सत्यमेव जयते
Ministry of Health & Family Welfare
Government of India

Annual Report

National Antimicrobial Surveillance Network (NARS-Net)

Reporting period:
January – December 2023

National Programme on AMR Containment,
National Centre for Disease Control (NCDC)
Directorate General of Health services
Ministry of Health & Family Welfare
Government of India

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Acronyms

AMR	Antimicrobial Resistance
Amox-clav	Amoxicillin/Clavulanic acid
AST	Antimicrobial Susceptibility Testing
BMD	Broth Microdilution
CBDDR	Centre for Bacterial Diseases and Drug Resistance
CLSI	Clinical & Laboratory Standards Institute
CSV	Comma Separated Value
EQAS	External Quality Assessment Scheme
GLASS	Global Antimicrobial Resistance and Use Surveillance System
IPD	Inpatient Department
ICU	Intensive Care Unit
ID	Identification
IQC	Internal Quality Control
LIMS	Laboratory Information Management System
MRSA	Methicillin-Resistant Staphylococcus aureus
NARS-Net	National Antimicrobial Resistance Surveillance Network
NFGNB	Non-fermenting Gram-negative bacilli
NCDC	National Centre for Disease Control
NRL	National Reference Laboratory
OPD	Outpatient Department
OSBF	Other Sterile Body Fluids
PA	Pus Aspirate
R I S	Resistant Intermediate Sensitive
TMP-SMX	Trimethoprim-Sulfamethoxazole
SOP	Standard Operating Procedure
VBA	Visual Basic Application
VRE	Vancomycin-Resistant Enterococcus species
WHO	World Health Organization

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Executive Summary

The National AMR surveillance network (NARS-Net) under the National Programme on AMR Containment, coordinated by the National Centre for Disease Control (NCDC), has been expanded in a phased manner to include 50 laboratories in 33 states/UTs (as of March 2024). In 2017, NCDC was designated by the Ministry of Health and Family Welfare (MoHFW), Government of India as the National Coordinating Centre (NCC) for AMR surveillance and for submitting data to the WHO's Global Antimicrobial Resistance Surveillance and Use System (GLASS)[1]. Antimicrobial Resistance data of selected WHO priority pathogen isolates generated by healthcare hospital laboratories adhering to the standard International/National procedures and part of various AMR surveillance programs in India has been collated and submitted to WHO-GLASS data calls since 2018.

The current report covers the data submitted by NARS-Net sites during the reporting period from 01 January 2023 to 31 December 2023 and includes surveillance data from 41 sentinel sites in 31 States/ Union Territories. Continuous capacity-building trainings are conducted to ensure submission of quality of AMR surveillance data submitted by the sites. A standardized approach is being followed for effective surveillance based on standard operating procedures for antimicrobial susceptibility testing (AST), internal quality control (IQC), data management, and other technical guidelines including International Guidelines such as Clinical Laboratory Standard Institute Guidelines (CLSI) and European Committee for Antimicrobial Susceptibility Testing (EUCAST) documents. To ensure quality of data, AMR isolates designated as Alerts under the programme if isolated at the programme sites, such as vancomycin-resistant *S. aureus* and colistin-resistant Gram-negative bacteria, are mandated to be submitted to the AMR-national reference laboratory (NRL) located at the Centre for Bacterial Disease and Drug Resistance (CBDDR), NCDC for confirmation of identification and antimicrobial susceptibility testing (AST). The virtual capacity-building program "Extension for Community Healthcare Outcome (ECHO)" initiated in 2020, over and above the continuous hands-on training on bacteriology testing methods and data management using WHONET, has also impacted the quality of data. Trainings on colistin agar dilution and broth microdilution methods, both at the NRL at NCDC and onsite during site visits, have contributed to an increase in the number of

[1] https://ncdc.mohfw.gov.in/wp-content/uploads/2024/03/38028959841558086575.pdf

sentinel sites performing colistin agar dilution, colistin broth microdilution (BMD) and vancomycin BMD. Furthermore, shift from quarterly feedback on AMR data to monthly feedback through data quality monitoring calls done monthly with each site by the NCDC Officers, has resulted in close to real time correction of data and confirmation of alerts. This has played a crucial role in improving compliance to data standards defined under the programme. Also, as per the National AMR Surveillance SOP, all network sites are mandated to enroll in External Quality Assessment Scheme (EQAS) and implement internal quality control (IQC) measures to ensure quality of antibiotic discs and culture media so as to maintain microbiology laboratory standards.

Over the past seven years, there has been a gradual increase in the number of reported isolates, rising from 25,833 in 2017 to 1,51,652 in the current data reporting period. Since the last seven years, *Escherichia coli* (*E. coli*) has consistently remained the most commonly isolated pathogen, accounting for one-third (34%) of the AMR surveillance priority pathogens in 2023. Also, *E. coli* (51%) was found to be the predominant pathogen among the urinary isolates. Among the specimen types, urine (46%) was the most frequently reported specimen type followed by pus aspirate (29%) and blood (19%). *S. aureus* was the most isolated pathogen from pus aspirates (27%), aligning with the previous year's findings. Regarding location, over half of the priority pathogens (53%) were isolated from in-patient wards. *E. coli* was the most isolated pathogen in specimens from outpatients (43%) followed by those from patients in emergency settings (34%), in-patients (32%), and ICU patients (18%).

No significant change has been observed in the proportion Methicillin-resistant *S. aureus* (MRSA) isolated from blood in the current data reporting period compared to the data reported for 2022. While, there was an increase in the proportion of Vancomycin-resistant Enterococci (VRE) isolated from blood cultures (19%) compared to the previous year (13%).

The trend analysis for ESBL (extended-spectrum beta-lactamase) in blood isolates of *E. coli* revealed a decrease in ESBL-producing *E. coli* isolates from 86% in 2018 to 82% in 2023. The carbapenem-resistant Enterobacteriaceae (CRE) showed a gradual increase over the last two years, approximately, 40% of *E. coli* and 54% of *Klebsiella* spp. isolates were resistant to at least one of the carbapenems in the current year's data reporting period (35% and 47%, respectively reported in the year 2022). This increase in resistance may be attributed to the increased use of antimicrobials during the COVID-19 pandemic and or due to the increase in the size of data due to increase in the number of sentinel sites in the NARS-Net.

The data mentioned in this report is limited to Government hospitals, majorly Medical College Hospitals, which are part of public healthcare systems providing primary, secondary, and tertiary care in India.

1. National AMR Surveillance Network (NARS-Net) Report

1.1. Introduction

Antimicrobial resistance (AMR) is a serious threat affecting not just humans, but also animals, crops and the environment. AMR is recognized as one of the top ten public health threats by the World Health Organization (WHO). Antimicrobial resistance (AMR) is one of the top global public health and development threats. It is estimated that bacterial AMR was directly responsible for 1.27 million global deaths in 2019 and contributed to 4.95 million deaths[2] and this number is expected to go up if appropriate containment measures are not undertaken. To monitor AMR, a robust surveillance system is needed. In India, strengthening national, state and facility-level AMR surveillance requires real time data collection and analysis for monitoring the trends to inform necessary policies and guidelines.

The National Programme on AMR containment was initiated in 2013, during the 12th (2012-2017) five-year plan and is being coordinated by the National Centre for Disease Control (NCDC). Under the programme, the National AMR Surveillance Network (NARS-Net) has been established which generates annual reports on National AMR Surveillance data from tertiary care facilities since 2018. The current report is the seventh annual report. After the COVID-19 pandemic, with the return to pre-pandemic levels of health activity, there has been a substantial increase in the number of isolates of priority pathogens in the data submitted by the sites.

NARS-Net is being expanded to all states and Union Territories in a phased manner. Currently, 50 medical colleges/laboratories in 27 states and 6 UTs (as of March 2024) ensure geographic representation. The surveillance data submitted by the NARS-Net sentinel sites is analyzed after validation at NCDC using WHONET, a microbiology data management open-source offline software. The annual National AMR surveillance report and the semi-annual bulletins prepared by NCDC are shared with national and state stakeholders and available in the public domain on the NCDC website. The network data is also submitted annually to the World Health Organization's Global AMR Surveillance and Use System (WHO-GLASS) since 2018 by NCDC, which has been notified by MoHFW as the National Coordinating Centre for AMR Surveillance in India.

[2] Antimicrobial Resistance Collaborators. (2022). Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. The Lancet; 399(10325): P629-655.

The NARS-Net sentinel sites conduct laboratory-based AMR surveillance of nine priority bacterial pathogens namely

1. *Staphylococcus aureus*
2. *Enterococcus* species
3. *Escherichia coli*
4. *Klebsiella* species
5. *Pseudomonas* species
6. *Acinetobacter* species
7. *Salmonella enterica* serotype Typhi and Paratyphi
8. *Shigella* species
9. *Vibrio cholerae*

Table 1: Priority Pathogens and specimens included under AMR Surveillance

Clinical Specimen	Laboratory case-definition	Priority pathogens under AMR Surveillance
Blood		*Enterococcus* species *Staphylococcus aureus* *Escherichia coli* *Klebsiella* species *Acinetobacter* species *Pseudomonas* species *Salmonella enterica* serovar Typhi *Salmonella enterica* serovar Paratyphi
Urine	Clinically significant bacteriuria	*Enterococcus* species *Escherichia coli* *Klebsiella* species *Acinetobacter* species *Pseudomonas* species
Pus Aspirate	Growth of pathogenic bacteria from aspirated purulent material from a closed infected site	*Enterococcus* species *Staphylococcus aureus* *Escherichia coli* *Klebsiella* species *Acinetobacter* species *Pseudomonas* species
Other sterile body fluids*	Growth of pathogenic bacteria from a sterile body fluid specimen	*Enterococcus* species *Staphylococcus aureus* *Escherichia coli* *Klebsiella* species *Acinetobacter* species *Pseudomonas* species
Stool	Isolation of pathogen from stool	*Salmonella enterica* serovar Typhi *Salmonella enterica* serovar Paratyphi *Shigella* species *Vibrio cholerae*

* Other sterile body fluids (OSBF)- Include abdominal fluid, amniotic fluid, bile, cerebrospinal fluid, cyst, endocardium, hip fluid, joint fluid, knee fluid, lymph node, semen, broncho-alveolar

lavage, spleen, pleural fluid, pericardial fluid, bone marrow, Bartholin's cyst, fluid, gastric fluid, gallbladder, breast milk and prostatic fluid.

All the participating network sites submit AMR data of nine priority pathogens from the listed specimen types to NCDC. NCDC provides ongoing technical support to each sentinel surveillance network laboratory to ensure proper specimen collection, bacterial culture, identification and antimicrobial susceptibility testing (AST), quality management systems and data management. Sites perform antimicrobial susceptibility testing by disk diffusion, broth microdilution, agar dilution, and automated antimicrobial susceptibility testing systems as per the programme SoPs.

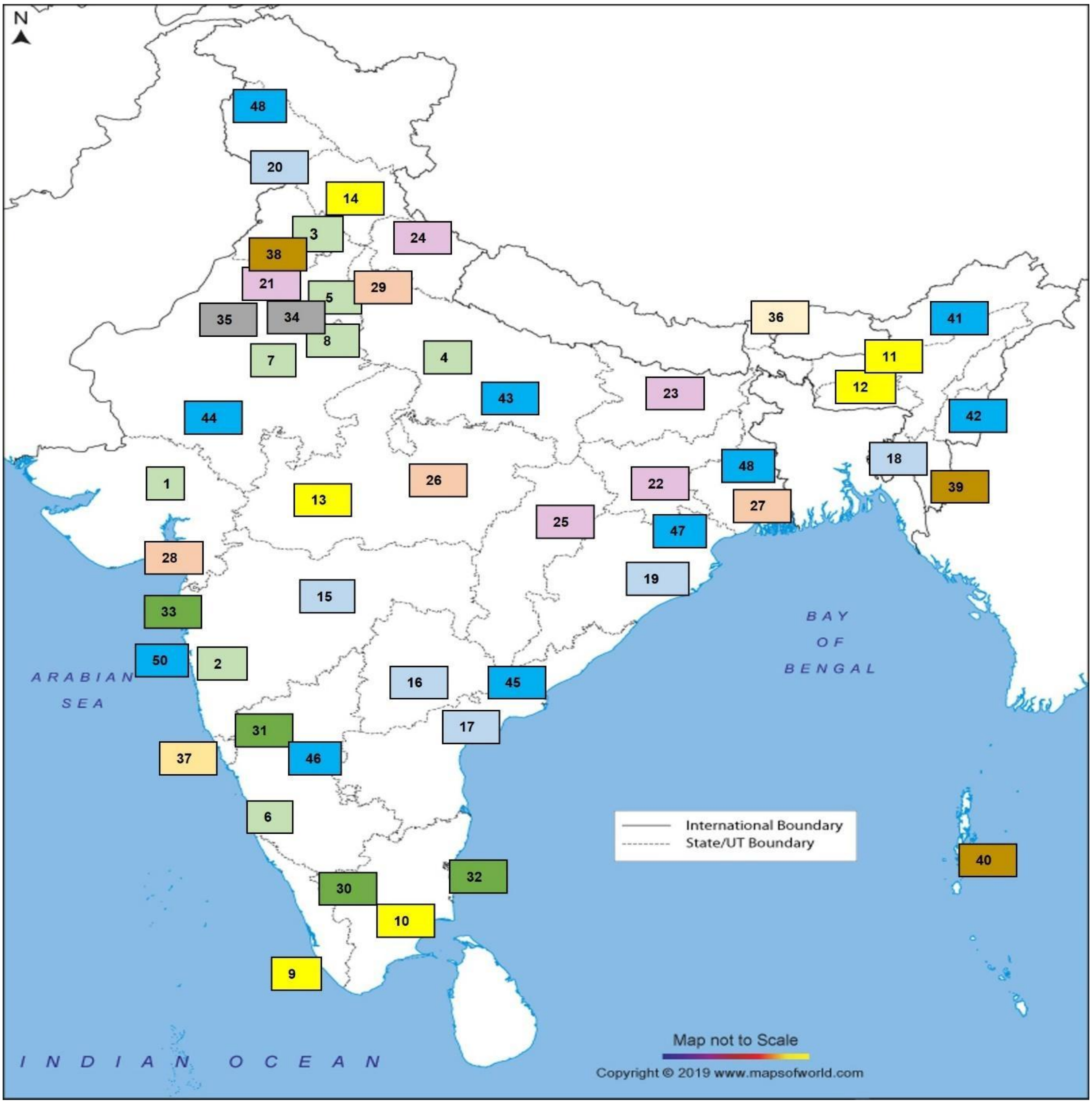


Figure 1- National AMR Surveillance Network laboratories under NARS-Net as of March 2024

The WHONET 2023, an open-source offline microbiology data management desktop application, is used for entering, collating and analyzing routine antimicrobial susceptibility data generated by manual testing methods and automated systems at the laboratories. The classification of the isolates as susceptible, intermediate, or resistant is based on the recent Clinical & Laboratory Standards Institute (CLSI) guidelines.

All sentinel sites submit the AMR data monthly after validating during the monthly data monitoring virtual calls conducted by the designated AMR nodal officers for the respective site at NCDC.

The monthly data calls include validation of data quality with respect to the completeness of data fields and compliance with the AMR Surveillance panel of antibiotics. To ensure data quality, the network sites are mandated to perform Internal quality control testing as per the programme SoPs and participate in the External Quality Assessment Scheme (EQAS) for bacteriology. In addition, defined number of isolates are submitted by the sites for confirmation every quarter to the National Reference Laboratory (NRL) located in the Centre for Bacterial Diseases and Drug Resistance (CBDDR) at NCDC. After confirmation at the NRL, feedback is provided to the sites. Antibiotic-resistant alert isolates of public health concern, as defined under the programme, are also submitted for confirmation to the NRL at NCDC with the duly filled alert form.

In addition, trainings and onsite support visits are conducted to strengthen bacteriology laboratory capacity, identify the challenges and improve the quality of culture, identification and AST practices. In addition, NCDC frequently organizes trainings and workshops on use of WHONET AMR data management software to facilitate timely AMR surveillance data flow from network sites to NCDC. Hands-on training and tools are also provided for developing facility-level antibiograms.

This annual report covers the AMR data from January 2023 to December 2023. During this period, data has been submitted by 41 sentinel surveillance sites distributed nationwide.

A single file is generated from all the cumulative AMR data files and data de-duplication is done before carrying out the analysis. For analysis, only the first antibiotic susceptibility result is considered for each patient per specimen type and pathogen. For example, if two blood cultures from the same patient yield growth of *E. coli*, only the first has been included in the data; if the growth of *E. coli* is detected in one culture and of *K. pneumoniae* in the other, both results are considered. If there is the growth of *E. coli* in one blood culture and in one urine culture from the same patient, both specimen types are included. From each patient, only the first isolate of a given species isolated during the investigated time interval was included, regardless of its susceptibility profile.

1.2. Findings

This NARS-Net report includes data of 1,51,652 priority pathogen isolates reported by 41 sites in 2023 (List at Annexure-1). The data reported was cleaned and validated at NCDC before analysis and preparation of the annual report. The AMR alert bacterial isolates included in the report are those that have been confirmed at the NRL. All the colistin-resistant Gram-negative priority bacterial isolates have been confirmed using broth microdilution.

1.2.1. Data Deduplication

Deduplication of reported data of 151,652 isolates using WHONET revealed that 142,660 isolates data is from unique patients, which has been further taken for AST analysis. Figure 2 depicts the distribution of AMR surveillance priority pathogen isolates before and after deduplication.

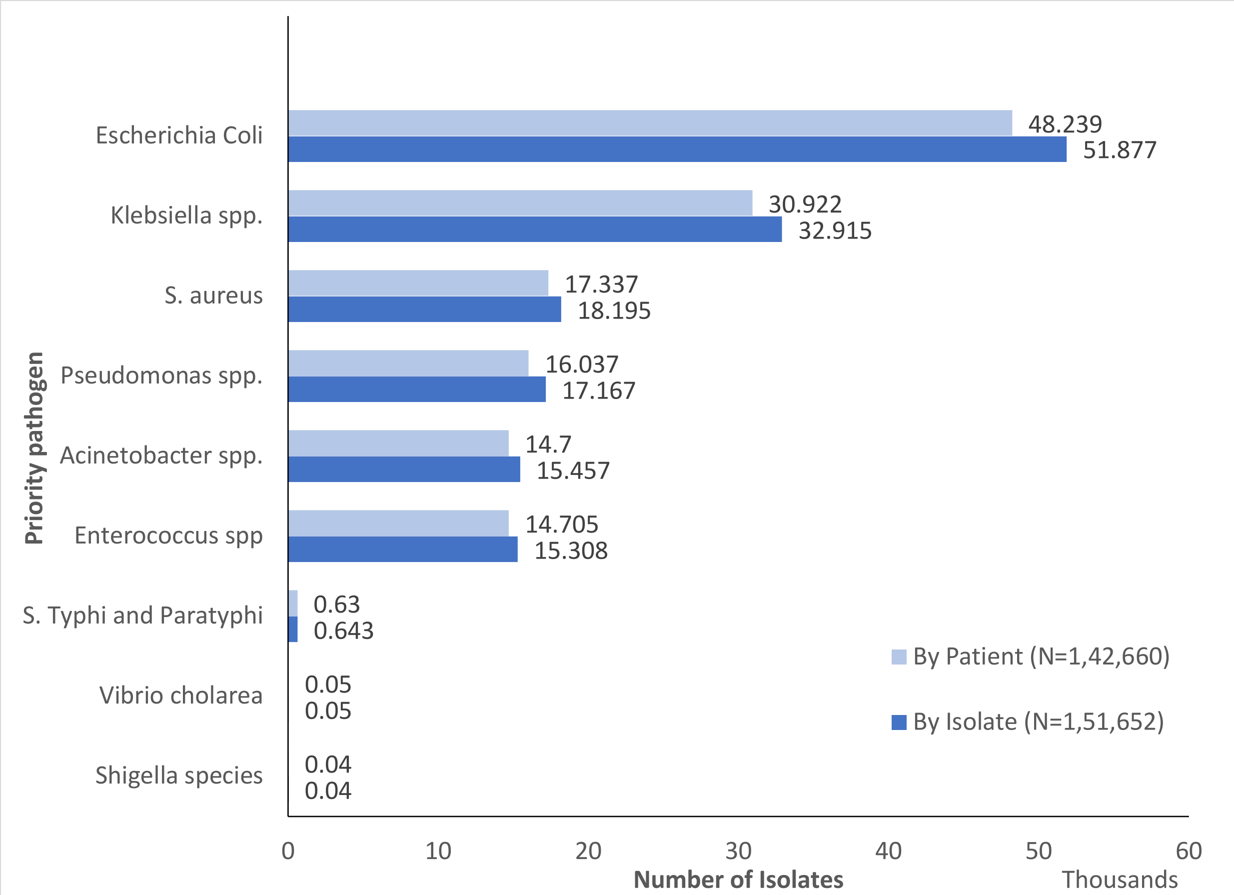
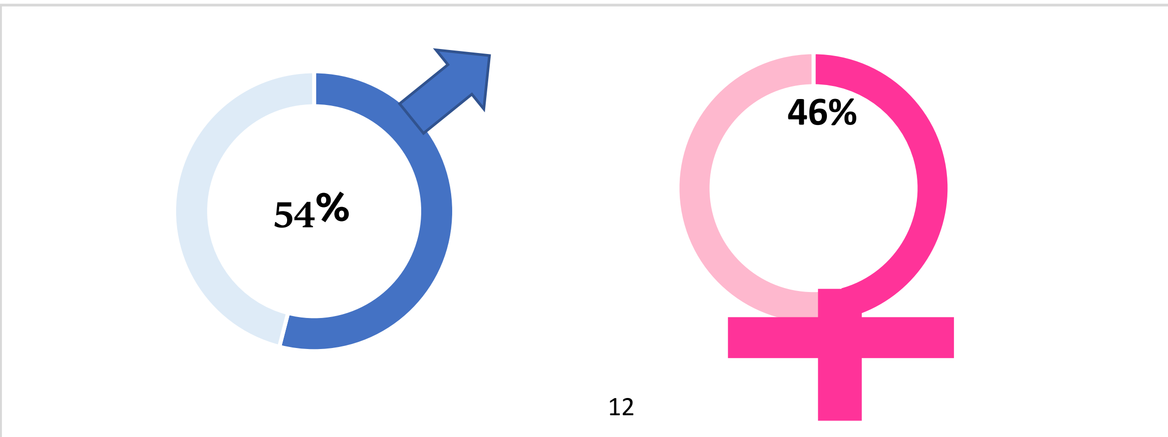


Figure 2- Distribution of priority pathogen isolates and Unique patient isolates

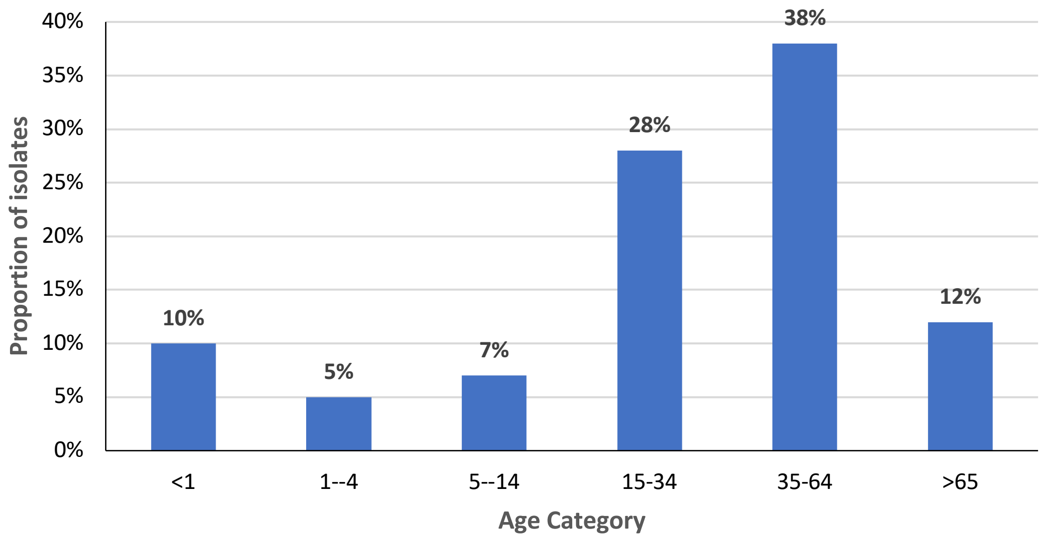
1.2.2. Age and Gender distribution of reported AMR data

Among 1,42,660 unique patients, AST data in this report is from almost equal number of male and female patients (Fig 3). As per the age category, almost a third of unique patients are 36-60, whereas the lowest was reported from under five. About 66 % of AST data was reported from the productive age group of 15-64. Figure 4 represents the distribution of priority bacterial pathogen isolates by age category.



*gender details were missing for 133 isolates

Figure 3 - Distribution of priority pathogen isolates by gender (N=1,42,660)



*Age details were missing for 3,586 isolates

Figure 4- Distribution of all priority pathogen isolates by age category (N=1,42,660)

In the AMR surveillance data reported under NARS-Net during 2023, the most commonly isolated priority bacterial pathogen was *E. coli* (34%), which is similar to the previous four years, followed by *Klebsiella* species (22%), *S. aureus* (12%), *Pseudomonas* species (11%), *Acinetobacter* species (10%) *Enterococcus* species (10%) and *Salmonella* enterica serovar Typhi and Paratyphi (0.4 %) (Table 3). The highest number of isolates in this report are from urine specimens (46%) (Table 2) .

Table 2: Distribution of priority pathogen isolates based on specimen type (N=1,42,660)

Specimen Type	Number of isolates	(%)
Urine	65,917	(46 %)
Blood	26,678	(19 %)
Pus Aspirate	41,993	(29 %)
Other sterile body fluids	7,975	(5.6 %)
Stool	97	(0.07 %)
Total	**1,42,660**	

From urine specimens, *E. coli* (51%) was the most commonly isolated pathogen, from blood specimen the most common priority pathogen isolated was *Acinetobacter* species (23%);

among pus aspirates was *S. aureus* (27%). *Shigella* species (0.028%) and *Vibrio cholerae* (0.035%) were the least commonly isolated pathogens from stool among all reportable pathogens. *E. coli* (23%) and *Acinetobacter* species (23%) were the most commonly isolated pathogens from other sterile body fluids (Table 3).

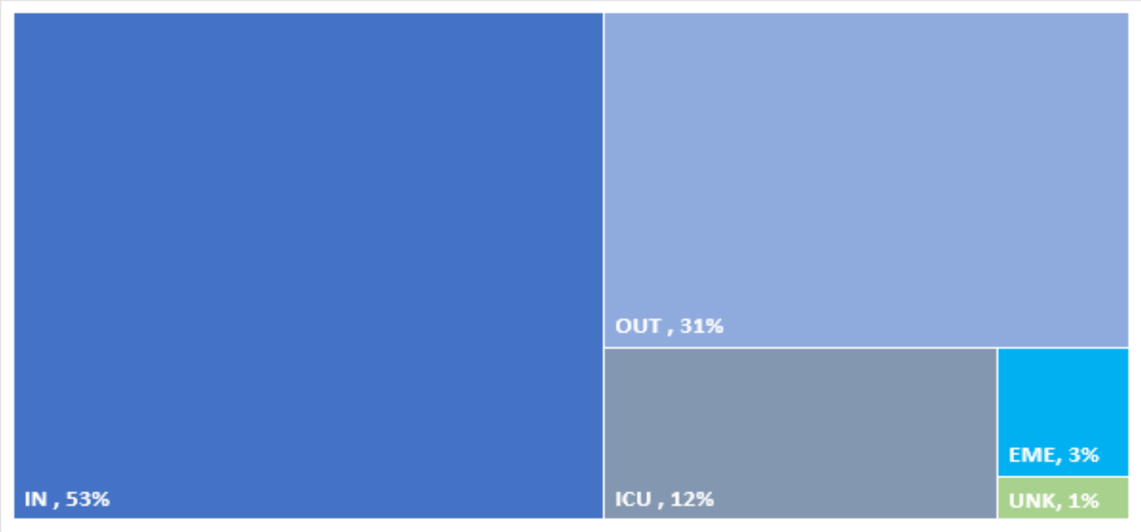
Table 3- Distribution of isolates by specimen type (N= 1,42,660)

Priority Pathogen	Blood		Pus aspirate		OSBF		Urine		Stool	
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
S. aureus	5278	(20%)	11340	(27%)	719	(9%)	x		x	
Enterococcus spp.	2803	(11%)	1508	(4%)	645	(8%)	9749	(15%)	x	
Escherichia Coli	2833	(11%)	9710	(23%)	1814	(23%)	33882	(51%)	x	
Klebsiella spp.	5914	(22%)	8700	(21%)	1694	(21%)	14614	(22%)	x	
Salmonella Typhi and *Paratyphi*	623	(2%)	x		x		x		7	
Pseudomonas spp.	2989	(11%)	6870	(16%)	1290	(16%)	4888	(7%)	x	
Acinetobacter spp.	6238	(23%)	3865	(9%)	1813	(23%)	2784	(4%)	x	
Shigella species	x		x		x		x		40	
Vibrio cholerae	x		x		x		x		50	
Total	26,678	(100)	41,993	(100)	7,975	(100)	65,917	(100)	97	

x - Specimen type not included under the program; *OBSF- Include abdominal fluid, amniotic fluid, bile, cerebrospinal fluid, cyst, endocardium, hip fluid, joint fluid, knee fluid, lymph node, semen, broncho-alveolar lavage, spleen, pleural fluid, pericardial fluid, bone marrow, bartholin's cyst, fluid, gastric fluid, gall bladder, breast milk and prostatic fluid

Table 4 - Specimen type wise distribution of isolates (N= 1,42,660)

Priority	*S. aureus*	*Enterococcus* spp.	*Escherichia Coli*	*Klebsiella* spp.	*Salmonella Typhi* and *Paratyphi*	*Pseudomonas* spp.	*Acinetobacter* spp.	*Shigella* species	*Vibrio cholerae*
Blood	5278 (30%)	2803 (19%)	2833 (6%)	5914 (19%)	623 (99%)	2989 (19%)	6238 (42.4%)	x	x
Pus aspirate	11340 (65%)	1508 (10%)	9710 (20%)	8700 (28%)	x	6870 (43%)	3865 (26.3%)	x	x
OSBF	719 (4%)	645 (4%)	1814 (4%)	1694 (5.5%)	x	1290 (8%)	1813 (12.3%)	x	x
Urine	x	9749 (66%)	33882 (70%)	14614 (47%)	x	4888 (30%)	2784 (19%)	x	x
Stool	x	x	x	x	7 (1%)	x	x	40	50
Total	17337 (100%)	14705 (100%)	48239 (100%)	30922 (100%)	630 (100%)	16037 (100%)	14700 (100%)	40	50



IN – Inpatient; OUT–Outpatient; ICU –Intensive care; EME –Emergency; UNK – Unknown; *Location type field was missing in 1639 isolates

Figure 5- Distribution of isolates by location type (N=1,42,660)

In the 2023 AMR surveillance data, the majority of isolates were from patients admitted in hospital wards (IPD- 53%) whereas the least number of isolates belonged to patients from the Emergency department (3%). Almost a third of the isolates (31%) were from patients visiting the outpatient clinics. About 12% of the priority pathogens were isolated from Intensive care units (Fig. 5).

Table 5 - Distribution of priority pathogen isolates by location type (N=1,42,660)

Priority Pathogen	Inpatient (N=76,170)		Outpatient (N=43,836)		I.C.U. (N=17,163)		Emergency (N=3,852)	
	N	(%)	N	(%)	N	(%)	N	(%)
Escherichia coli	24045	(32)	18995	(43)	3160	(18)	1307	(34)
Klebsiella species	17186	(23)	8579	(20)	4246	(25)	613	(16)
Salmonella Typhi and *Paratyphi*	372	(0.5)	150	(0.34)	88	(0.5)	20	(0.5)
Pseudomonas species	8771	(12)	4812	(11)	1975	(12)	310	(8)
Acinetobacter species	8182	(11)	2392	(5)	3611	(21)	367	(10)
S. aureus	9692	(13)	4573	(10)	1954	(11)	934	(24)
Enterococcus species	7881	(10)	4315	(10)	2127	(12)	276	(7)
Shigella species	22	(0.03)	15	(0.03)		(0)	1	(0.03)
Vibrio cholerae	19	(0.02)	5	(0.01)	2	(0.01)	24	(0.62)

*Location type field was missing in 1639 isolates

Amongst the inpatients, the most commonly isolated priority pathogen was *Escherichia coli* (32%) followed by *Klebsiella* spp. (23%), however an inverse scenario was seen in Intensive care units wherein *Klebsiella* spp. (25%) was the most commonly isolated pathogen followed by *Acinetobacter* spp. (21%) and *Escherichia coli* (18%) (Table 5). *Escherichia coli* was also the most commonly isolated pathogen from Outpatient clinics (43%) and emergency departments (34%). In contrast, the least commonly isolated pathogen amongst all of the location types was *Salmonella Typhi* and *Paratyphi, Shigella* species and *Vibrio cholerae* (Table 5).

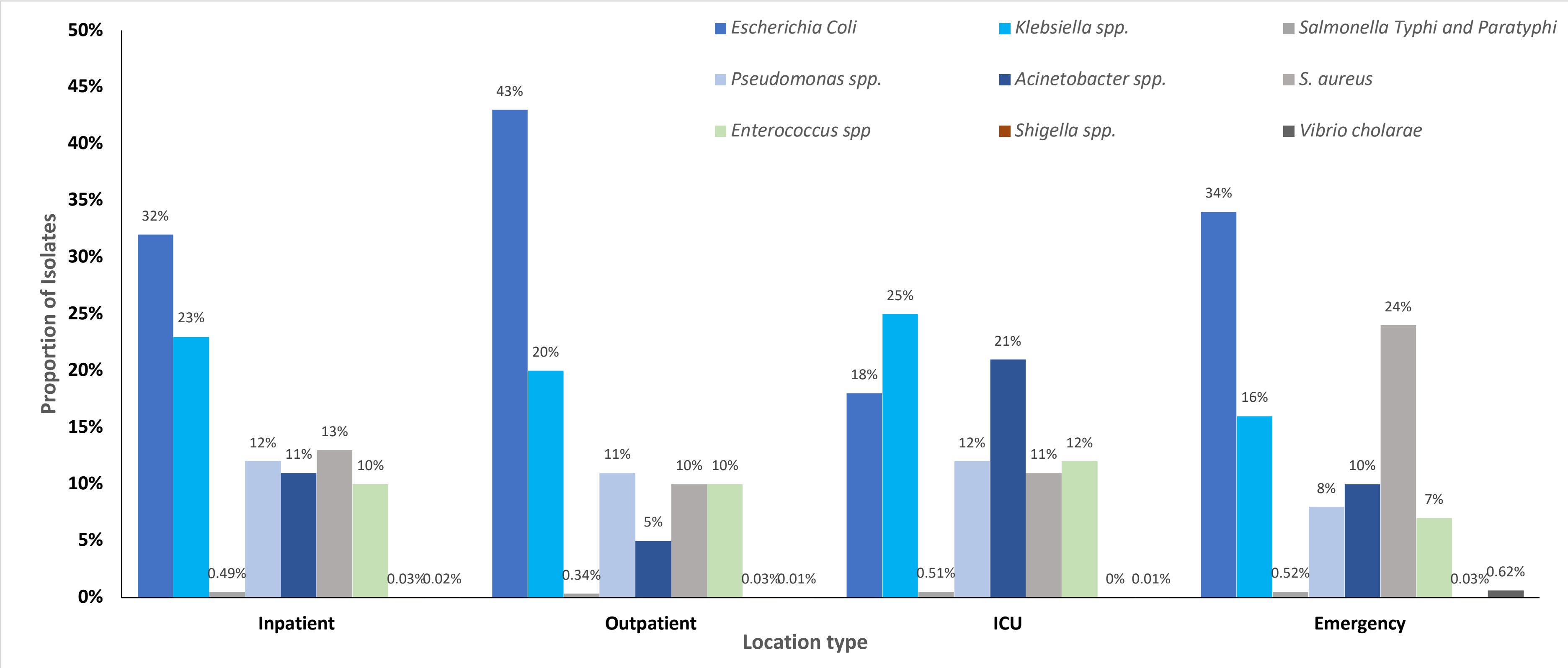


Figure 6- Distribution of priority pathogen isolates by location-type

1.2.3. AMR profile of priority pathogens

1.2.3.1. Gram-Positive Cocci

The AMR surveillance under NARS-Net covers the two most prevalent gram-positive bacterial human pathogens i.e., *Staphylococcus aureus* and *Enterococcus* species. The AST data of 33,503 Gram-positive Cocci (GPC) were submitted to NCDC, of which 32,042 isolates were from unique patients.

Staphylococcus aureus

Staphylococcus aureus constituted an overall 12% among the priority pathogen isolates (Table. 3). During the 2023 reporting period, a total of 18,195 *S. aureus* isolates data were submitted to NCDC of which 17,337 isolates were from unique patients. AST analysis of 17,337 isolates indicates the significant contribution of *S. aureus* in bacteremia as the isolation rate from blood is 30%, whereas, 65% of *Staphylococcus aureus* isolated from aspirated pus and 4% from sterile body fluids (Table 4).

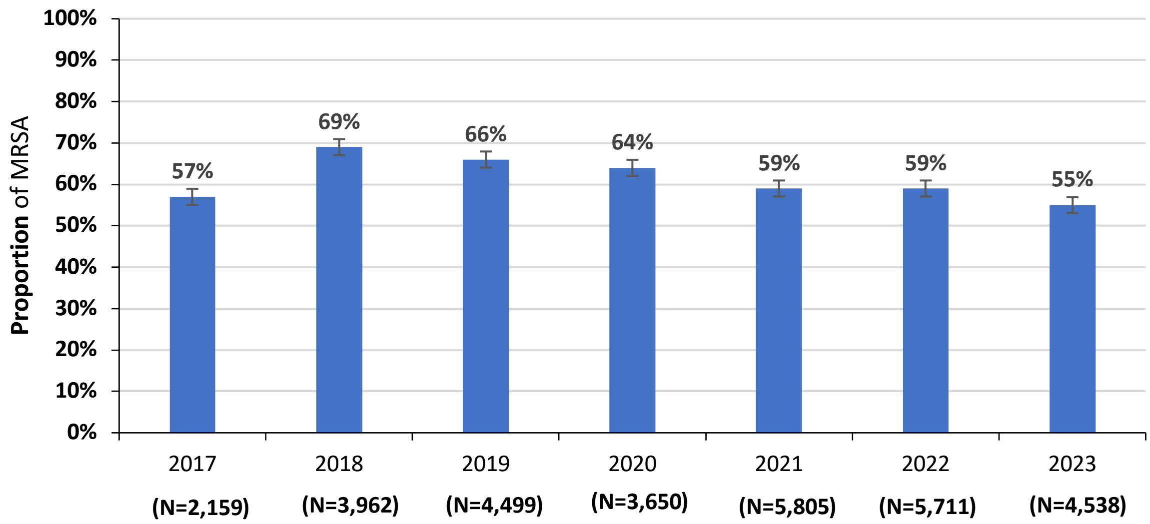
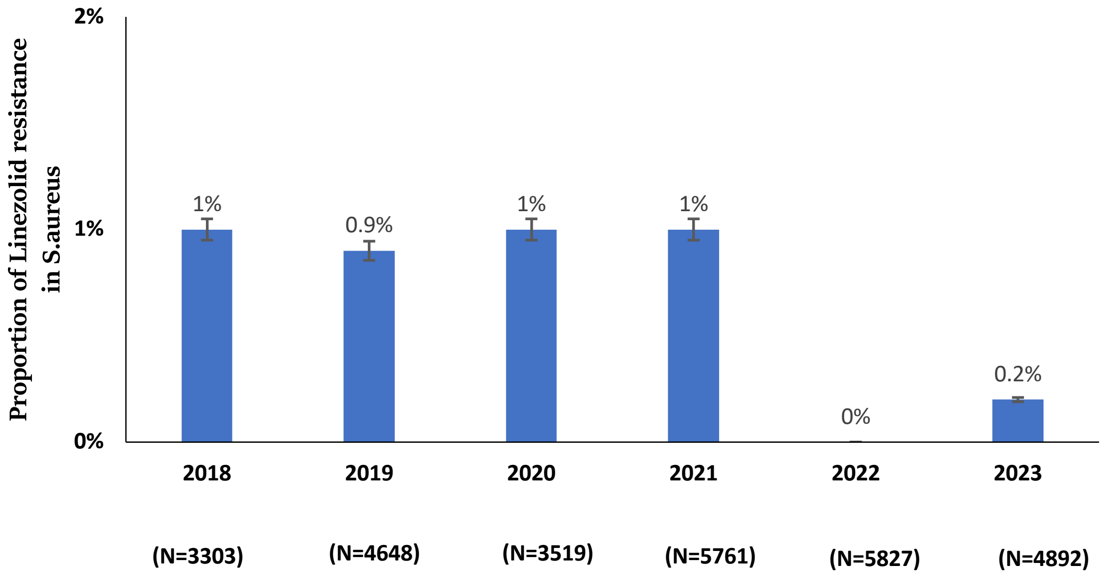


Figure 7- Trends of Methicillin-resistant *S. aureus* (MRSA) isolated from blood (2017-2023)

Approximately half of *Staphylococcus aureus* isolated from blood (55%; 95% (confidence interval) CI: 53.7-56.6) and from pus aspirates (54%; 95% CI: 53-55) were resistant to cefoxitin (a surrogate for mecA-mediated oxacillin resistance) meanwhile, the resistance to cefoxitin in pus aspirates and other sterile body fluid was lower in comparison to the blood isolates (Table 6).



*Alert pathogens confirmed at NRL, NCDC only were included in the data

Figure 8 - Trends of Linezolid resistant *S. aureus* isolated from blood (2018 to 2023)

Trend analysis of MRSA isolated from blood over the past 6 years showed decrease in proportion of MRSA from 69% (2018) to 55% (2023).

Linezolid resistance in *S. aureus* isolated from blood was consistently found to be approx. 1% in the last five years. However, in 2022, none of the *S. aureus* isolated from blood were resistant to linezolid (Fig. 8). Notably, there seems to be a 0.2% rise in resistance to linezolid in this reporting period from Jan to Dec 2023. Out of 11,240 isolates tested on Vancomycin screen agar, none showed growth on the vancomycin screen agar plate.

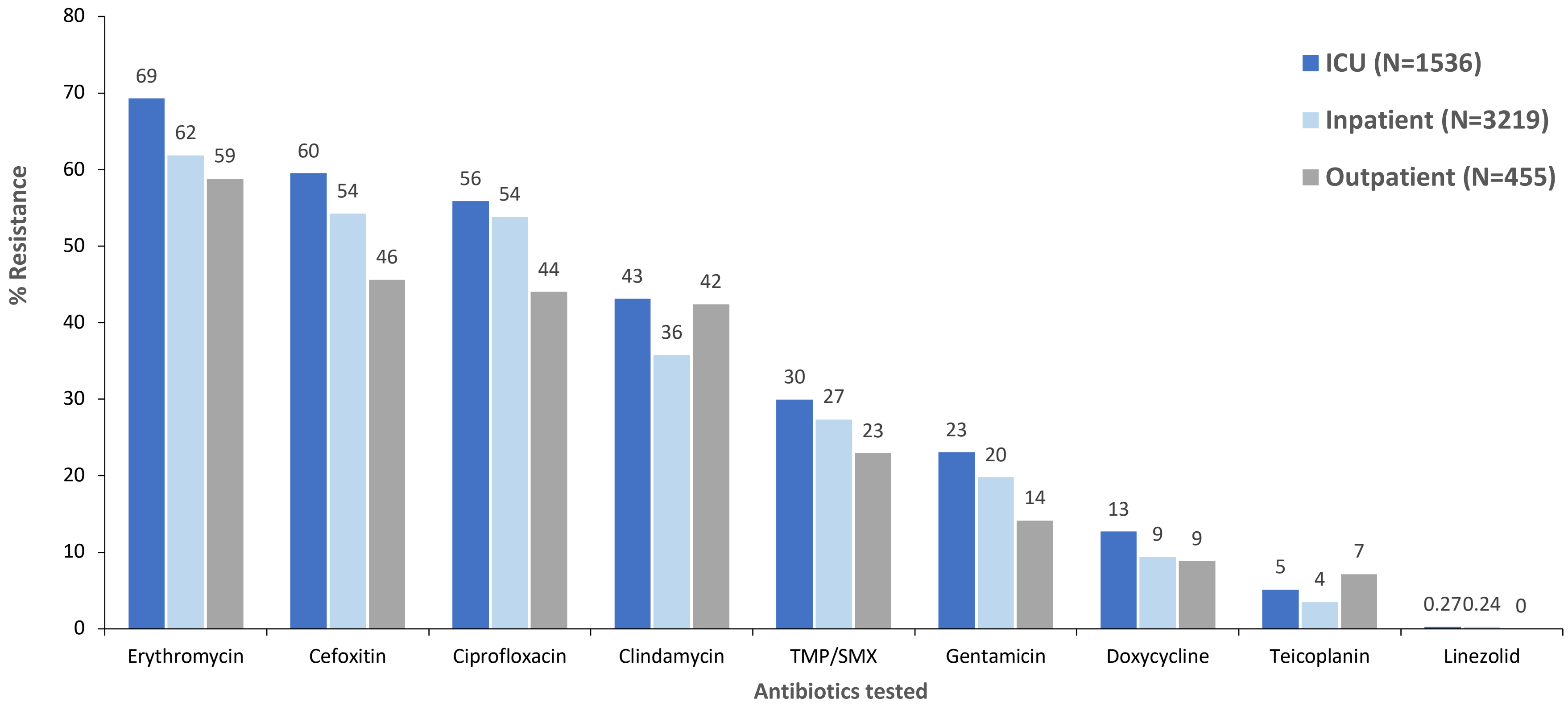
Among the GPCs isolated in the data reported, *S. aureus* was the most isolated GPC from all the location settings like inpatient wards (55%), outpatient clinics (51%) and the emergency department (77%) in contrast from intensive care settings, *Enterococcus* (52%) was mostly isolated (Table 4). Resistance to all the surveillance panel antibiotics were proportionately higher among isolates from intensive care setting than those from outpatient clinics and the inpatient wards as seen in Fig. 9.

Table 6 - Resistance profile of *Staphylococcus aureus* (N=17,337)

Antibiotic tested	Blood (N=5,278)			Pus Aspirate (N=11,340)			Other Sterile Body Fluids (N=719)		
	Number Tested	(%R)	95% CI	Number Tested	(%R)	95% CI	Number Tested	(%R)	95% CI
Cefoxitin	4538	55	53.7-56.6	10146	54	53.0-55.0	650	45	41.1-48.8
Ciprofloxacin	4519	54	52.2-55.1	9473	69	67.6-69.5	625	57	53.0-60.9
Clindamycin	5074	38	37.1-39.8	10853	28	27.6-29.3	692	30	26.6-33.5
Doxycycline	4553	10	9.5-11.3	9097	8	7.9-9.1	612	12	9.8-15.2
Erythromycin	4878	64	62.2-64.9	10258	54	53.0-54.9	682	54	50.4-58.0
Gentamicin	4484	20	19.2-21.5	9574	21	20.3-22.0	654	22	19.4-25.9
Linezolid*	4896	0	0.1-0.4	10673	0.02	0-0.1	702	0	0.0-0.7
TMP/SMX	4206	28	26.5-29.2	8839	19	18.5-20.2	589	27	23.2-30.5
Teicoplanin	943	4	3.1-5.8	1565	6	4.8-7.3	147	3	1.3-8.2

*Alert pathogens confirmed at NRL, NCDC only were included in the data

TMP/SMX –Trimethoprim/sulfamethoxazole



*Data of the emergency department was clubbed with data from inpatient wards; Location type for 68 isolates data is missing

TMP/SMX -Trimethoprim/sulfamethoxazole

Figure 9 – Resistance profile of *S. aureus* in blood (N=5,210)

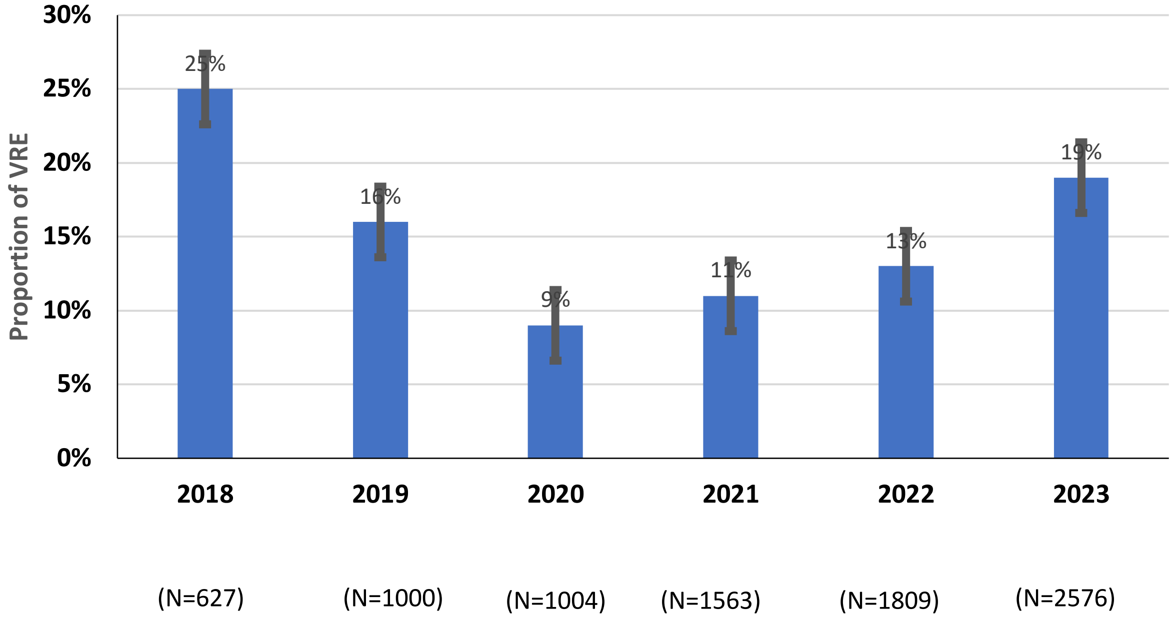
Enterococcus species

Enterococcus species contributed 10% amongst nine priority pathogens isolated by the surveillance sites while contributing to 46% of the Gram-positive cocci (Table 4). A total of 15,308 *Enterococcus* species isolates data were submitted by the NARS Net sites of which 14,705 isolates were from unique patients (Fig. 2). Upon analysis of 14,705 unique patient isolates, isolation rates from specimen types like urine, blood, pus aspirates and other sterile body fluids were 66%, 19%, 10% and 4% respectively (Table 4).

Among *Enterococcus* species isolated from blood, erythromycin resistance was noted to be 79% (CI: 77.7- 80.9) followed by Ampicillin (68%, CI: 65.7-69.6). A similar resistance pattern was also seen in other specimen types like pus aspirate and sterile body fluids (Table 7). Notably, resistance to linezolid (1.7%, CI: 1.2-2.3) amongst blood isolates is significantly higher than last year. Resistance to linezolid among other specimen types like pus aspirate (0.4%, CI: 0.1-0.9) and other sterile body fluid (1.5%, CI: 0.8 -3.1).

Among the urinary isolates, over half of the isolates were resistant to first-line antibiotic ampicillin (56%, CI: 54.5 – 56.7) and Gentamicin-high (52%, CI: 50.8-52.9). Moreover, 82% of all urine *Enterococci* isolates were resistant to ciprofloxacin (CI: 81.1 - 82.8). Only 0.6 % (CI: 0.4-0.8) and 6% (CI: 5.9- 6.9) of the isolates from urine were resistant to reserve antibiotics like linezolid and Vancomycin. (Table 7).

Compared with the other priority pathogens under the programme, *Enterococcus* species isolated from various location types were sparse. One in 10 isolates were from inpatient wards and outpatient clinics each (Table 5). Upon AST analysis of blood isolates from various location types in healthcare facilities, resistance to the entire panel of antibiotics was found to be higher in isolates from intensive care units in comparison to the inpatient wards and outpatient clinics except for gentamicin-high, doxycycline and teicoplanin (Fig. 11)



*Alert pathogens confirmed at NRL, NCDC only were included in the data

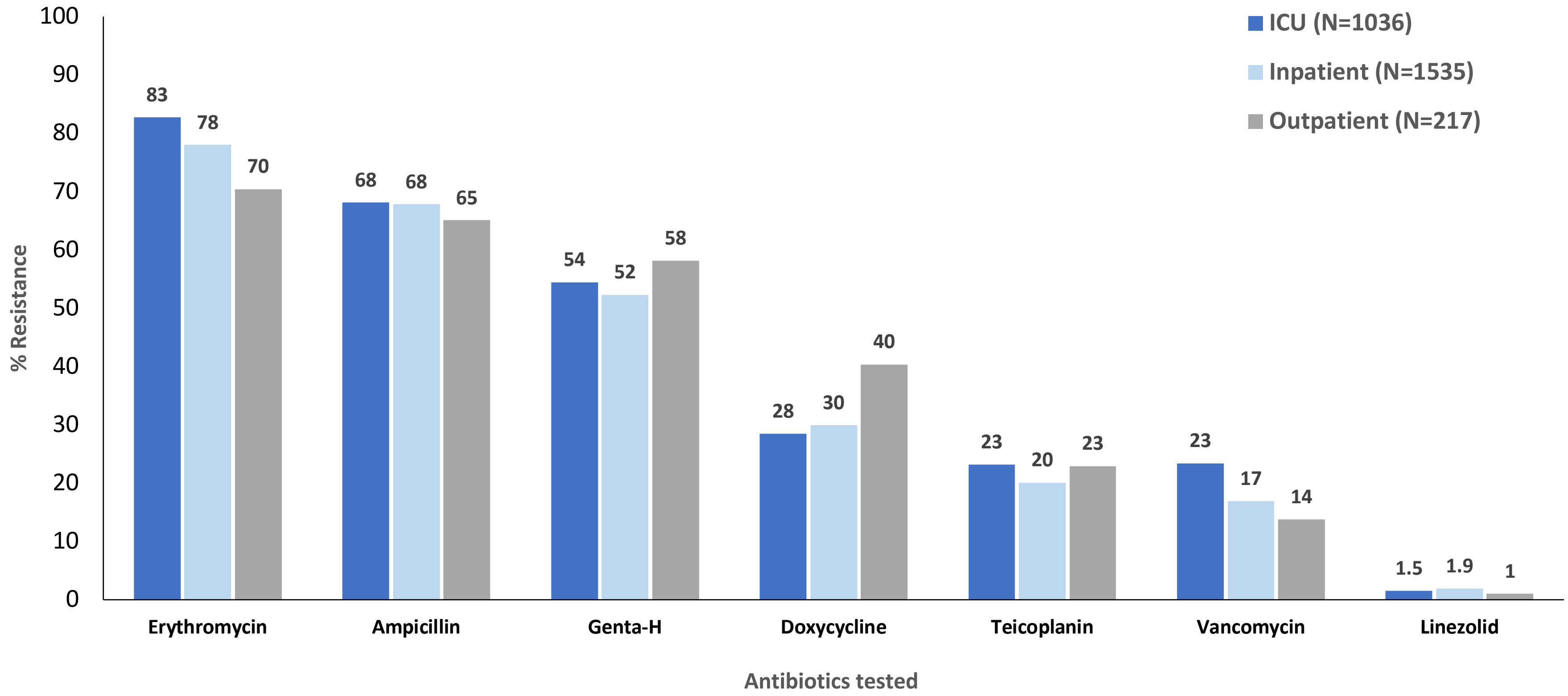
Figure 10: Trends of Vancomycin resistant *Enterococcus* sp. (VRE) isolated from blood (2018-2023)

Trend analysis of VRE isolated from blood showed increase in the proportion of VRE from 2020 (9%) to 2023 (19%).

Table 7 - Resistance profile of *Enterococcus* species (N=11,072)

	Blood (N=2,803)			Pus Aspirate (N=1,508)			OSBF (N=645)			Urine (N=9,749)		
Antibiotic Tested	Number Tested	%R	95% CI	Number Tested	%R	95% CI	Number Tested	%R	95% CI	Number Tested	%R	95% CI
Ampicillin	2275	68	65.7-69.6	1287	47	44.6-50.1	540	59	54.2-62.7	8208	56	54.5-56.7
Doxycycline	2069	30	28.1-32.1	1111	32	29.1-34.7	491	35	30.8-39.5	3399	48	46.5-49.9
Erythromycin	2435	79	77.7-80.9	1258	73	70.8-75.8	593	80	76.1-82.7		x	
Gentamicin-High	2434	53	51.5-55.5	1321	38	35.2-40.5	580	47	42.6-50.9	8705	52	50.8-52.9
Linezolid	2561	1.7	1.2-2.3	1359	0.4	0.1-0.9	613	1.5	0.8-3.1	8929	0.6	0.4-0.8
Teicoplanin	1457	22	19.7-24.0	670	15	12.2-17.7	289	15	11.1-19.6	3418	19	17.6-20.2
Vancomycin	2576	19	17.6-20.7	1361	5	4.3-6.8	605	14	11.3-17.0	8808	6	5.9-6.9
Ciprofloxacin		x			x			x		7755	82	81.1-82.8
Fosfomycin		x			x			x		3434	20	18.8-21.5
Nitrofurantoin		x			x			x		7357	27	25.6-27.7
Tetracycline		x			x			x		6067	73	71.4-73.7

*Alert pathogens confirmed at NRL, NCDC only were included in the data



*Data from the emergency department was clubbed with data from inpatient wards; the Location type for 15 isolates is unknown

Figure 11- Resistance profile of *Enterococcus* species in blood (N=2,788)

1.2.3.2. Gram-Negative Bacilli

Under NARS Net, the seven Gram-negative bacilli of public health importance are included in AMR surveillance. These are *Escherichia coli, Klebsiella* species, *Pseudomonas* species, *Acinetobacter* species, *Salmonella* enterica serovar Typhi and Paratyphi, *Shigella* species *and Vibrio cholerae*. AST data of 1,18,149 isolates of gram-negative bacilli have been reported from 1,10,618 unique patients from January 2023 to December 2023 from 41 sentinel sites.

1.2.3.2.1. Enterobacteriaceae

Data of 85,475 isolates of *E. coli, Klebsiella* species, *Salmonella enterica* serovar Typhi and Paratyphi and *Shigella* species was submitted by network sites from 79,841 unique patients. The most commonly reported isolates among all the priority pathogens (56%) and among the Gram-negative bacteria (72%) belong to *Enterobacteriaceae*.

Escherichia coli

A total of 51,877 *E. coli* isolates were reported from 48,239 unique patients. These isolates contributed to one-third of the unique patient AST data during the year 2023 (Fig. 2). *E coli* was most commonly isolated from the urine samples (70%) followed by pus aspirate (20%), blood (6%) and sterile body fluids (4%) (Table 4). Regarding the resistance pattern, the highest resistance was observed to ampicillin among all the specimen types (Table 8). A high proportion of resistance to ciprofloxacin was observed with 72% (CI: 70-73.6) resistance in blood isolates and 80% in OSBF isolates. Fifty-seven percentage of resistance (CI: 54.6- 58.8) to trimethoprim-sulfamethoxazole was seen among blood isolates, similar pattern was observed for other specimen types. Resistance to nitrofurantoin in the urine isolates has increased from 9% during 2022 to 16% (CI: 15.9 – 16.7) in the current reporting period. (Table 8).

Among the third generation cephalosporins, 82% (CI: 80.3- 83.7) resistance to cefotaxime was observed in blood isolates and 75% (CI: 74.9 - 76) in urine isolates. Imipenem resistance in *E. coli* was observed to be 39% (CI: 37.1 – 41.1) in blood isolates and 21% (CI: 20.6 – 21.6) in urine isolates (Table 8). Colistin susceptibility testing has been done using the broth microdilution method as per CLSI document M02 and M100 wherein the 2023 data showed resistance to colistin in three isolates from blood, six from OSBF, one from pus aspirate and twelve from urine and these isolates were further confirmed in the NRL at NCDC.

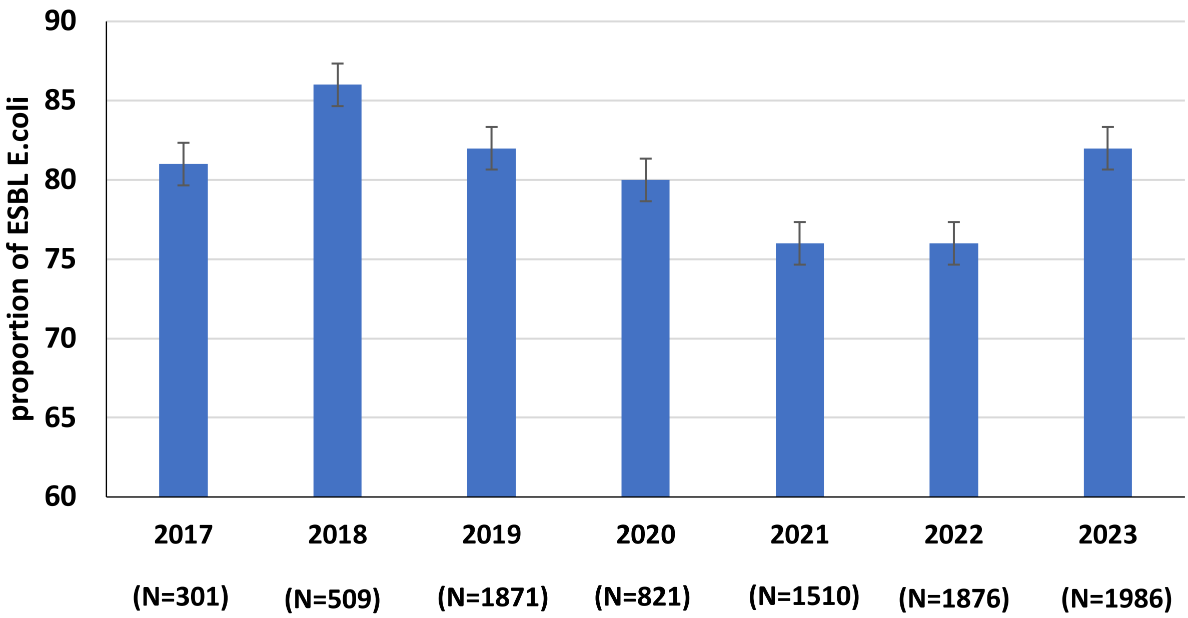


Figure 12- Trends of Extended spectrum beta-lactamase (ESBL) producing *E. coli* isolated from blood (2017-2023)

Trend analysis for ESBL producing *E. coli* from blood showed an increase (82%) compared to the previous 2 years (76%). (Fig 12).

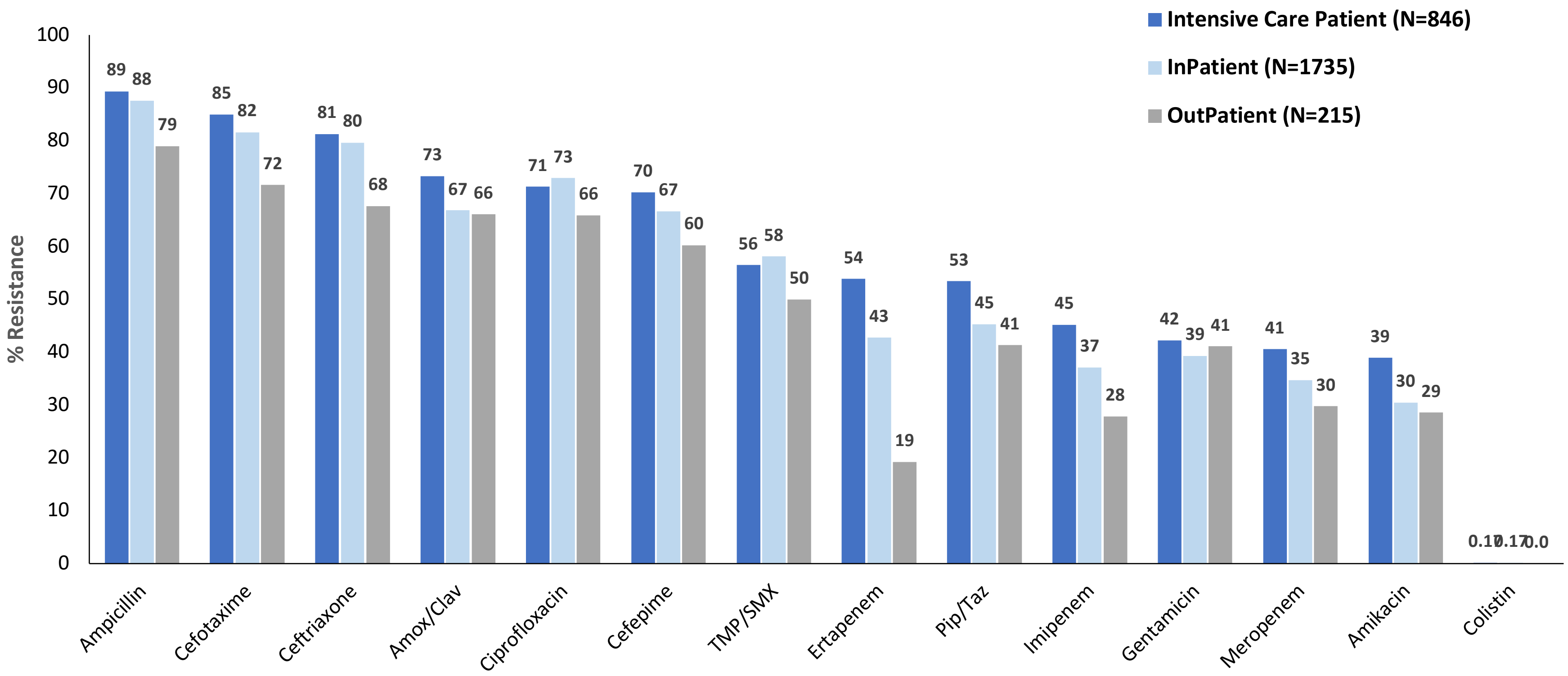
Among blood isolates of *E. coli*, resistance profile based on the location type showed higher resistance to all the surveillance panel antibiotics in isolates from the intensive care units as compared to isolates from inpatient and outpatient departments. (Fig 13)

Table 8- Resistance profile of *Escherichia coli* (N=48,239)

	Blood (N=2,833)			PA (N=9,710)			OSBF (N=1,814)			Urine (N=33,882)		
Antibiotic Tested	Number Tested	%R	95% CI	Number Tested	%R	95% CI	Number Tested	%R	95% CI	Number Tested	%R	95% CI
Ampicillin	1901	87	85.9-88.9	7372	88	87.9-90.7	1484	88	86.4-89.7	24992	86	85.7-86.5
Amox/Clav	1678	70	67.4-71.8	6048	69	66.6-71.2	1088	73	70.0-75.4	19583	56	55.0-56.4
Pip/Taz	2317	48	46.0-50.1	7240	44	38.9-46.8	1428	45	42.6-47.9	21645	30	29.4-30.6
Ceftriaxone	1114	80	77.4-82.2	3945	76	73.8-77.2	705	81	77.9-83.8	11107	70	68.7-70.4
Cefotaxime	1986	82	80.3-83.7	7728	81	79.8-84.3	1495	82	79.8-83.8	27068	75	74.9-76.0
Cefepime	2430	67	65.5-69.2	8239	64	59.7-64.6	1646	64	61.8-66.5	27750	56	55.3-56.5
Ertapenem	1007	47	43.8-50.0	2594	38	34.5-43	617	44	40.5-48.4	11009	27	26.1-27.8
Imipenem	2314	39	37.1-41.1	7443	28	26.2-31.6	1576	33	30.3-35.0	27319	21	20.6-21.6
Meropenem	1907	36	34.3-38.7	6345	25	22.7-28.4	1187	29	26.2-31.4	19903	17	16.4-17.5
Amikacin	2489	33	31.0-34.8	8041	28	24.1-28.0	1622	26	24.0-28.3	25503	22	21.9-23.0
Gentamicin	2266	40	38.3-42.3	7088	36	31.1-38.7	1400	35	32.3-37.4	20430	30	28.9-30.2
Ciprofloxacin	2427	72	70.0-73.6	7797	78	75.7-79.3	1620	80	77.5-81.5	28791	76	75.4-76.4
TMP/SMX	2176	57	54.6-58.8	7268	58	55.2-59.5	1447	60	57.5-62.7	27596	57	56.2-57.4
Colistin	1858	0.16	0-0.5	5333	0.0	0.0-0.1	1255	0.48	0.2-1.1	12069	0.10	0.1-0.2
Fosfomycin		x			x			x		12771	4	3.7-4.4
Nitrofurantoin		X			x			x		30769	16	15.9-16.7
Doxycycline				2080	41	37.5-42.8	524	48	43.7-52.5		x	

x- Drug bug combination for the specimen type not included in the NARS-Net surveillance panel

TMP/SMX - Trimethoprim/sulfamethoxazole
Amox-clav -Amoxicillin/Clavulanic acid



PipTaz – Piperacillin-Tazobactam
Amox-clav -Amoxicillin/Clavulanic acid
TMP/SMX - Trimethoprim/sulfamethoxazole

*Data from the emergency department was clubbed with data from inpatient wards; the Location type for 37 isolates is unknown

Figure 13 - Resistance profile of *Escherichia coli* in blood (N=2,796)

Klebsiella species

In the current data reporting period, 32,915 *Klebsiella* species isolates were reported of which 30,922 were from unique patients. The isolation rate of *Klebsiella* spp. in data reported by the sentinel sites was highest from urine (47%) followed by pus aspirate (28%), blood (19%) and OSBF (5.5%) (Table 4).

Among the urine isolates, one-third of the isolates tested against aminoglycosides namely amikacin (36%, CI: 35 – 36.8) were found to be resistant; while 47% (CI: 46.6 - 48.3) resistance was observed to nitrofurantoin (Table 9). Seven of every 10 isolates of *Klebsiella* spp. from urine were found to be resistant to third generation cephalosporins. With respect to carbapenem resistance in urine isolates, resistance to ertapenem (42%, CI: 40.2- 43.2) was highest.

Like urine isolates, *Klebsiella* species from blood showed high level of resistance to the third generation cephalosporins (83% - 84%). Imipenem resistance in *Klebsiella* species isolated from blood was observed to be 51% (CI: 49.7 – 52.6) whereas 30% (CI: 29.5-31.2) resistance was observed in urine isolates. (Table 9). Resistance to reserve class of antibiotic, colistin, was found to be highest in *Klebsiella* spp. compared to other Gram-negative priority pathogens isolated from all the specimen types. These resistant isolates were further confirmed at the NRL in NCDC (Table 9).

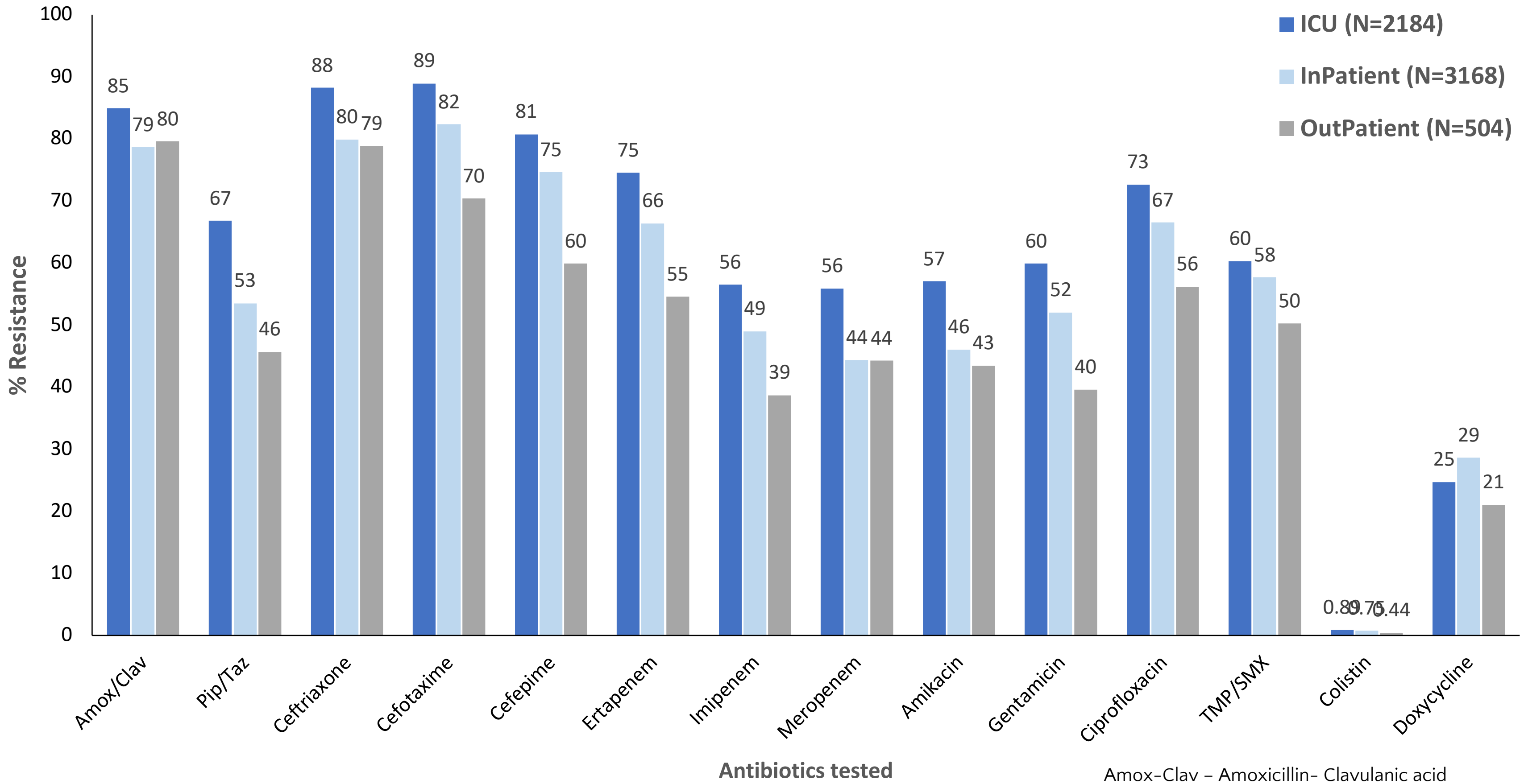
Klebsiella species' location type wise AST data revealed similar resistance pattern like other priority pathogens wherein higher resistance was seen in isolates from intensive care units compared to inpatient and outpatient departments (Fig. 14).

Table 9 - Resistance profile of *Klebsiella* species (N=24,377)

	Blood (N=5,914)			PA (N=8,700)			OSBF (N=1,694)			Urine (N=14,614)		
Antibiotic Tested	Number Tested	%R	95% CI	Number Tested	%R	95% CI	Number Tested	%R	95% CI	Number Tested	%R	95% CI
Amox/Clav	3388	81	80.1-82.8	5762	77	76.1-78.3	966	77	74.4-79.8	8737	65	64.0-66.0
Pip/Taz	4968	58	56.8-59.6	6803	51	49.4-51.7	1398	54	51.1-56.4	9427	39	37.9-39.9
Ceftriaxone	2416	83	81.9-84.9	3462	72	70.3-73.3	585	76	72.2-79.3	4840	63	61.4-64.2
Cefotaxime	4060	84	82.9-85.1	6967	79	78.0-79.9	1375	80	77.4-81.7	11585	71	69.8-71.5
Cefepime	4874	76	74.8-77.2	7551	68	66.7-68.8	1489	67	64.8-69.7	12253	59	57.7-59.4
Ertapenem	1766	70	68.0-72.3	1826	51	48.4-53.1	525	56	51.8-60.5	4048	42	40.2-43.2
Imipenem	4874	51	49.7-52.6	7028	40	39.1-41.5	1464	48	45.6-50.8	11954	30	29.5-31.2
Meropenem	4163	49	47.8-50.8	6287	39	37.6-40.0	1095	45	42.1-48.0	8784	27	25.7-27.6
Amikacin	5181	50	48.8-51.5	7454	45	44.3-46.5	1512	47	44.2-49.3	11554	36	35.0-36.8
Gentamicin	4651	54	52.7-55.5	6538	50	48.7-51.2	1317	48	45.7-51.2	9417	37	35.8-37.7
Ciprofloxacin	4911	68	66.8-69.4	7067	70	69.4-71.5	1511	69	67.0-71.7	12483	64	63.3-65.0
TMP/SMX	4418	58	56.7-59.6	6722	58	57.1-59.4	1399	61	58.3-63.5	11855	53	52.4-54.2
Colistin	3805	0.8	0.5-1.1	4523	0.3	0.2-0.6	1137	0.8	0.4-1.6	7021	0.4	0.3-0.6
Doxycycline	897	27	23.8-29.7	1520	31	28.6-33.3	455	41	36.1-45.3		x	
Nitrofurantoin		x			x			X		12629	47	46.6-48.3

*Alert pathogens confirmed at NRL, NCDC only were included in the data
x- Drug bug combination for the specimen type not included in NARS-Net surveillance panel

TMP/SMX - Trimethoprim/sulfamethoxazole
Amox-clav -Amoxicillin/Clavulanic acid
Pip/Taz- Piperacillin Tazobactam



Amox-Clav – Amoxicillin- Clavulanic acid
PipTaz – Piperacillin-Tazobactam
TMP/SMX - Trimethoprim/sulfamethoxazole

*Data from the emergency department was clubbed with data from inpatient wards; the Location type for 58 isolates is unknown

Figure 14 - Resistance profile of *Klebsiella* species isolated from blood (N=5,856)

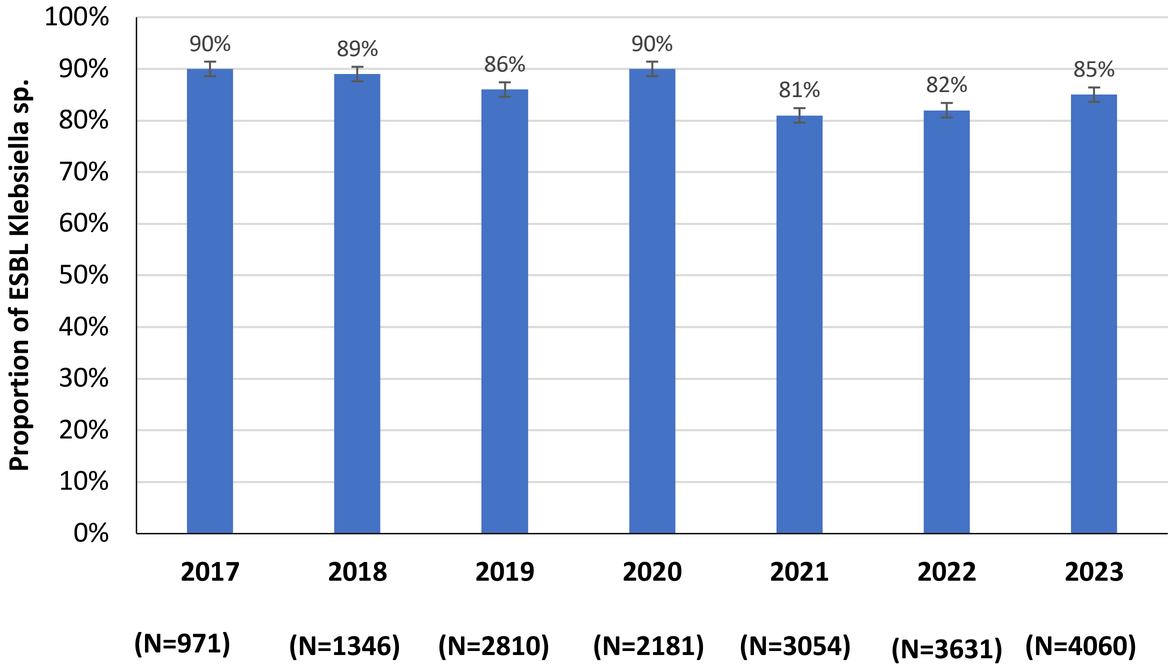


Figure 15 - Trends of Extended-Spectrum Beta-Lactamase (ESBL) producing *Klebsiella* sp. in blood (2017-2023)

Trend analysis of ESBL producing *Klebsiella* spp. from blood showed consistently high level of resistance over last 7 years.

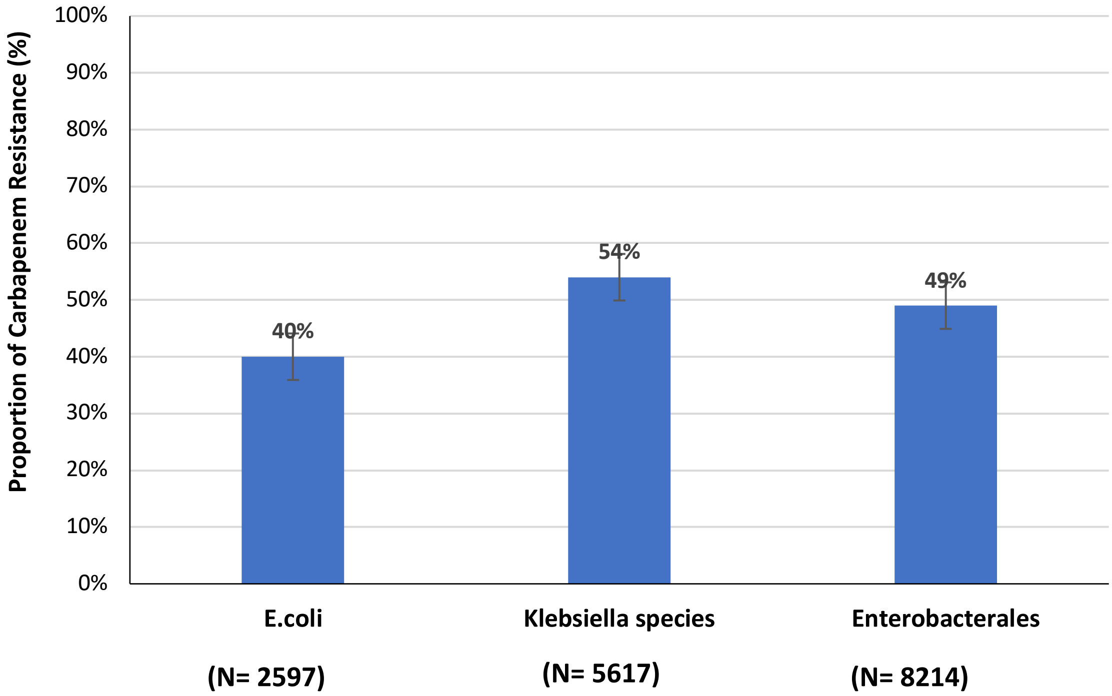


Figure 16 - Carbapenem resistance among Enterobacterales isolated from blood (Jan 2023 - Dec 2023)

Forty percent of *E. coli* isolated from blood showed resistance to carbapenems whereas nearly half of the *Klebsiella* spp. (54%) isolated from blood were resistant to at least one of the carbapenems (imipenem/ertapenem/meropenem). Notably, carbapenem resistance in Enterobacterales (CRE) has increased to 49% in this data reporting period from the previous year (43%). (Fig 16)

Salmonella enterica serovar Typhi and Paratyphi

In the current reporting period, data of 643 *Salmonella enterica* serovar Typhi and Paratyphi isolates was submitted to NCDC, of which 630 isolates were from unique patients. Seven of these isolates were from stool specimens. Data of 623 unique isolates of *S. enterica* Typhi (N=537) and S. Paratyphi (N=86) from blood has been analyzed. Compared to ciprofloxacin, lower resistance rates to first-line antibiotics like ampicillin, chloramphenicol and trimethoprim/sulfamethoxazole were observed. Two isolates of *Salmonella enterica* serovar Typhi were found to be resistant to ceftriaxone, four isolates were resistant to azithromycin and no resistance was observed against imipenem (Table 10). All the ceftriaxone and azithromycin resistant S. Typhi isolates included in this report were also confirmed at the AMR-NRL at NCDC.

Shigella species

In this reporting period, data of 40 isolates of *Shigella* species was submitted from stool specimens. The resistance in *Shigella* species was found to be highest to ampicillin and ciprofloxacin; lower level of resistance was observed to chloramphenicol (Table 10).

Table 10 - Resistance profile of *Salmonella enterica* Typhi and Paratyphi (N=623) from blood and *Shigella* species (N=40) from stool

Antibiotic tested	*S. Typhi* (N=537)			*S. Paratyphi* (N=86)		*Shigella species* (N=40)	
	Number tested	Resistance (%)	95% CI	Number tested	(Number Resistant)	Number tested	(Number Resistant)
Ampicillin	502	(6)	4.0-8.3	79	(1)	38	31
Azithromycin	480	(0.8)	0.3-2.3	x		33	9
Ceftriaxone	492	(0.4)	0.1-1.6	80	(1)	36	10
Chloramphenicol	487	(1.4)	0.6-3.1	81	(1)	32	7
Ciprofloxacin	522	(40)	35.6-44.2	84	(12)	39	29
Imipenem	504	(0)	0.0-0.0	77	(0)	x	
Trimethoprim/ Sulfamethoxazole	518	(4.4)	2.9-6.7	82	(1)	39	21

*Alert pathogens confirmed at NRL, NCDC were included in the data for analysis

1.2.3.2.2. Non-Fermenting Gram-Negative Bacilli

Among the non-fermenting Gram-negative bacilli (NF GNB) included in the data submitted during Jan-Dec 2023 from the NARS-Net sentinel sites, *Pseudomonas* species was the most frequently isolated pathogen from 16,037 unique patients followed by *Acinetobacter* species (14,700) (Fig 2). Among the NF GNB, *Pseudomonas* species was the predominant isolate among inpatients, while *Acinetobacter* species was the predominant isolate among the patients in ICU settings (Table 5).

Pseudomonas species

Surveillance sites in 2023 submitted data of 17,167 isolates of *Pseudomonas* spp. from 16,037 unique patients (Fig 2). *Pseudomonas* spp. isolates included in the data during current reporting period were most commonly isolated from pus aspirate (43%), urine (30%), blood (19%), and other sterile body fluids (8%) (Table 4).

Approximately 50% of urine isolates were resistant to ciprofloxacin and to the third-generation cephalosporin (ceftazidime). Forty four percent of *Pseudomonas* spp. isolated from blood showed resistance to ceftazidime (CI: 42.5 – 49.3) whereas approximately one-third of isolates showed resistance to ciprofloxacin (31%) and to gentamicin (29%). The imipenem resistance in blood isolates of *Pseudomonas* spp. was found to be 33% (CI: 30.8 – 34.7) (Table 11)

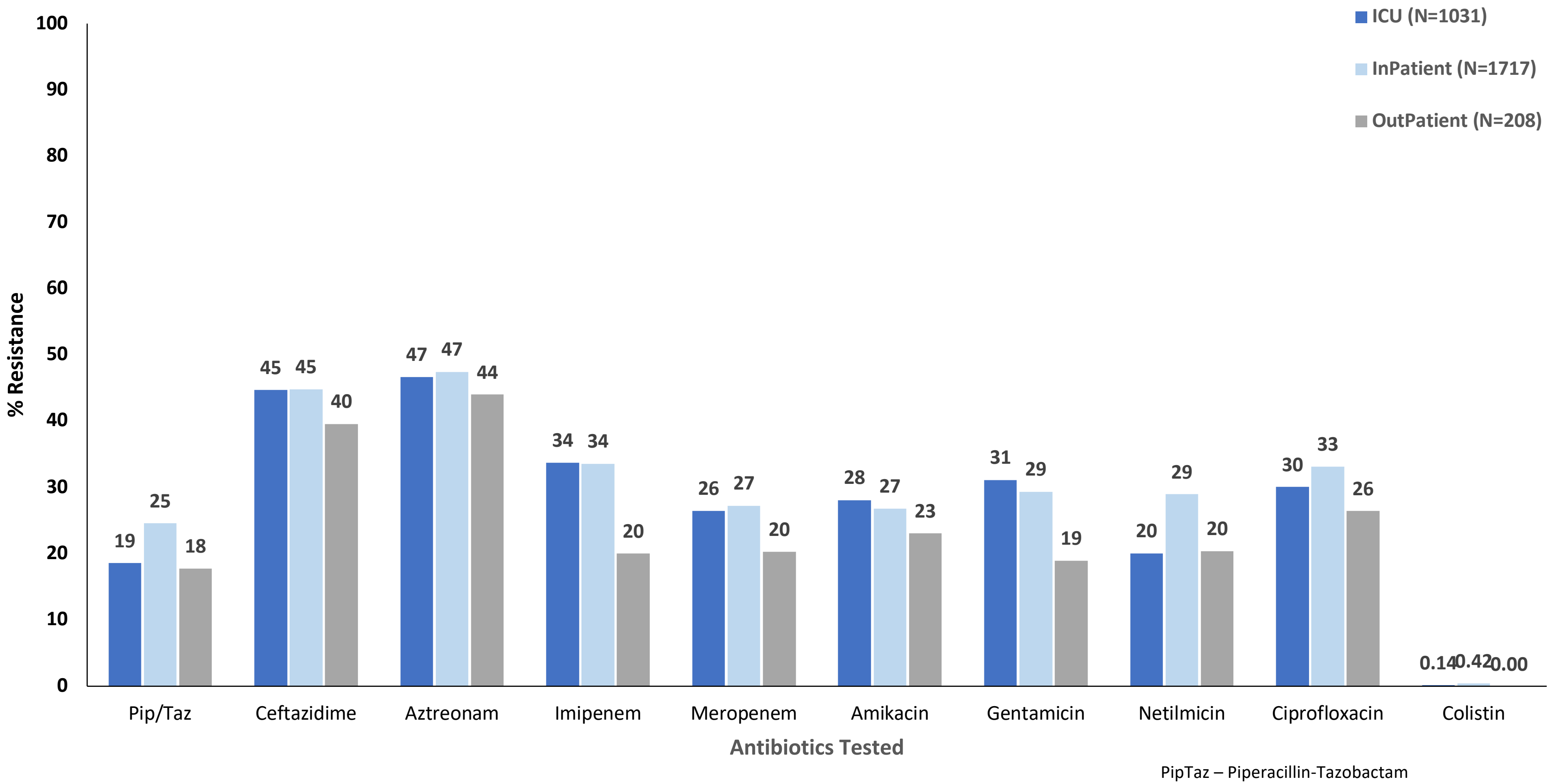
Concerning the reserve group of antibiotics namely colistin, two isolates from blood (0.1%), one from pus aspirate (0.02%), two from sterile body fluids (0.2%) and one from urine (0.03%) were found to be resistant (Table 11).

Isolates of *Pseudomonas* spp. from blood cultures of patients in Intensive care units, Inpatient and outpatient departments showed highest resistance to ceftazidime and aztreonam among the tested antibiotics. (Fig.17).

Table 11 - Resistance profile of *Pseudomonas* species (N=16,037)

Antibiotic Tested	Blood (N=2,989)			Pus Aspirate (N=6,870)			OSBF (N=1,290)			Urine (N=4,888)		
	Number Tested	%R	95 % CI	Number Tested	(%R)	95 % CI	Number Tested	(%R)	95 % CI	Number Tested	(%R)	95 % CI
Amikacin	2704	27	25.4-28.8	5809	34	32.9-35.3	1160	26	23.5-28.6	4386	41	39.5-42.4
Aztreonam	1736	47	44.6-49.3	4427	31	29.5-32.2	819	34	30.7-37.3	2991	36	34.4-37.9
Ceftazidime	2590	44	42.5-46.4	6124	49	48.1-50.6	1176	41	38.5-44.2	4377	54	52.7-55.7
Ciprofloxacin	2579	31	29.7-33.3	5739	45	43.2-45.8	1131	34	31.4-37.0	4209	57	55.1-58.1
Colistin	1772	0.11	0.2-0.9	3493	0.02	0-0.3	740	0.2	0-0.9	2513	0.03	0.1-0.4
Gentamicin	2119	29	27.4-31.4	5014	35	33.5-36.1	943	24	21.0-26.5	3582	40	38.4-41.6
Imipenem	2337	33	30.8-34.7	5564	32	30.3-32.8	1090	36	33.0-38.8	4067	41	39.3-42.3
Meropenem	2081	26	24.4-28.2	5099	26	24.9-27.3	802	27	23.7-29.9	2772	36	34.3-37.9
Netilmicin	835	24	21.2-27.1	2035	32	30.2-34.3	404	27	22.8-31.6	1408	42	39.4-44.6
Piperacillin/ Tazobactam	2687	22	20.3-23.5	5741	25	24.4-26.6	1097	20	17.7-22.5	4214	28	26.4-29.1

*Alert pathogens confirmed at NRL, NCDC only were included in the data



*Data from the emergency department was clubbed with data from inpatient wards; the Location type for 33 isolates is unknown

Figure 17-Resistance profile of *Pseudomonas* species in blood (N=2,956)

Acinetobacter spp.

Data of a total of 15,457 *Acinetobacter* species isolates was submitted by network sites during this reporting period Jan 2023 – Dec 2023, of which 14,700 were from unique patients. Among all specimen types under the programme, *Acinetobacter* species was most commonly isolated from blood (42%) followed by pus aspirate (26%), urine (19%) and other sterile body fluids (12%). (Table 4)

Blood isolates showed the highest resistance to ceftazidime (80%; CI: 78.5- 80.7). High level of resistance to ceftazidime was also observed in other specimen types that is pus aspirate (81%), sterile body fluids (78%, CI: 75.7 – 79.8) and urine (65%, CI: 62.4- 66.7) (Table 12).

Sixty six percent of isolates (CI: 64.9- 67.5) from blood cultures, 67% (CI: 65.2- 68.5) of isolates from pus aspirates and 71% (CI: 69.0- 73.5) of isolates from sterile body fluids were resistant to imipenem.

Acinetobacter species isolates from blood cultures of the ICU patients had a higher level of resistance to all tested antibiotics compared to other location types (Fig 18).

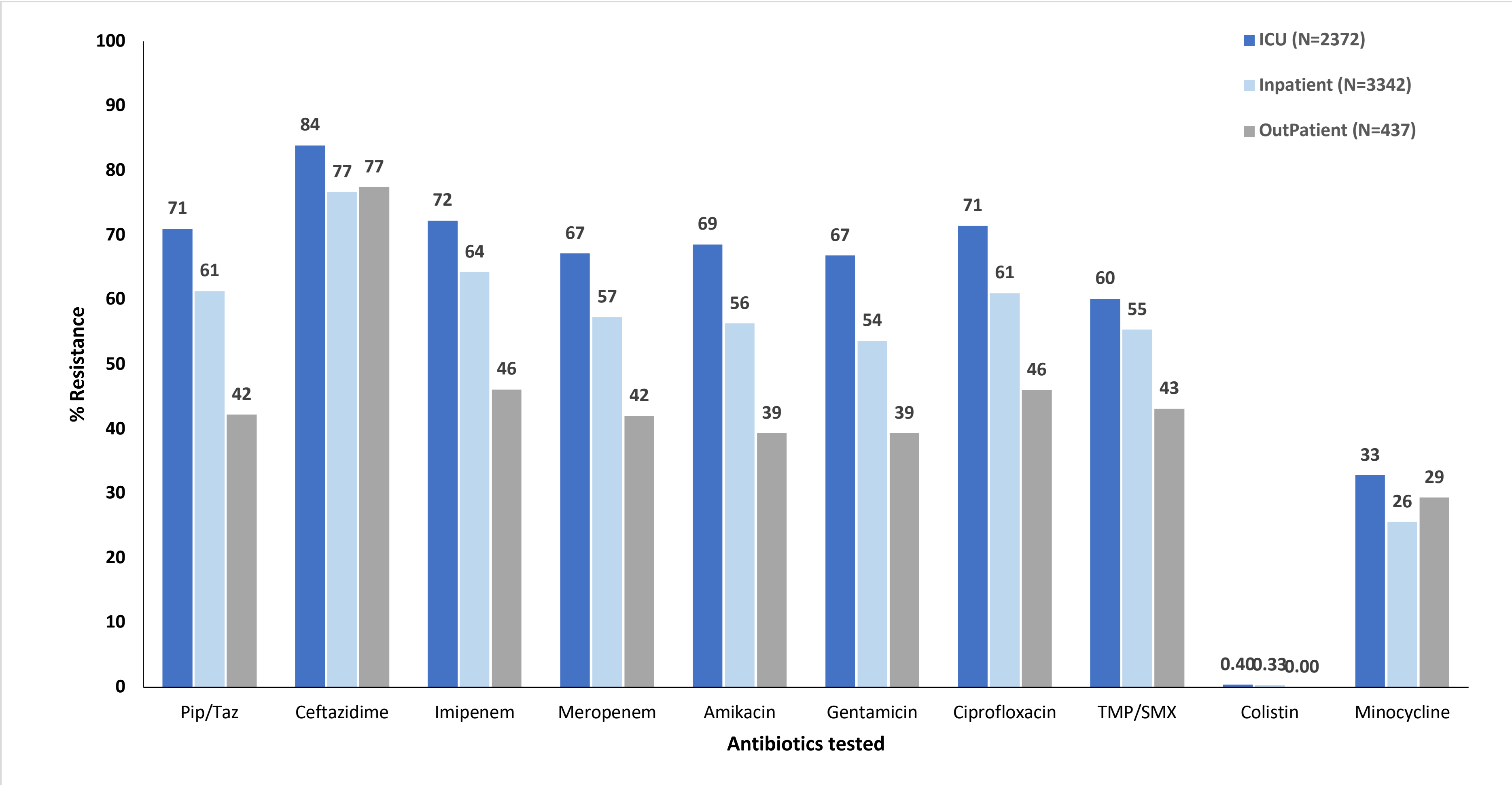
Colistin resistance was observed to be 0.3% in the inpatient setting and 0.4% in isolates from the ICU settings (Fig 18).

Table 12 - Resistance profile of *Acinetobacter* species (N=14,700)

	Blood (N=6,238)			OSBF (N=1,813)			PA (N=3,865)			Urine (N=2,784)		
Antibiotic Tested	Number Tested	%R	95% CI	Number Tested	%R	95% CI	Number Tested	%R	95% CI	Number Tested	%R	95% CI
Amp/Sul		x		411	70	64.8-74.0	1016	68	64.7-70.6	557	57	52.3-60.7
Pip/Taz	5724	64	62.7-65.3	1635	63	60.4-65.1	3251	69	67.2-70.4	2350	39	36.7-40.6
Ceftazidime	5406	80	78.5-80.7	1577	78	75.7-79.8	3127	81	79.5-82.3	2001	65	62.4-66.7
Imipenem	5378	66	64.9-67.5	1608	71	69.0-73.5	3203	67	65.2-68.5	2285	43	41.4-45.5
Meropenem	3315	61	59.4-62.7	1028	68	65.1-70.9	2527	64	61.8-65.6	1357	36	33.4-38.6
Amikacin	5838	60	58.8-61.3	1664	64	61.1-65.8	3331	68	66.9-70.0	2076	44	41.8-46.1
Gentamicin	5574	58	56.8-59.4	1621	61	58.8-63.6	3209	68	66.7-69.9	2043	46	43.4-47.8
Ciprofloxacin	5611	64	63.0-65.5	1645	66	63.9-68.5	3203	76	74.4-77.4	2353	50	48.1-52.2
TMP/SMX	4119	56	54.9-58.0	1446	59	56.1-61.3	2755	64	62.3-65.9	2103	45	42.6-46.9
Colistin	4382	0.3	0.2-0.6	1347	0.4	0.2-1.0	2233	0.18	0.1-0.5	1120	0.2	0.1-0.9
Minocycline	4683	29	27.7-30.4	1438	30	27.9-32.7	2513	32	29.7-33.4	1832	27	24.5-28.6
Tetracycline		x			x			x		681	46	42.0-49.6

*Alert pathogens confirmed at NRL, NCDC only were included in the data

TMP/SMX - Trimethoprim/sulfamethoxazole
Amp/Sul-Ampicillin Sulbactam
Pip/Taz- Piperacillin Tazobactam



*Data from the emergency department was clubbed with data from inpatient wards; the Location type for 87 isolates is unknown

TMP/SMX - Trimethoprim/sulfamethoxazole
PipTaz – Piperacillin-Tazobactam

Figure 18 - Resistance profile of *Acinetobacter* species in blood (N=6,151)

1.2.3.2.3. *Vibrionaceae*

Vibrio cholerae

In the current reporting period (Jan 2023 – Dec 2023), data of 50 isolates of *Vibrio cholerae* confirmed at AMR-NRL has been analyzed. Resistance was observed to 5 of the 6 antibiotics tested in the panel. The highest resistance was observed to trimethoprim/sulfamethoxazole.

Table 13 - Resistance profile of *Vibrio cholerae* (N=50)

Antibiotic Tested	Number Tested	Number Resistant
Ampicillin	46	9
Trimethoprim/ Sulfamethoxazole	47	42
Azithromycin	29	1
Chloramphenicol	39	7
Doxycycline	21	0
Tetracycline	31	1

1.3. Discussion

This report is the seventh annual report of the National AMR Surveillance Network. Compared to the previous year, the number of sites submitting data has increased from 37 to 41 tertiary care hospital laboratories. Like the previous year's findings, *Escherichia coli* (*E. coli*) accounted for 34% of the isolated pathogens in the AMR Surveillance data for 2023. Amongst the urine isolates, *E. coli* (51%) was the most commonly isolated priority pathogen, and urine was the most common specimen type (46%). As consistent with previous reports, *S. aureus* was most commonly isolated from pus aspirates (65%).

Trend analysis for ESBL-producing *E. coli* isolates from blood showed a decrease in their proportion from 86% in 2018 to 82% in 2023. This decline may be attributed to improved internal and external quality management systems mandated at all network sites under the programme and more representative data from different regions of India compared to earlier years.

Due to challenges in methodology/results for colistin-resistant Gram-negative bacteria and Vancomycin-resistant *S. aureus* using manual/automated AST systems, only isolates confirmed at AMR-NRL using broth microdilution at CBDDR NCDC have been included in this report. Many sentinel sites have standardized and started performing colistin agar dilution and colistin BMD tests. No significant changes have been observed in colistin resistance patterns over the past five years.

The high percentage of carbapenem resistance in *K. pneumoniae* (54%), *E. coli* (40%), and *Acinetobacter* spp. (approximately 66%) in blood samples are concerning. These findings highlight serious challenges in treatment options for patients with infections caused by these priority bacterial pathogens.

According to the surveillance data reported under NARS-Net, there has been a gradual increase in the proportion of Vancomycin-resistant Enterococcus (VRE) in blood isolates from 11% in 2021 to 19% in 2023. No Vancomycin-intermediate Staphylococcus aureus (VISA) or Vancomycin-resistant Staphylococcus aureus (VRSA) has been reported over these years.

A decrease in the proportion of Methicillin-resistant *S. aureus* (MRSA) in blood has been observed, with 55% observed this year compared to previous years since 2018.

A virtual capacity-building program was initiated via the ECHO platform in 2020 to improve bacteriology testing methods and standardize antimicrobial susceptibility testing (AST) practices across network sites. Additionally, the EQAS program coordinated by the NRL at NCDC, hands-on laboratory and data management trainings, site support visits, monthly data quality monitoring and feedback calls, and annual review meetings have continuously supported the sites for improving the quality of surveillance.

AST data of the six WHO priority bacterial pathogens is submitted annually to WHO's Global AMR Surveillance System (GLASS). These pathogens include *S. aureus, E. coli, Klebsiella species, Salmonella* Typhi/ParaTyphi, and *Acinetobacter baumanii.*

The antimicrobial resistance surveillance in India over the last 6 years has shown gradually increasing resistance to both first-line and second-line antibiotics. This issue is further exacerbated by the limited availability of new antimicrobial agents, underscoring the urgent need for investment for antibiotic research and development. In addition to focusing on research, it is crucial to implement infection prevention and control (IPC) and Antimicrobial Stewardship (AMS) programs to prevent and control AMR.

In summary, the AMR surveillance results from NARS-NET emphasize the importance of taking concerted action to strengthen implementation of facility-level, state, and national infection prevention and control programs and antimicrobial stewardship practices. This can be achieved by developing and implementing IPC programs and facility-level antibiotic policies that align with national treatment guidelines for infectious diseases while considering the local context. It is essential to approach this issue with structured policies and guidelines to effectively combat AMR throughout India.

1.4. Annexure I

List of NARS-Net sites that contributed AMR data for the period Jan 2023 to Dec 2023

1. Lady Hardinge Medical College and Associated hospitals, Delhi
2. Vardhman Mahavir Medical college and SJ Hospital, Delhi
3. SMS medical College, Jaipur, Rajasthan
4. BJ Medical College, Ahmedabad, Gujarat
5. BJ Medical college, Pune, Maharashtra
6. Government Medical college, Chandigarh
7. Mysore Medical college, Mysuru, Karnataka
8. GSVM Medical College, Kanpur, Uttar Pradesh
9. Gauhati Medical College and Hospital, Guwahati, Assam
10. KAP V. Government Medical College, Tiruchirappalli, Tamil Nadu
11. NEIGRIHMS, Shillong, Meghalaya
12. Govt. Medical College, Thiruvananthapuram, Kerala
13. MGM College and Hospital, Indore, Madhya Pradesh
14. Indira Gandhi Medical College, Shimla, Himachal Pradesh
15. Govt. Medical College and Hospital, Aurangabad, Maharashtra
16. Osmania Medical College, Hyderabad, Telangana
17. Govt. Medical College & Hospital, Jammu, Jammu and Kashmir
18. Agartala Govt. Medical College, Agartala, Tripura
19. Guntur Medical College, Guntur, Andhra Pradesh
20. SCB Medical College & Hospital, Cuttack, Odisha
21. Pt. Jawaharlal Nehru Memorial Medical College, Raipur, Chhattisgarh
22. Rajendra Institute of Medical Sciences, Ranchi, Jharkhand
23. Pandit Bhagwat Dayal Sharma, Post Graduate Institute of Medical Sciences (PGIMS) Rohtak, Haryana
24. Indira Gandhi Institute of Medical Sciences, Sheikpura, Patna, Bihar
25. Govt. Medical College, Haldwani, Uttarakhand
26. Gandhi Medical College, Bhopal, Madhya Pradesh
27. Calcutta School of Tropical Medicine, Kolkata, West Bengal
28. Lala Lajpat Rai Memorial (LLRM) Medical College, Meerut, Uttar Pradesh
29. GMERS Medical College and Civil Hospital, Valsad, Gujarat
30. Coimbatore Medical College & Hospital, Coimbatore, Tamil Nadu
31. Karnataka Institute of Medical Sciences (KIMS), Hubli, Karnataka
32. Indira Gandhi Medical College & Research Institute (IGMC & RI) Puducherry
33. NAMO Medical Education and Research Institute (MERI), Silvassa, Dadra & Nagar Haveli
34. Maulana Azad Medical College (MAMC) and Associated Hospitals, Delhi
35. Sardar Patel Medical College (SPMC) and Hospital, Bikaner, Rajasthan
36. Goa Medical College & Hospital, Bambolim, Goa

37. STNM Medical College & Hospital, Gangtok, Sikkim
38. Government Medical College, Patiala, Punjab
39. Zoram Medical College, Falkawn, Mizoram
40. Andaman & Nicobar Islands Institute of Medical Sciences (ANIIMS), Andaman & Nicobar Islands
41. Rabindranath Tagore Medical College, Udaipur, Rajasthan