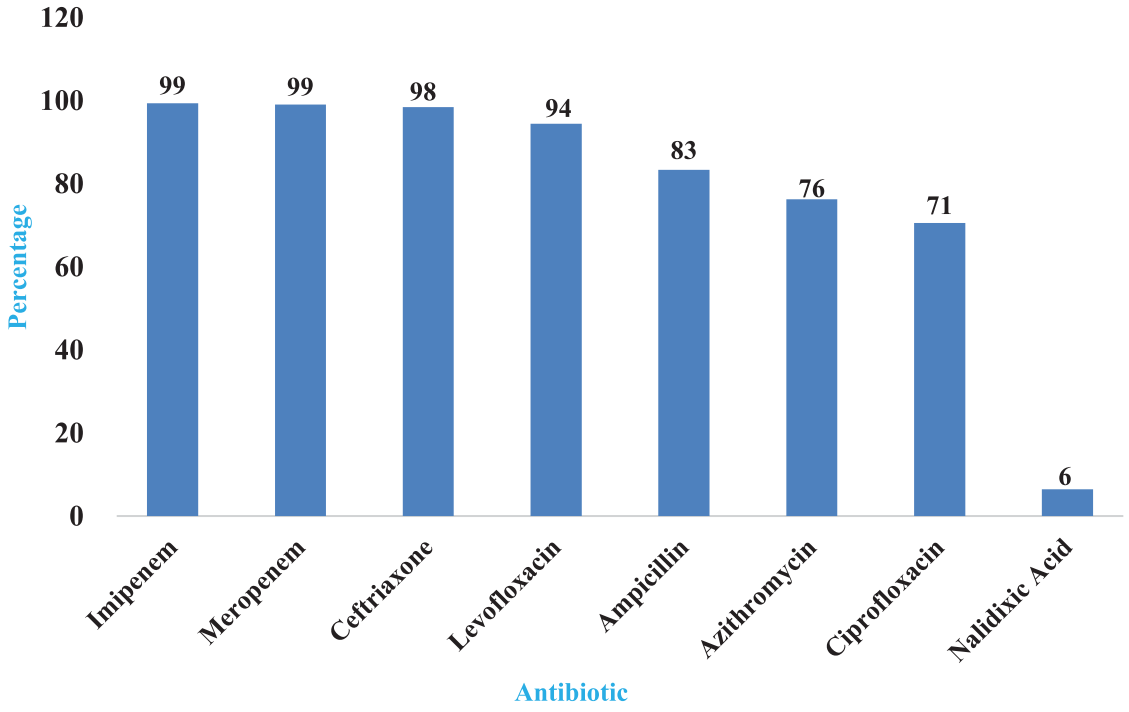


Figure 39: Susceptibility pattern of *Salmonella Typhi* (n=2,262)

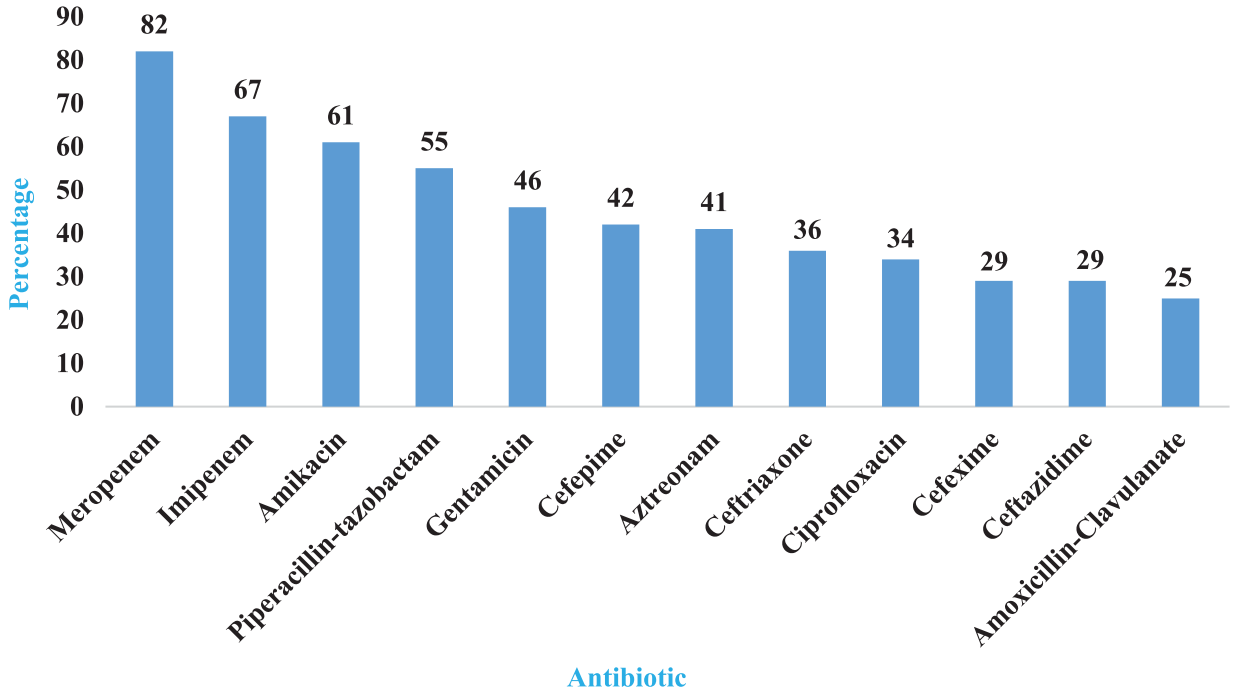


Figure 40: Susceptibility pattern of *Proteus spp*. (n=697)

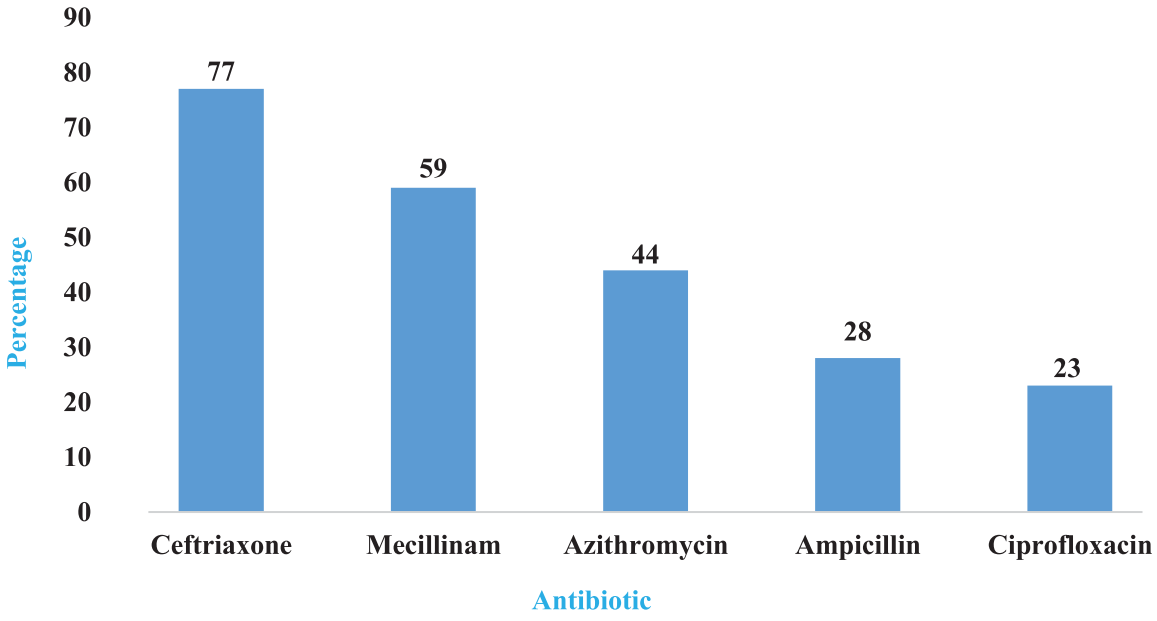


Figure 41: Susceptibility pattern of *Shigella spp*. (n=71)

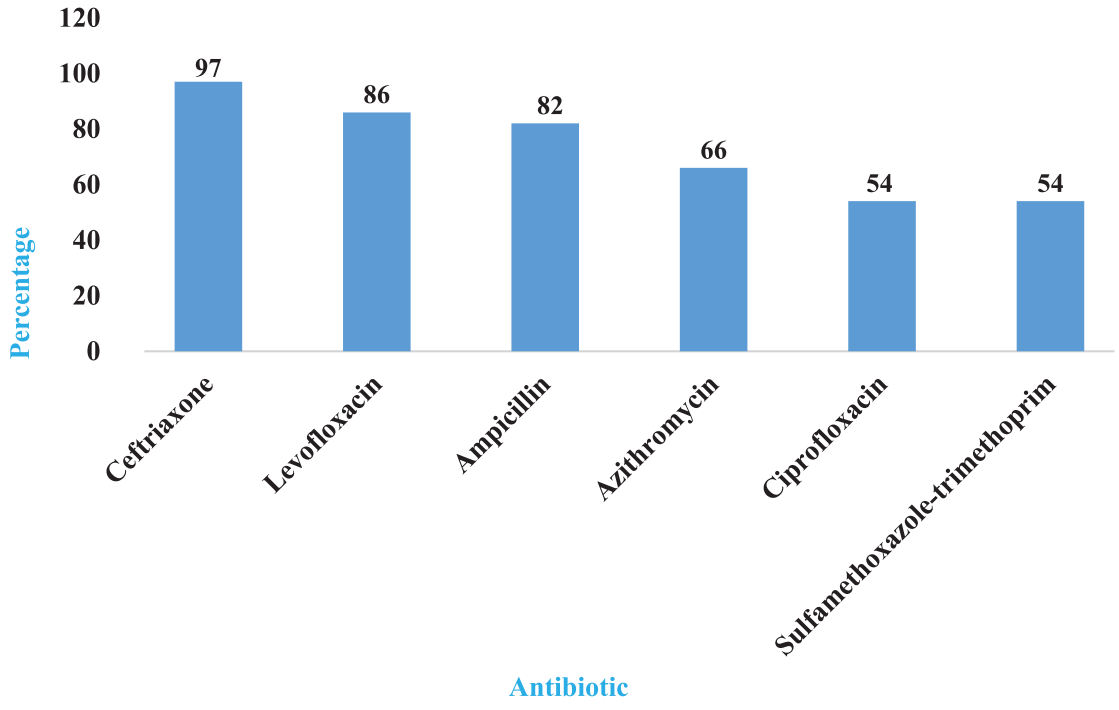


Figure 42: Susceptibility pattern of Non-typhoidal *Salmonella* (n=39)

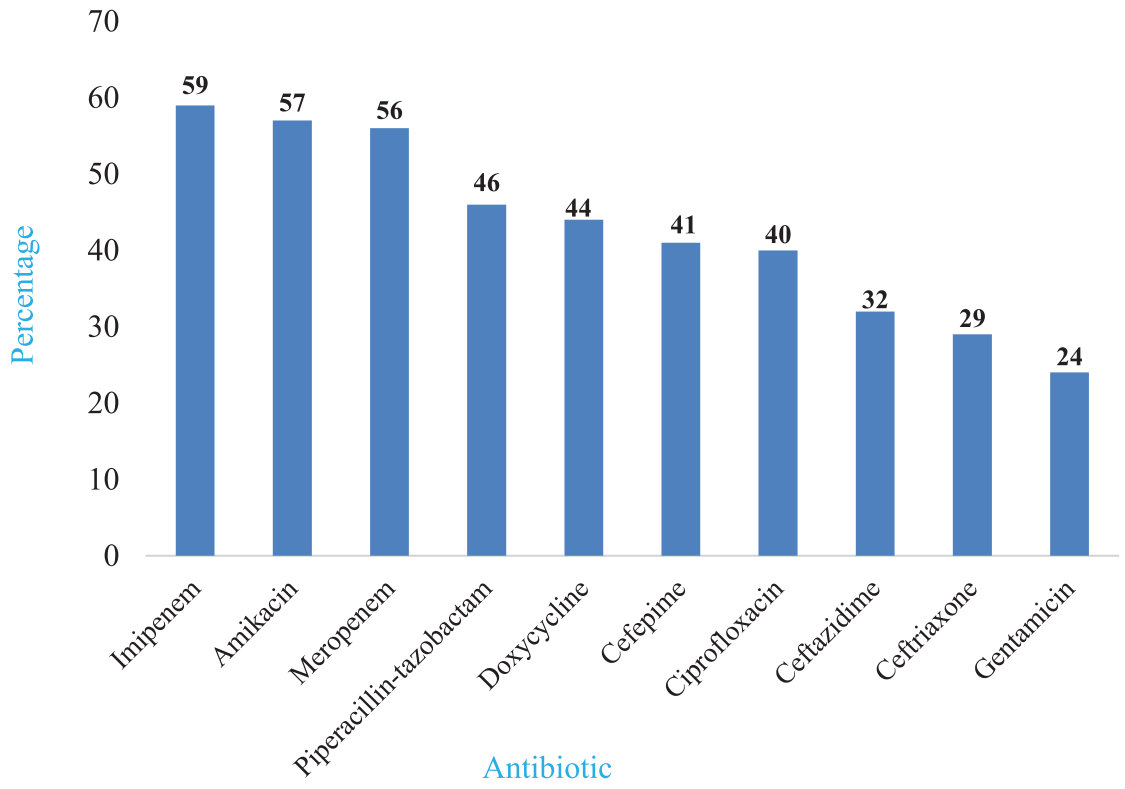


Figure 43: Susceptibility pattern of *(Acb) complex* (n=2,054)

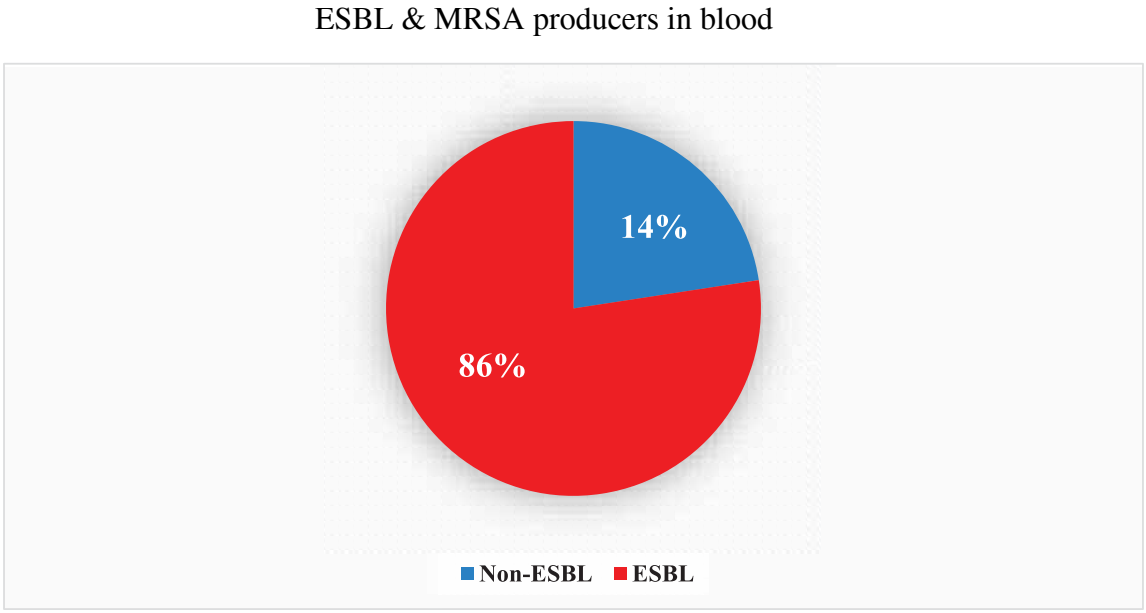


Figure 44: Suspected ESBL producing *E. coli* in blood (n=316) (according to SDG definition*)

(*SDG definition of ESBL- E. coli resistant to third generation cephalosporins: E. coli isolates that are resistant as defined by current internationally recognized clinical breakpoints for third generation cephalosporins (e.g., EUCAST or CLSI), specifically ceftriaxone or cefotaxime or ceftazidime)

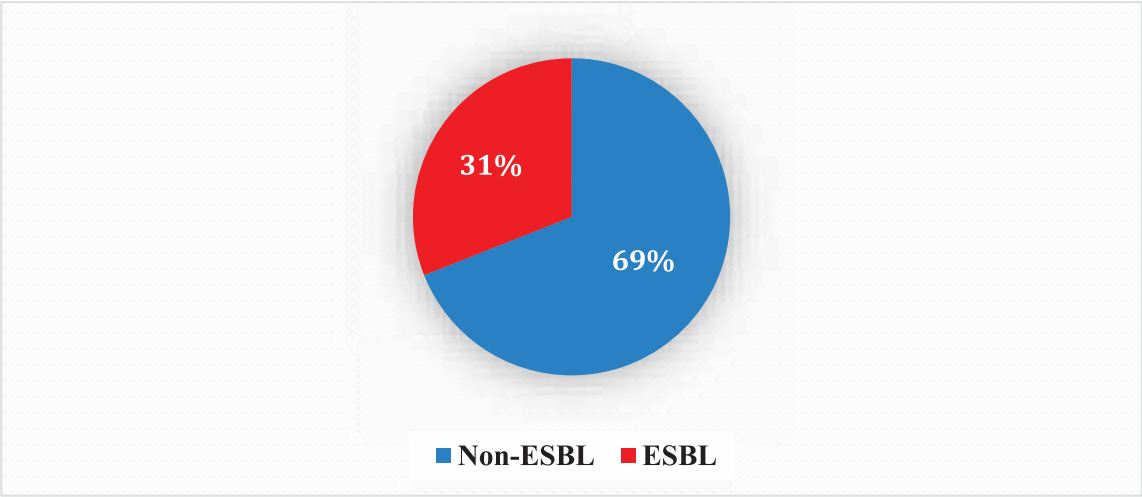


Figure 45: Confirmed* ESBL producing *E. coli* in blood (n=48)
(According to CLSI M100 33rd edn.)

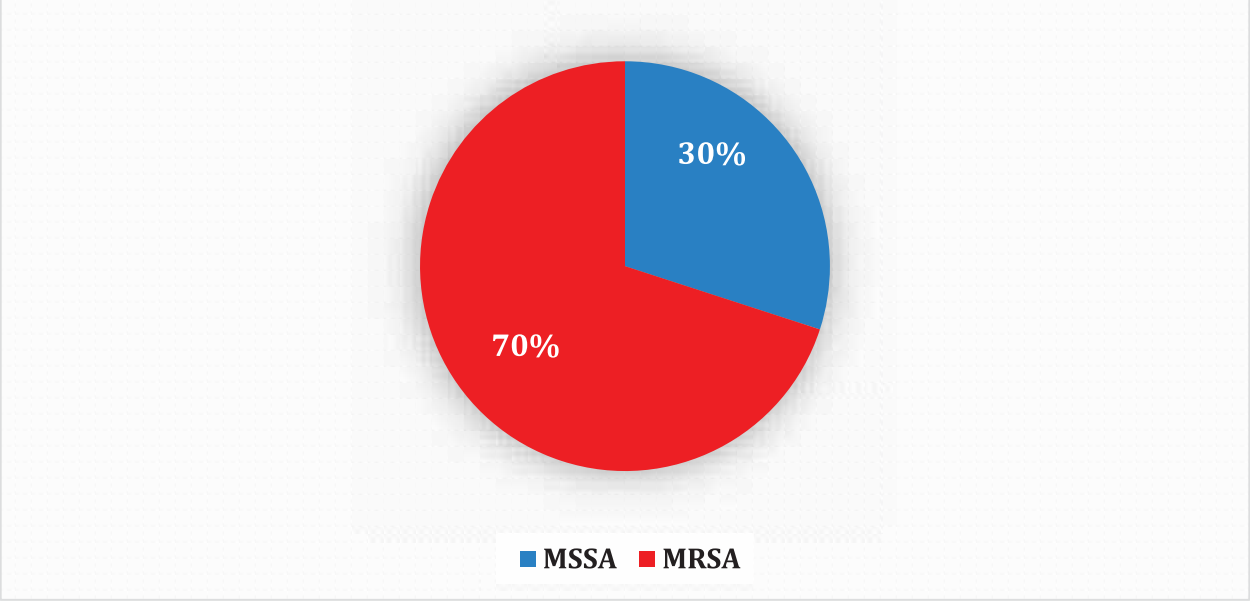


Figure 46: MRSA* and MSSA in blood (n=150)
(*MRSA=Methicillin Resistant *S. aureus*)

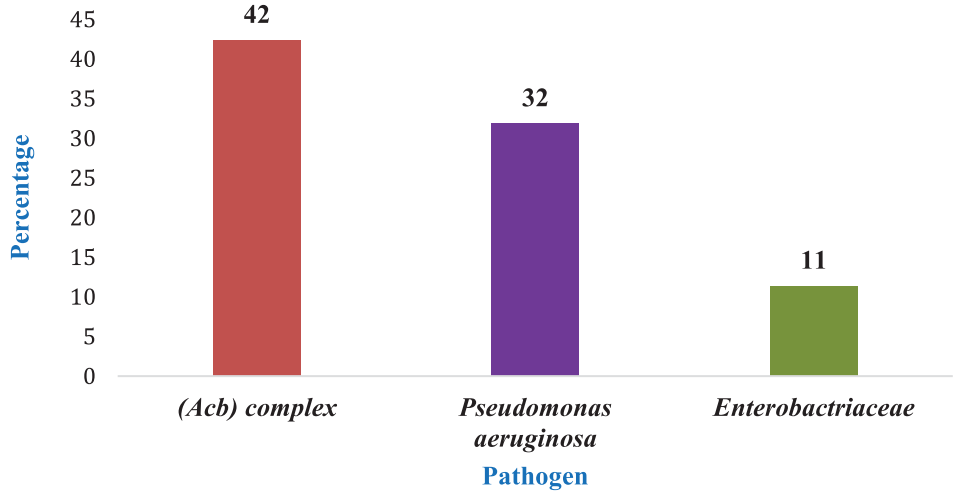


Figure 47: Resistance Pattern of Carbapenem (WHO Critical Priority Pathogens)

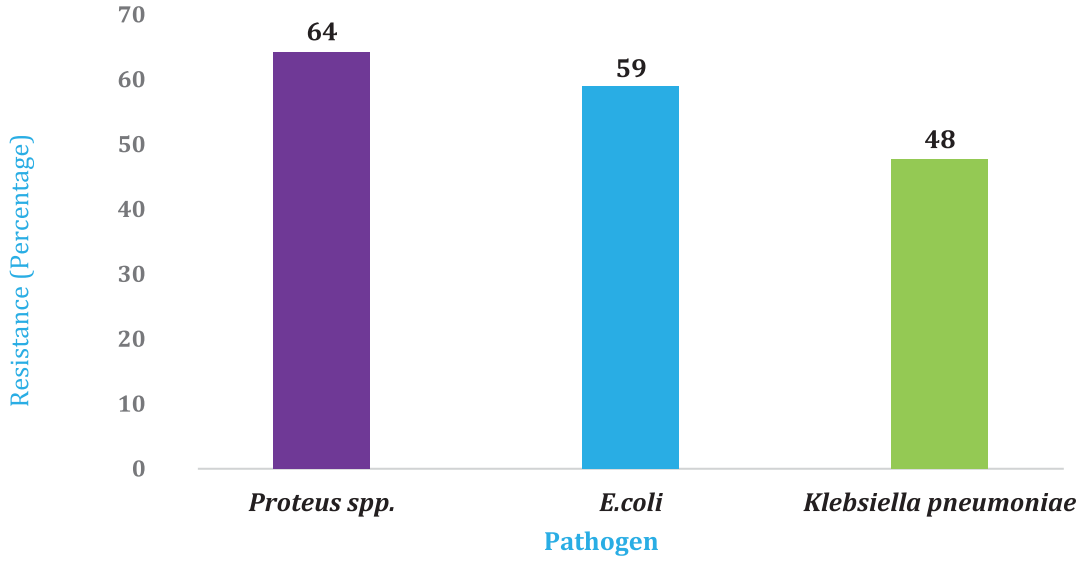


Figure 48: Resistance pattern of WHO Critical Priority Pathogens (Enterobacteriaceae) to ceftriaxone

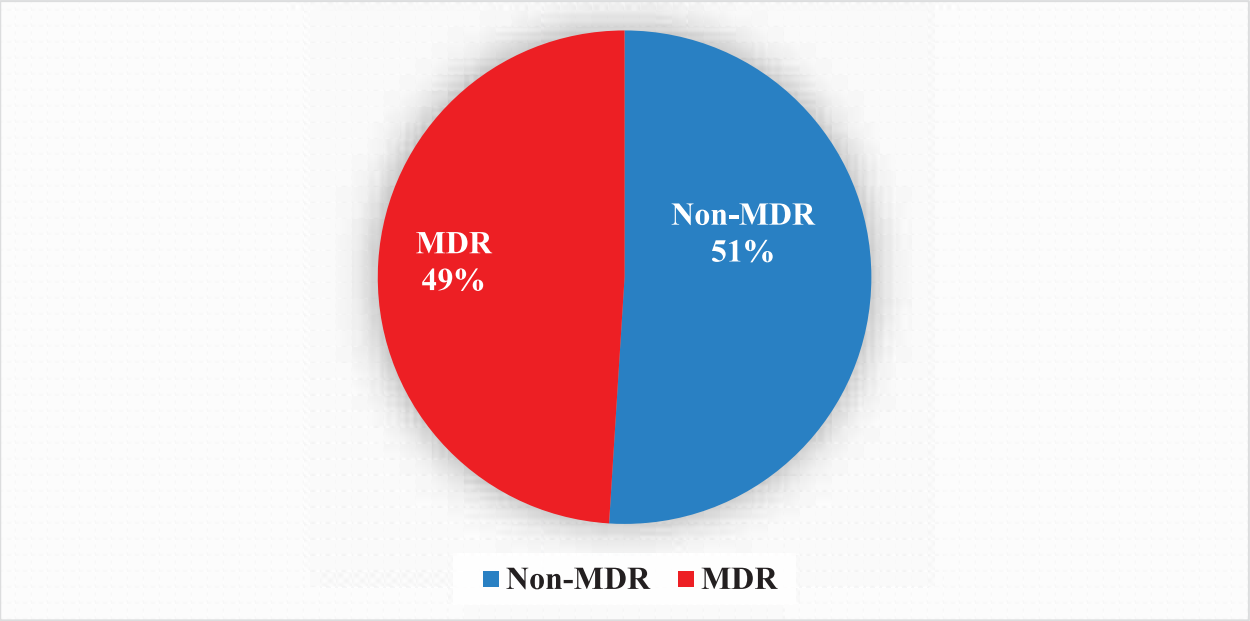


Figure 49: Overall percentage of MDR pathogen

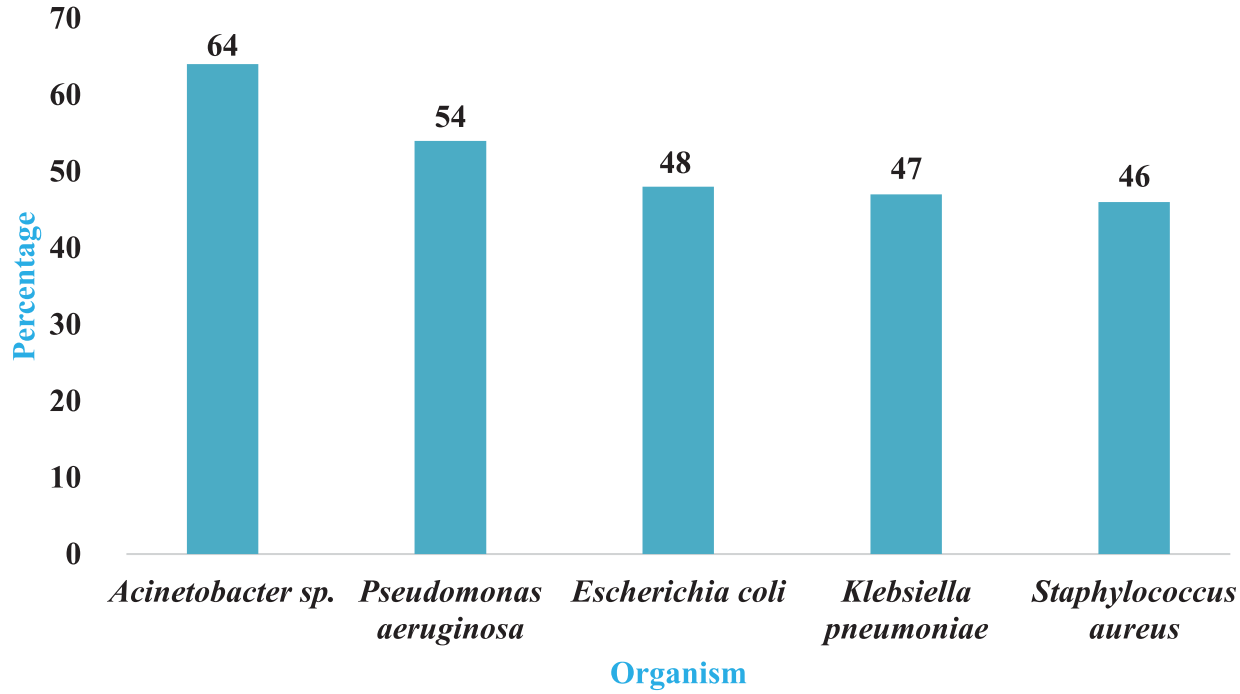


Figure 50: Overall percentage of MDR in different organisms

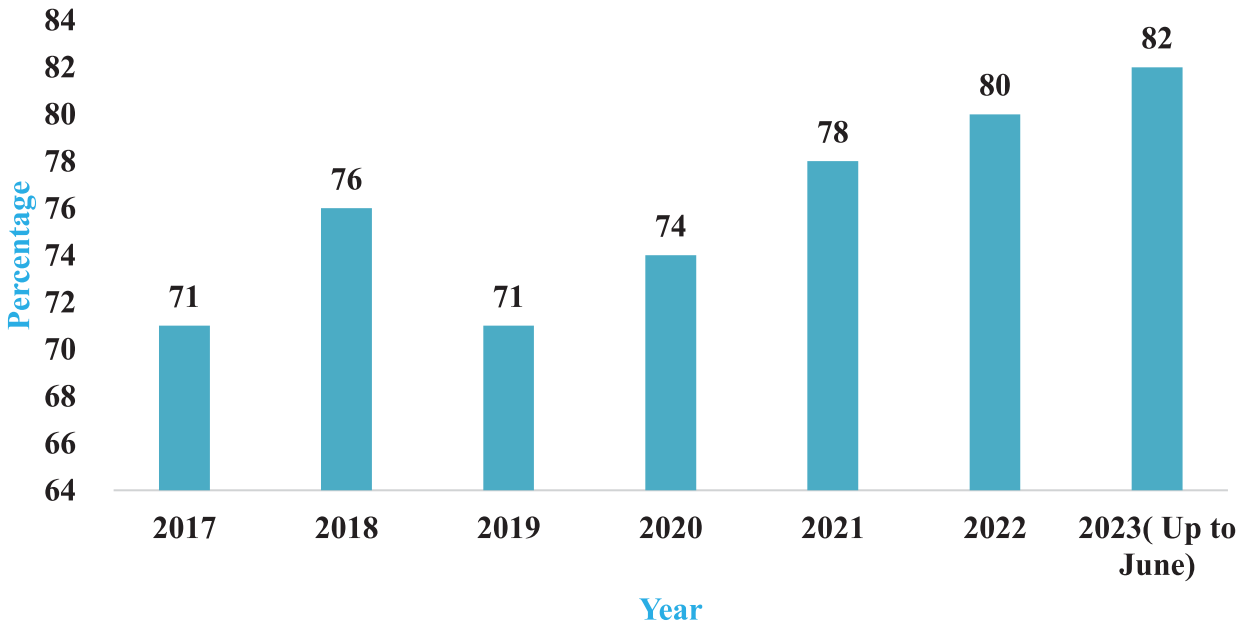


Figure 51: Yearly trend percentage of MDR in case-based surveillance (2017-2023)

Color coding

Colour	%S value	Colour	%S value	Colour	%S value	Colour	%S value	Reference
Green	>80%	Yellow	60-80%	Red	<60%	Grey	Data not available	Chapter 4, CLSI M39, 5th Ed

Antibiogram of Gram-Negative Bacteria:

Organisms	Name of Antibiotic																				
	Amoxicillin-Clavulanate	Amikacin	Ampicillin	Azithromycin	Aztreonam	Cefexime	Ceftazidime	Ciprofloxacin	Cefepime	Ceftriaxone	Cefuroxime	Doxycycline	Gentamicin	Imipenem	Meropenem	Levofloxacin	Piperacillin-tazobactam	Sulfamethoxazole- Trimethoprim	Tetracycline	Fosfomycin (Urine sample only)	Nitrofurantoin (Urine sample only)	Nalidixic Acid (Urine sample only)	Netilmycin
E. coli	42	91	14		50	27	57	41	60	41	28		69	92	91		74	41		97	79		
Klebsiella pneumoniae	39	81	2		58	37	59	54	64	52	35		55	84	82		68	34	42	82	41		
Proteus spp.	25	61	9		41	29	29	34	42	36	16		46	67	82		55	25	17		41		
Pseudomonas aeruginosa		88			35		38	44	42					68	68		60						68
Enterobacter spp.	7	84			65	40		50	67	55	8			77	87		62	33*			24		
Salmonella spp.			81	69				48		97				99	98	86						6	
Non typhoidal Salmonella			82	66				54		97				99	99	86		54				6	
Shigella spp.			28	44				23		77								40					
(Acb) complex		57					32	40	41	29		44	24	59	56		46	29					

Antibiogram of Gram-Positive Bacteria:

Organisms	Name of Antibiotic															
	Ampicillin	Azithromycin	Oxacillin	Ciprofloxacin	Ceftriaxone	Clindamycin	Doxycycline	Erythromycin	Gentamicin	Linezolid	Levofloxacin	Penicillin G	Sulfamethoxazole - Trimethoprim	Tetracycline	Vancomycin	Nitrofurantoin (Urine sample only)
Staphylococcus aureus		14	36	30		44	66		64	79		8	49			72
Enterococcus spp.	74			37						90		61		22	83	85
Coagulase negative staphylococci		17	66	44		35	70		36	85		14	30			82
Streptococcus pneumoniae					76	72	65	26		93	52	43	36*		84	

Gram negative Organisms	Class	
	Carbapenems	Tetracyclines
E. coli	91	44
Klebsiella pneumoniae	83	42
Proteus spp.	75	17
Pseudomonas aeruginosa	68	
Enterobacter spp.	82	
Salmonella spp.	99	
Non typhoidal Salmonella	99	
(Acb) complex	58	44

Gram positive Organisms	Class
	Tetracyclines
Staphylococcus aureus	66
Enterococcus spp.	22
Coagulase negative staphylococci	70
Streptococcus pneumoniae	65

Antibiogram of Gram-Negative and Gram-Positive Bacteria: ICU

Organisms	Name of Antibiotic																							Class	
	Amoxicillin-Clavulanate	Amikacin	Ampicillin	Azithromycin	Aztreonam	Oxacillin	Cefexime	Ceftazidime	Ciprofloxacin	Cefepime	Ceftriaxone	Cefuroxime	Colistin	Doxycycline	Gentamicin	Imipenem	Meropenem	Linezolid	Piperacillin-tazobactam	Sulfamethoxazole - Trimethoprim	Tetracycline	Nitrofurantoin (Urine sample)	Netilmycin		Carbapenems	Tetracyclines
Gram negative																									
E. coli	15	47	5		13		7	12	16	12	9	5			35	69	27		26	30	44	38			51	44
Klebsiella pneumoniae	7	27	1		7		7	4	13	6	4	2			28	35	23		17	12	21				32	21
Proteus spp.	22*	43	0		13		0	0	21	0	0	0			31	25	35		35	21	18				27	18
Pseudomonas aeruginosa					17			12	25	11						30	30		31				43		30	
Salmonella spp.			62	69					11		86					92									92	
(Acb) complex		12						1	4	1	2		89	22	10	11	5		4	20					9	22
Gram positive																									
Staphylococcus aureus				6		3			25					60	29			69		40	33				41

*Sample size is <30.

Antibiogram of Gram-Negative and Gram-Positive Bacteria: Ward

Organisms	Name of Antibiotic																							Class	
	Amoxicillin-Clavulanate	Amikacin	Ampicillin	Azithromycin	Aztreonam	Oxacillin	Cefexime	Ceftazidime	Ciprofloxacin	Cefepime	Ceftriaxone	Cefuroxime	Clindamycin	Doxycycline	Gentamicin	Imipenem	Meropenem	Linezolid	Piperacillin-tazobactam	Sulfamethoxazole- Trimethoprim	Tetracycline	Nitrofurantoin (Urine sample only)	Netilmycin		Carbapenems	Tertracyclines
Gram negative																									
E. coli	18	67	3		19		8	19	28	22	16	10			56	80	62		44	41	31	65			77	31
Klebsiella pneumoniae	16	60	2		22		21	18	31	27	19	13			55	76	49		41	40	34	46			71	66
Proteus spp.	16	43	7		29		20	20	29	26	18	10			35	59	62		47	26	15	28			62	15
Pseudomonas aeruginosa					25			21	33	22						64	36		49				52		43	
Salmonella spp.			66	73					19		94					100	100*								100	
Shigella spp.			30	39					20		76									41						
(Acb) complex		42						8	23	12	29			23	38	49	43		39	35					57	21
Gram positive																									
Staphylococcus aureus				16		33			28				43		62			77		50	30					40
Coagulase negative staphylococci				0*		0*			19				0*	31*	15			28*		33						27*

*Sample size is <30.

Antibiogram of Gram-Negative and Gram-Positive Bacteria: OPD

Organisms	Name of Antibiotic																												Class	
	Amoxicillin-Clavulanate	Amikacin	Ampicillin	Azithromycin	Aztreonam	Oxacillin	Cefexime	Ceftazidime	Ciprofloxacin	Cefepime	Ceftriaxone	Cefuroxime	Clindamycin	Doxycycline	Gentamicin	Imipenem	Meropenem	Linezolid	Penicillin G	Piperacillin-tazobactam	Sulfamethoxazole- Trimethoprim	Tetracycline	Vancomycin	Fosfomycin (Urine sample only)	Nitrofurantoin (Urine sample only)	Cefazolin (Urine sample only)	Nalidixic Acid (Urine sample only)	Netilmycin		Carbapenems	Tetracyclines
Gram negative																														
E. coli	34	84	10		40		22	38	42	46	42	27			77	89	85			63	45	48		100	82	67*				88	47
Klebsiella pneumoniae	35	79	4		53		39	46	53	58	55	37			73	87	77			52	51	54			53					84	54
Proteus spp.	34	76	7		53		25	29	38	45	52	16			75	53	78			52	37	23			48					60	23
Pseudomonas aeruginosa		65			29			32	44	39						73	36			60								58		62	
Salmonella spp.			82	93					6		99					100														100	
(Acb) complex		82						26	51	48	22			55*	69	63*	77*			64	51	52*								69	
Gram positive																														
Staphylococcus aureus				12		49			35				56	76	79			85			55				74						75
Enterococcus spp.			58						36									77	39			21	65		74						20
Coagulase negative staphylococci				22*		50*			59*					77*	84*			67*			50*										69*

*Sample size is <30.

Antibiotic Use of All Sites (2017-2023)

In case-based surveillance along with the laboratory data we also take the antibiotic use history of the patient. So far, we have 20,868 antibiotic use history. Among which highest data came from indoor patient (61%) followed by ICU patients (26%). We have found the use of third generation cephalosporin Ceftriaxone is overall the most used drug in all the medical colleges and hospitals (31%) followed by Flucloxacillin (12%). Ceftriaxone is also the most used drug in ICU (33.1%) and ward (34.6%). In OPD patients we have found Ciprofloxacin the most used (19.1%) antibiotic. Interestingly, other than diarrhoea and UTI patients Ceftriaxone is the highest used antibiotic in wound infection, blood stream infection and LRTI. In case of UTI patients, most of them are OPD patients and diarrhoea patients Ciprofloxacin and Azithromycin are the highest used antibiotics respectively.

In site wise antibiotic analysis, we have found Ceftriaxone is the topmost used antibiotic of most of the hospitals except SBMCH, CoxMCH and BITID. In these hospitals Azithromycin, Flucloxacillin and Ciprofloxacin are found to be the highest used antibiotic for the patients included in surveillance. However, they are the second highest antibiotic in those hospitals. This may be due to more collection of samples from outdoor patients and less or no ICU patients.

In the year wise trend analysis, we have clear indication of rising trend of use of Meropenem and Azithromycin and downward trend of Flucloxacillin use since 2021.

Overall, we have found highest (73%) use of WATCH group of drug and only 3% use of reserve group of drugs. Among the reserve drug Linezolid was mostly used followed by Tigecycline. Highest percentage of reserve group of drugs was used in burn patients followed by ICU patients where colistin was the topmost (68.8%) used antibiotic.

Interestingly we have found use of some reserve group of antibiotics in OPD patients. Here Linezolid is the topmost used reserve drug followed by Tigecycline.

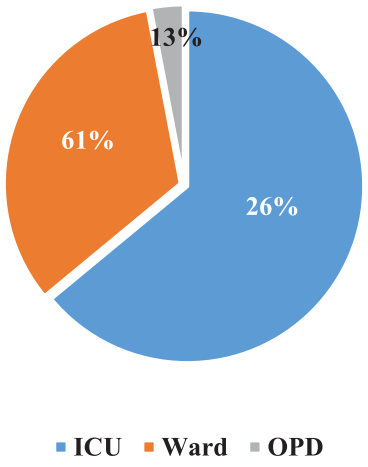


Figure 52: Distribution of Antibiotic usage in different locations (n=20,868)

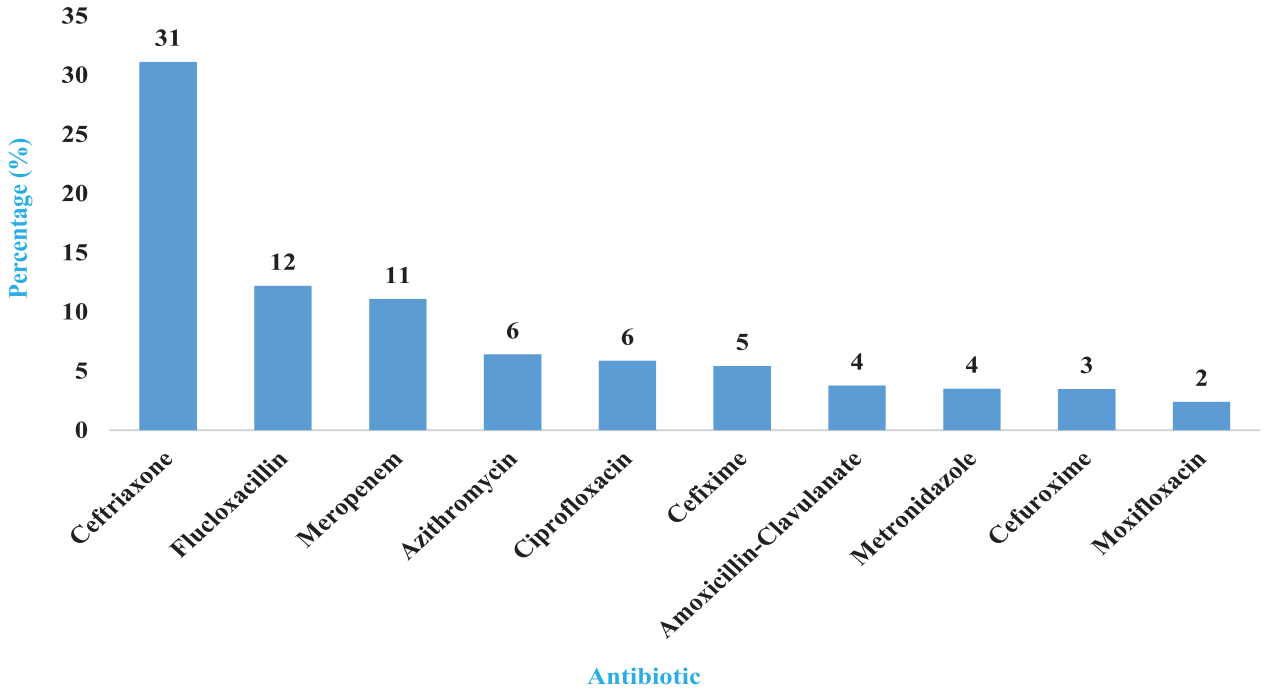


Figure 53: Ten Most commonly used antibiotics (n=20,868)

Table 6: Ten Most commonly used antibiotics in different locations

ICU (n=5,445)	Ward (n=12,697)	OPD (n=2,726)
Ceftriaxone (33.1%)	Ceftriaxone (34.6%)	Ciprofloxacin (19.1%)
Meropenem (31.5%)	Flucloxacillin (17.1%)	Azithromycin (12%)
Moxifloxacin (4.7%)	Azithromycin (7.7%)	Cefixime (10.8%)
Flucloxacillin (4.3%)	Cefixime (6.1%)	Ceftriaxone (10.8%)
Piperacillin-Tazobactam (3.545%)	Ciprofloxacin (5.2%)	Cefuroxime (8.5%)
Tigecycline (3.1%)	Amoxicillin-Clavulanate (4.5%)	Cefuroxime+ Clavulanate (5.4%)
Metronidazole (2.2%)	Meropenem (4.2%)	Flucloxacillin (5.2%)
Amoxicillin-Clavulanate (2.1%)	Metronidazole (3.8%)	Levofloxacin (4.3%)
Vancomycin (1.3%)	Cefuroxime (3.6%)	Metronidazole (4.3%)
Clindamycin (1.2%)	Moxifloxacin (1.5%)	Amoxicillin-Clavulanate (3.3%)

Table 7: Antibiotic usage according to cases

Wound infection (n= 8,278)	UTI (n= 2,061)	Blood stream infection (n= 5,249)	LRTI, Endotracheal aspirate specimen (n=1,772)	LRTI, Sputum specimen (n= 1,498)	Diarrhea (n= 2,010)
Ceftriaxone (31.7%)	Ciprofloxacin (18.6%)	Ceftriaxone (38.1%)	Ceftriaxone (30.5%)	Ceftriaxone (43.7%)	Azithromycin (43.1%)
Flucloxacillin (27.2%)	Ceftriaxone (17.5%)	Meropenem (25.4%)	Meropenem (28.1%)	Amoxicillin-Clavulanate (21.8%)	Ciprofloxacin (29.2%)
Cefixime (7.3%)	Cefixime (11.3%)	Cefixime (4.1%)	Moxifloxacin (5%)	Azithromycin (6.6%)	Ceftriaxone (15.2%)
Cefuroxime (4.9%)	Cefuroxime (10%)	Moxifloxacin (3.9%)	Flucloxacillin (4.6%)	Clarithromycin (6.2%)	Metronidazole (7.1%)
Metronidazole (4.8%)	Azithromycin (9.2%)	Flucloxacillin (3.1%)	Metronidazole (4.4%)	Moxifloxacin (4.9%)	Doxycycline (2.9%)
Meropenem (3.7%)	Meropenem (6.3%)	Amoxicillin-Clavulanate (2.5%)	Piperacillin-Tazobactam (4.1%)	Cefixime (3.2%)	Cefixime (0.8%)
Amoxicillin-Clavulanate (2.6%)	Cefuroxime+ Clavulanate (4.9%)	Piperacillin-Tazobactam (2.3%)	Amoxicillin-Clavulanate (3.4%)	Ciprofloxacin (2.1%)	Ceftazidime (0.3%)
Clindamycin (2.3%)	Nitrofurantoin (3.7%)	Azithromycin (2.1%)	Tigecycline (2.6%)	Levofloxacin (2%)	Cefuroxime (0.2%)
Amikacin (2.2%)	Levofloxacin (2%)	Tigecycline (1.9%)	Clindamycin (1.8%)	Meropenem (1.9%)	Vancomycin (0.1%)
Linezolid (2.1%)	Amoxicillin-Clavulanate (1.9%)	Ciprofloxacin (1.4%)	Vancomycin (1.7%)	Cefuroxime (1.8%)	Erythromycin (0.1%)

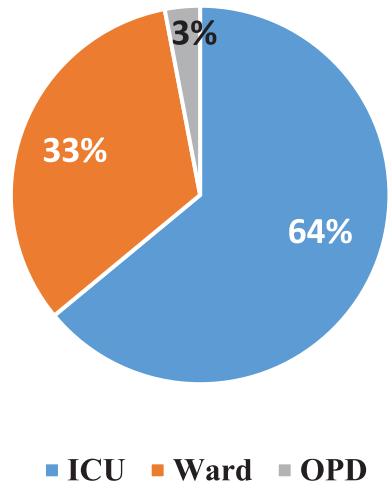


Figure 54: Distribution of antibiotics used in blood stream infection in different locations (n=5249)

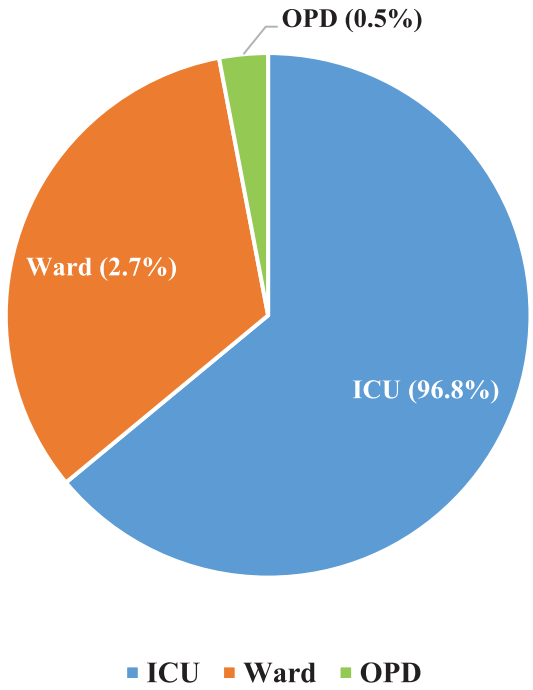


Figure 55: Distribution of antibiotics used in LRTI patients of different locations (n=1,772)

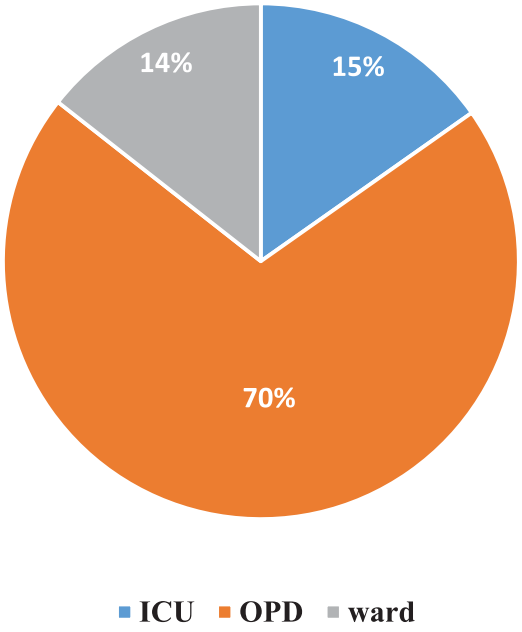


Figure 56: Distribution of antibiotics used in UTI in different locations (n=2,061)

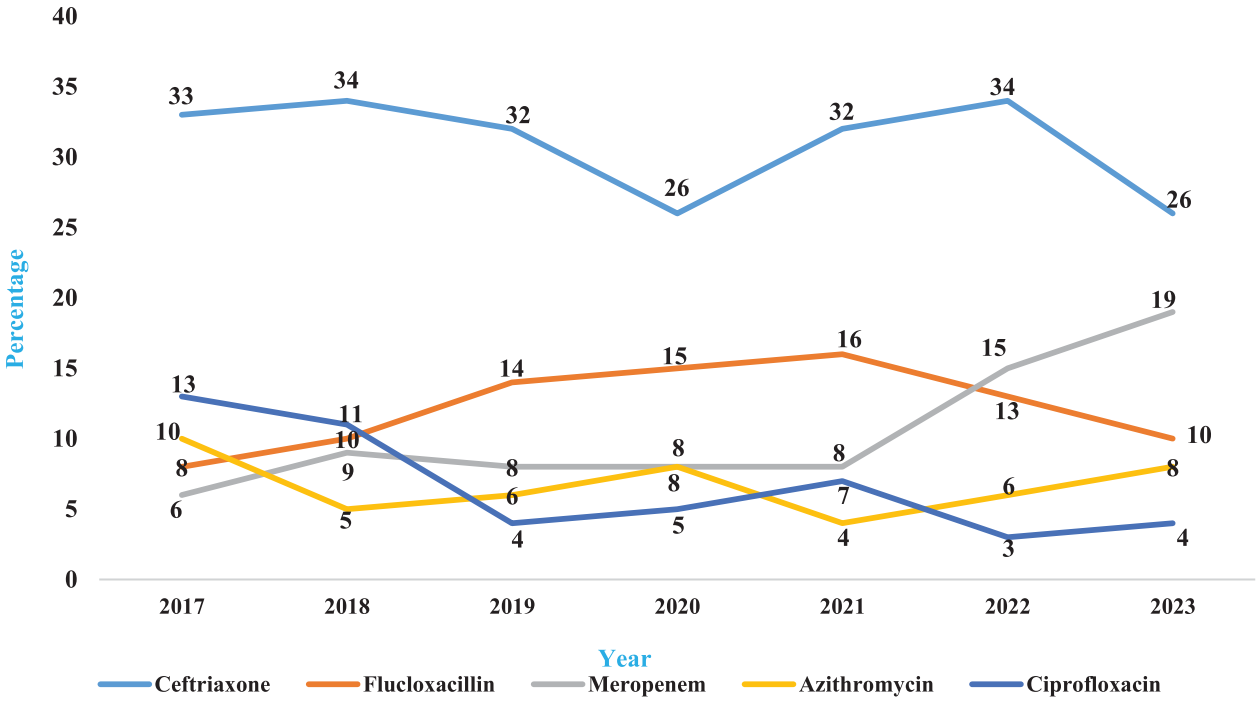


Figure 57: Yearly Trend of five most used antibiotics

Table 8: Most used antibiotics in different sites

DMCH (n=1690)	UAMCH (n=2733)	MMCH (n=4877)	RMCH (n=5249)	RpMCH (n=3431)	SBMCH (n=98)	SOMCH (n=712)	KMCH (n=1363)	CoxMCH (n=455)	BITID (n=228)	CMCH (n=32)
Ceftriaxone (17.1%)	Ceftriaxone (16.8%)	Ceftriaxone (30.1%)	Ceftriaxone (33.1%)	Ceftriaxone (51.5%)	Azithromycin (42.8%)	Ceftriaxone (38.6%)	Ceftriaxone (23.6%)	Flucloxacilin (36.2%)	Ciprofloxacin (67.1%)	Ceftriaxone (50%)
Meropenem (15.6%)	Meropenem (14.8%)	Flucloxacillin (11.3%)	Meropenem (17.9%)	Flucloxacillin (14.4%)	Ceftriaxone (11.2%)	Flucloxacillin (24.4%)	Flucloxacillin (22.1%)	Ceftriaxone (27%)	Ceftriaxone (10.1%)	Flucloxacillin (15.6%)
Clindamycin (8.4%)	Moxifloxacin (10.3%)	Metronidazole (10%)	Flucloxacillin (13.2%)	Cefixime (8.1%)	Cefixime (9.1%)	Cefixime (6.4%)	Cefixime (9.7%)	Azithromycin (14.2%)	Metronidazole (10%)	Piperacillin-Tazobactam (12.5%)
Amikacin (6.5%)	Cefixime (6.4%)	Ciprofloxacin (9.3%)	Azithromycin (10.2%)	Meropenem (6.5%)	Trimethoprim/ Sulfamethoxazole (6.1%)	Cefuroxime (5.8%)	Meropenem (8.8%)	Ciprofloxacin (8.3%)	Azithromycin (7.8%)	Azithromycin (9.3%)
Amoxicillin-Clavulanate (6.5%)	Amoxicillin-Clavulanate (5.6%)	Amoxicillin-Clavulanate (6.6%)	Cefixime (3.6%)	Azithromycin (5.2%)	Amoxicillin-Clavulanate (5.1%)	Metronidazole (4.9%)	Linezolid (6.8%)	Metronidazole (3.7%)	Cefuroxime (1.7%)	Meropenem (6.2%)
Ceftazidime (5.6%)	Ciprofloxacin (5.4%)	Meropenem (6.5%)	Ciprofloxacin (3.7%)	Ciprofloxacin (3.8%)	Cefuroxime (5.2%)	Amikacin (3.6%)	Cefuroxime (6.1%)	Meropenem (2.4%)	Amoxicillin-Clavulanate (1.3%)	Amoxicillin-Clavulanate (3.1%)
Clarithromycin (4.9%)	Azithromycin (5.1%)	Azithromycin (5.6%)	Cefuroxime (3.2%)	Moxifloxacin (3.3%)	Meropenem (5.1%)	Ciprofloxacin (2.8%)	Amoxicillin-Clavulanate (4.5%)	Amikacin (1.9%)	Cefixime (0.4%)	Ciprofloxacin (3.1%)
Metronidazole (4.9%)	Levofloxacin (4.8%)	Cefixime (5.7%)	Tigecycline (2.9%)	Amoxicillin-Clavulanate (1.9%)	Levofloxacin (4.1%)	Amoxicillin-Clavulanate (2.6%)	Ciprofloxacin (3.3%)	Amoxicillin-Clavulanate (1.7%)	Doxycycline (0.4%)	
Cefuroxime (4%)	Cefuroxime (4.7%)	Cefuroxime (4.2%)	Piperacillin-Tazobactam (2.4%)	Cefepime (1.5%)	Nitrofurantoin (4%)	Meropenem (2.5%)	Azithromycin (3.1%)	Cefuroxime (0.8%)	Levofloxacin (0.4%)	
Colistin (3.9%)	Flucloxacillin (4.6%)	Doxycycline (2.6%)	Doripenem (1.3%)	Cefuroxime+ Clavulanate (0.7%)	Flucloxacillin (2%)	Levofloxacin (1.5%)	Cefuroxime+ Clavulanate (2.3%)	Linezolid (0.6%)	Meropenem (0.4%)	

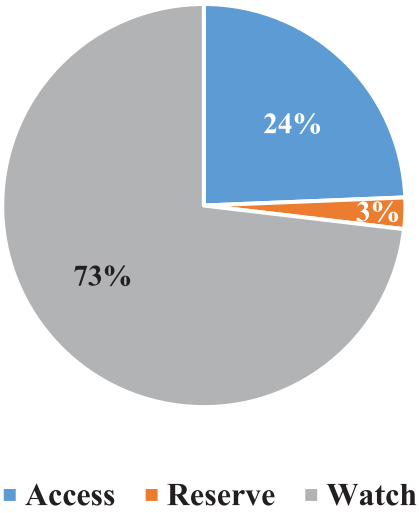


Figure 58: Distribution of AWaRe drug (n=20,627)

Table 9: Distribution of Reserve drug usage

Reserve Drug	N=517	
	n	%
Linezolid	234	45
Tigecycline	187	36
Colistin	79	15
Polymyxin B	12	2
Aztreonam	3	1
Ceftazidime+Avibactam	2	0.4

Table 10: Utilization of reserve drugs across hospital departments

Department	Reserve Drug	Total
	n (%)	N
Burn	80 (12)	668
ICU	256 (4.7)	5432
Medicine	20 (0.3)	6503
Surgery	147 (2.2)	6614
Others	14(1)	1410

Table 11: Distribution of antibiotic usage in various hospital departments for reserve antibiotics

Department	Aztreonam	Ceftazidime +Avibactam	Colistin	Linezolid	Polymyxin B	Tigecycline	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	N
Burn	-	-	55 (68.8)	24 (30)	-	1 (1.3)	80
ICU	2 (0.78)	2 (0.78)	15(5.9)	51 (19.9)	12 (4.7)	174 (67.9)	256
Medicine	-	-	5(25)	12 (60)	-	3 (15)	20
Surgery	1 (0.68)	-	3(2)	143 (97.3)	-	-	147
Others	-	-	1(7.1)	4 (28.6)	-	9 (64.3)	14
Total	3 (0.58)	2 (0.39)	79 (15.3)	234 (45.3)	12 (2.3)	187 (36.2	517

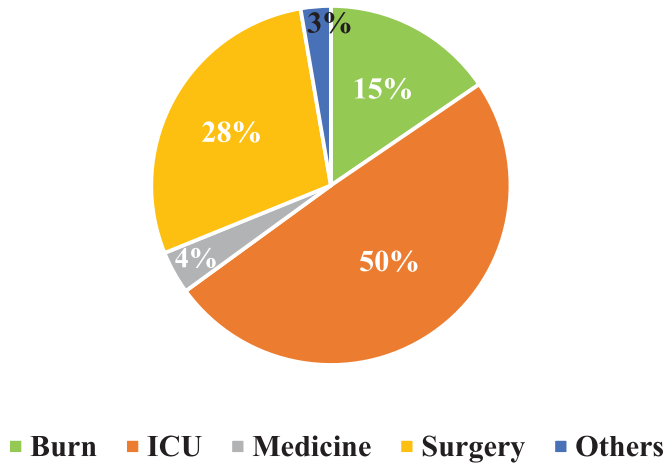


Figure 59: Distribution of reserve drug usage in different departments (n=517)

Table 12: Usage of Reserve drugs in different locations

Locations	Aztreonam	Ceftazidime	Colistin	Linezolid	Polymyxin B	Tigecycline	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	N
ICU	2 (0.8)	2 (0.8)	15 (5.9)	51 (19.9)	12 (4.7)	174 (68)	256
Ward	1 (0.4)	-	63 (26.5)	163 (68.5)	-	11 (4.6)	238
OPD	-	-	1 (4.4)	20 (87)	-	2 (8.7)	23

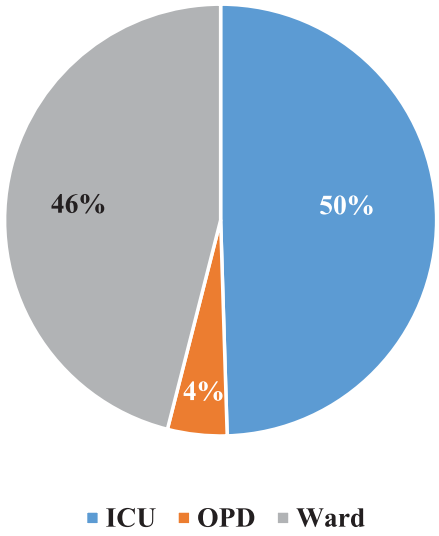


Figure 60: Distribution of reserve drug usage in different locations (n=517)

Table 13: Utilization of reserve drugs across hospital locations

Locations	Reserve Drug	Total
	n (%)	N
ICU	256 (4.7)	5,432
Ward	238(1.9)	12,620
OPD	23(0.9)	2,575

Table 14: Distribution of reserve drug used in OPD

Antibiotic name	N=23	
	n	%
Linezolid	20	87
Tigecycline	2	9
Colistin	1	4

Important points to be noted

1. Most of the antibiotics are developing more and more resistance with time specially those are used more.
2. *E. coli* is the most isolated organism in the laboratory.
3. *Acinetobacter spp., P. aeruginosa, K. pneumoniae and S. aureus* are found to be more resistant among isolated bacteria.
4. There is a substantial difference in resistance of bacteria derived from Outpatient departments, indoors and ICU patients. The organisms isolated from ICU are least susceptible to antibiotics followed by those derived from indoors.
5. Except for a limited number of antibiotics for Gram positive and Gram-negative bacteria the susceptibility of most of the antibiotics are not satisfactory.
6. In Gram positive bacteria Linezolid and Nitrofurantoin (in case of urine sample) are more susceptible
7. In case of Gram-negative bacteria Amikacin, Imipenem, Meropenem and Fosfomycin (in case of urine) are found more susceptible.
8. Ceftriaxone and Cefixime being the top listed used antibiotic have poor susceptibility and the susceptibility is decreasing further.
9. SDG AMR indicator ESBL *E. coli* in blood is 31% and another indicator MRSA is 70%
10. Ceftriaxone resistance is increasing steadily and Carbapenem group of drugs is also showing increasing resistance trend.
11. MDR organisms (Resistant to at least one antibiotic from one group, total 3 or more groups) in case-based surveillance has increased over the time from 71% to 82% from 2017 to 2023.
12. More MDR pathogen is observed in *Acinetobacter spp*. followed by *Pseudomonas aeruginosa*
13. Susceptibility increased in Clindamycin and surprisingly Linezolid.

Antibiotic use

1. Ceftriaxone is the topmost used antibiotic in hospitals well ahead of the 2nd drug Flucloxacillin
2. In ward and ICU, it is the topmost used drug.
3. Cefixime is within the top five used antibiotic in ward and ICU.
4. The only reserve drug in top ten used antibiotic in ICU is Tigecycline
5. Total four Access group of drugs were used in ICU. These are Flucloxacillin, Metronidazole, Amoxicillin and clavulanate combination and Clindamycin
6. Other than diarrhoea and UTI, ceftriaxone is the most preferred drug used in case-based surveillance patients. However, it is within the top five used drug list.
7. Linezolid is the most used reserve drug followed by Tigecycline
8. Most reserve drug is used in burn patients followed by patients admitted in ICU
9. The reserve drug Tigecycline, Colistin and Linezolid were most used reserve drug in ICU, burn patients, and in medicine and surgery department.

Conclusion and the way forward

The National AMR Surveillance conducted in Bangladesh is unique in a sense that it is at present a combination of both cases based and lab-based surveillance. In case-based surveillance active surveillance is done where other than laboratory data patient demographics, clinical presentation, antibiotic treatment histories, comorbidity is recorded by dedicated person. So, data can be used in broader perspective for advanced research. Moreover, the data management system is also unique as the whole system is managed by the own generated software which manages data sending from sentinel site to data visualization, downloading, monitoring, cleaning and dashboard. One of the main objectives of the surveillance is the capacity building of the participating laboratory which are mainly public and situated in different geographical locations, mainly at the divisional level so that it can be upgraded as a regional laboratory. The NRL being the central repository of all the resistant pathogen ensure further research and analysis of MDR pathogens.

The recent inclusion of private laboratories in the system has given access to most AMR data from even more geographical location of the country up to the district level. There is planning to expand the laboratory network and inclusion of more private laboratories into the system to have better understanding of AMR scenario of the country.

The future vision of the NRL is to include fungal pathogens, especially the candida spp., which is a growing threat to public health, especially the immunocompromised patients. Moreover, improving molecular diagnostic capacity and genome sequencing and more engagement and supporting in AMR research is the future commitment of the NRL. For the improvement of the laboratory quality of the sentinel site NRL is building its capacity to conduct EQA of the sites.

However, there are some challenges that should be addressed. The primary concern for the surveillance is that it is principally donor driven and huge resource demanding which is a main challenge to its sustainability. More Government support should be ensured for the sustainability of the program.

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Photo Gallery

Photo gallery

Lab Assessments

Inception Programs

Inception Meeting Antimicrobial Resistance Surveillance


Inception Meeting
Antimicrobial Resistance Surveillance

Consultative Meeting

Consultative Meeting for Exploring the Challenges of IPC and ASP in the Sentinel Sites in Antimicrobial Resistance (AMR) Surveillance, Bangladesh

Consultative Meeting on AMR Surveillance Protocol Update

Consultative Meeting for Updating Laboratory SOP of Antimicrobial Resistance (AMR) Surveillance, Bangladesh







updates

Trainings

Laboratory Data Analysis and Antibiogram Preparation

Hands-on Training of the Surveillance Microbiologist and Medical Technologist of AMR Surveillance in Bangladesh







Training and Refresher Training of the Surveillance Site Personnel

Training on WHONET




Monitoring & Supervision Visits



















Antimicrobial Resistance (AMR) Surveillance in Bangladesh
CDC

Site Selection Visits

Dissemination Programs

Central Dissemination program on Antimicrobial Resistance Surveillance in Bangladesh








Site Dissemination program on Antimicrobial Resistance Surveillance in Bangladesh

World AMR Awareness Week (WAAW) celebrations

Banner at IEDCR & Surveillance Sites

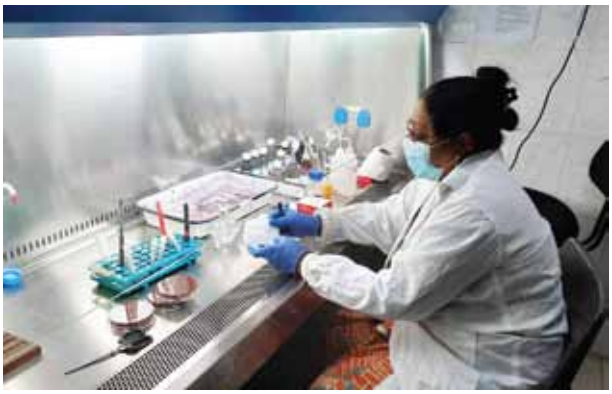
Prize Giving of Competitions Arranged for WAAW

Leaflet Distribution

Poster Exhibition

Rally

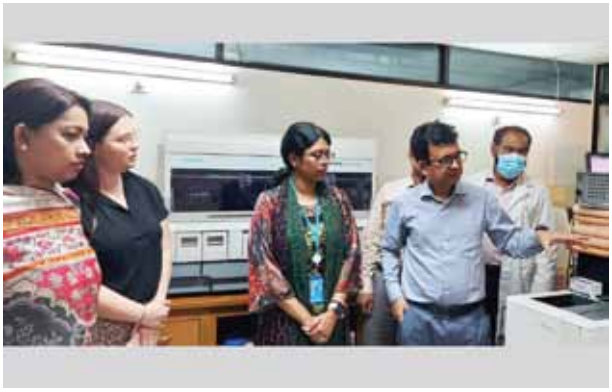
Laboratory activities at NRL



Different Team visiting NRL



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