



National Antimicrobial Resistance Surveillance Data

NARSNET Sites

- ✚ Lady Hardinge Medical College and Associated hospitals, Delhi
- ✚ Vardhman Mahavir Medical College and SJ Hospital, Delhi
- ✚ SMS Medical College, Jaipur, Rajasthan
- ✚ BJ Medical College, Ahmedabad, Gujarat
- ✚ BJ Medical college, Pune, Maharashtra
- ✚ Government Medical college, Chandigarh
- ✚ Mysore Medical College & Research Institute, Mysuru, Karnataka
- ✚ GSVM Medical College, Kanpur, Uttar Pradesh
- ✚ Gauhati Medical College and Hospital, Guwahati, Assam
- ✚ KAP V. Government Medical College, Tiruchirappalli, Tamil Nadu
- ✚ NEIGRIHMS, Shillong, Meghalaya
- ✚ Govt. Medical College, Thiruvananthapuram, Kerala
- ✚ MGM College and Hospital, Indore, Madhya Pradesh
- ✚ IGMC, Shimla, Himachal Pradesh
- ✚ Govt. Medical College and Hospital, Aurangabad, Maharashtra
- ✚ Osmania Medical College, Hyderabad, Telangana
- ✚ Govt. Medical College & Hospital, Jammu, J&K
- ✚ Agartala Govt. Medical College, Agartala, Tripura
- ✚ Guntur Medical College, Guntur, Andhra Pradesh
- ✚ SCB Medical College & Hospital, Cuttack, Odisha
- ✚ Pt. JLN Memorial Medical College, Raipur, Chhattisgarh
- ✚ Rajendra Institute of Medical Sciences, Ranchi, Jharkhand
- ✚ Pt. BDS PGIMS Rohtak, Haryana
- ✚ Indira Gandhi Institute of Medical Sciences, Sheikpura, Patna, Bihar
- ✚ Government Medical College, Haldwani, Uttarakhand
- ✚ Gandhi Medical College, Bhopal, Madhya Pradesh
- ✚ Calcutta School of Tropical Medicine, Kolkata, West Bengal
- ✚ LLRM Medical College, Meerut, Uttar Pradesh
- ✚ GMERS Medical College and Civil Hospital, Valsad, Gujarat
- ✚ Coimbatore Medical College & Hospital, Coimbatore, Tamil Nadu
- ✚ Karnataka Institute of Medical Sciences, Hubli, Karnataka
- ✚ Indira Gandhi Medical College & Research Institute, Puducherry
- ✚ NAMO MERI, Silvassa, Dadra & Nagar Haveli
- ✚ Maulana Azad Medical College (MAMC) and Associated Hospitals, Delhi
- ✚ Sardar Patel Medical College (SPMC) and Hospital, Bikaner, Rajasthan
- ✚ Goa Medical College & Hospital, Bambolim, Goa
- ✚ STNM Medical College & Hospital, Gangtok, Sikkim
- ✚ Government Medical College, Patiala, Punjab
- ✚ Zoram Medical College, Falkawn, Mizoram
- ✚ Andaman & Nicobar Islands Institute of Medical Sciences (ANIIMS), Andaman & Nicobar Islands
- ✚ Rabindranath Tagore Medical College, Udaipur, Rajasthan

National AMR Surveillance Network (NARS-Net)

Over the past decade, the issue of Antimicrobial resistance (AMR) has become more prominent on Global health agenda, requiring urgent prevention and control measures. The startling truth is that the era of effective antibiotics is already or will very soon come to an end.

One of the key initiative by Government of India to combat AMR is the launch of the "National Programme on Antimicrobial Resistance Containment" in 2013, coordinated by National Centre for Disease Control (NCDC), Delhi. The National AMR Surveillance Laboratory network (NARS-Net) established under the programme is being expanded in a phased manner throughout the country. NARS-Net currently includes 50 medical college laboratories in 27 states and 6 UTs (Fig. 1). These sentinel sites perform bacterial culture, identification & antimicrobial susceptibility testing (AST) by manual methods and/or using automated systems.

India is enrolled on the Global Antimicrobial Resistance Surveillance System (GLASS) for submission of country data annually in 2017. NCDC has been designated as the National Coordinating Centre for AMR Surveillance in the country. AST data for selected priority pathogens generated by these sentinel sites under NARSNET is compiled, analysed and annual reports are prepared by NCDC and uploaded on NCDC website in public domain. Since 2018, the data has also been collated for WHO-GLASS priority bacterial pathogens

and priority specimen types and submitted to GLASS .

All the participating network sites report AMR data of nine priority pathogens isolated from 5 specimen types (blood, urine, pus & other sterile body fluids, stool) to NCDC on a monthly basis for lab-based AMR Surveillance. The nine priority pathogens are detailed in Issue 01 of the semi-annual Bulletin for January 2023 – June 2023 AMR Surveillance data.

All network sites are mandated to enroll in National External Quality Assessment Scheme (EQAS) programs and to participate in AMR EQAS program at NCDC to ensure reliability of test results. Additionally, the sites are mandated to submit all emerging AMR alert isolates, as defined under the programme, to NCDC for confirmation. To ensure the data quality, sites are mandated to implement internal quality control measures for antibiotic discs and culture media quality control.

The virtual capacity-building program initiated through the ECHO platform in 2020 and the continuous hands on training on WHONET has been instrumental in standardizing bacteriology testing methods and report generation across the network sites. Technical support is also provided through on-site support visits, virtual and in person trainings and review meetings. This support has enabled substantial strengthening of bacteriology laboratory capacity at sites.

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

In addition, NCDC frequently organizes trainings and workshops on AMR data management using WHONET to standardize AMR surveillance data flow from network sites to NCDC.

This semi-annual report covers the AMR data from July 2023 to December 2023 from 41 sentinel surveillance sites.

Data Collection and Analysis

The network sites used WHONET 2023, an open-source, offline microbiology data management desktop application, to collect, collate and analyze routine antimicrobial susceptibility testing data generated at their laboratories. The classification of the isolates as susceptible, intermediate or resistant is based on the recent Clinical & Laboratory Standards Institute (CLSI) guidelines. During the 6-month reporting period, data of 75,155 priority pathogens has been reported from 41 sites under NARS-Net.

All sentinel NARS-Net sites are to submit monthly data within 5 working days of the next month. The monthly data is validated through virtual data quality monitoring calls by the respective nodal officers at NCDC. The validated and quality checked revised monthly data is submitted by the network sites with complete data fields and compliance to the AMR Surveillance panel of antibiotics.

While analyzing the data from each patient (unique patient), only the first isolate of a given species isolated from priority specimen type during the hospital stay and its susceptibility profile is considered.

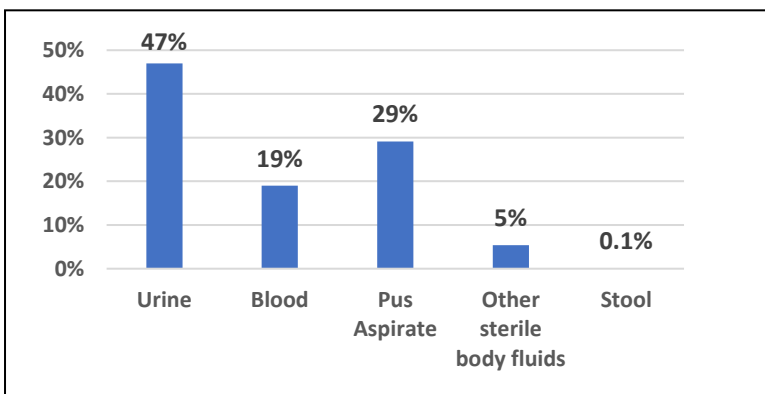


Fig. 1- Percentage Distribution of priority pathogen isolates based on specimen type, NARS-Net (July 2023-Dec 2023)

AMR Surveillance Profile

In the 2023 six-monthly AMR data (July to Dec 2023) reported from 75,155 unique patients, 54% male and 46% female patients, the most commonly isolated priority pathogen was *E. coli* (34%) followed by *Klebsiella* species (22%), *Pseudomonas* species and *S. aureus* (12%), *Acinetobacter* species (10%) and *Enterococcus* species (9%) and *Salmonella enterica* serovar Typhi and Paratyphi (0.5%) (Table 1).

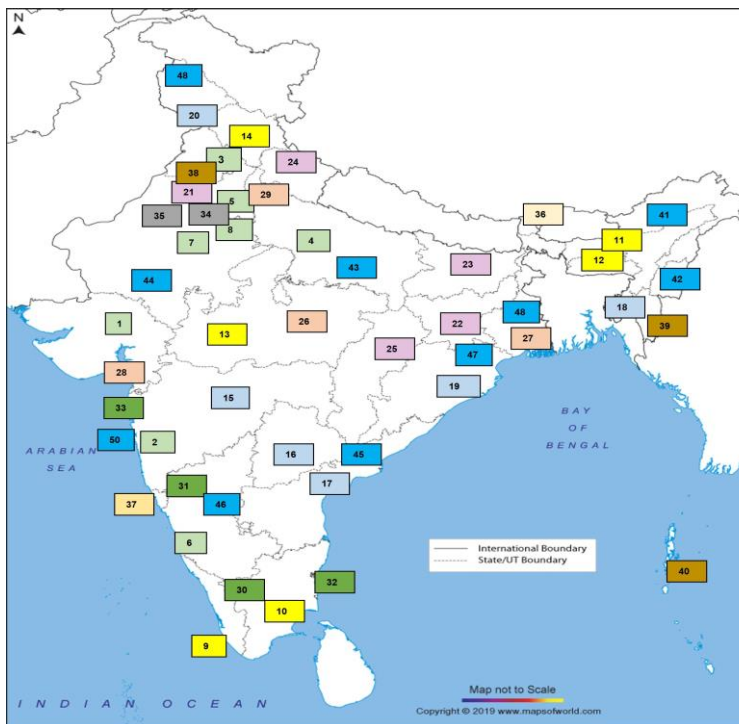


Fig. 2- Laboratories under National AMR Surveillance Network (NARS-Net)

The most common specimen type from which isolates have been reported in the current data reporting period was urine (47%). *E. coli* (52%) was the most commonly isolated pathogen from urinary specimens. From blood specimens, the most commonly isolated priority pathogen was *Klebsiella* species and *Acinetobacter* species (23%) and among pus aspirates *S. aureus* (26%) was observed to be most commonly isolated (Table 1).

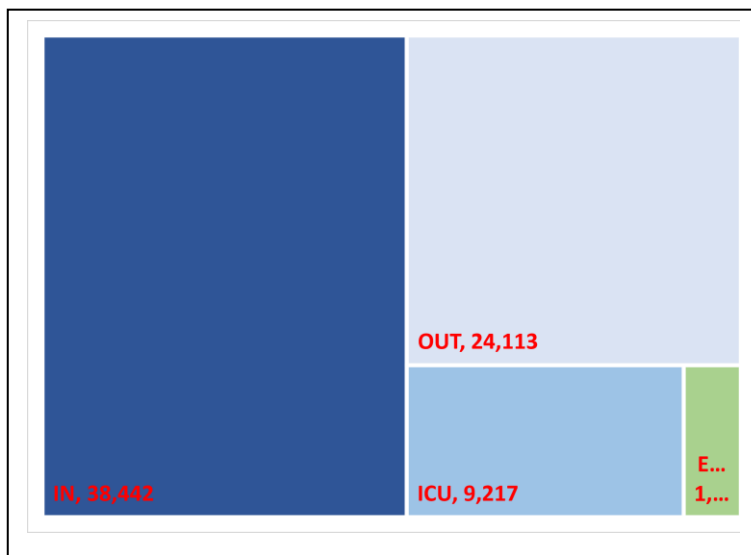


Figure 3- Distribution of priority pathogens isolates by location type (N=75,155), NARS-Net (July 2023-Dec 2023)
*1484 isolate location type no-known

Table 1- Distribution of priority pathogen by specimen type (N=75,155), NARS-Net (July 2023 - December 2023)

Priority Pathogen	Blood		Pus aspirate		OSBF#		Urine		Stool		Total	
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
<i>Staph. aureus</i>	2784	(20)	5724	(26)	387	(9)	x		x		8895	(12)
<i>Enterococcus spp.</i>	1293	(9)	718	(3)	268	(7)	4647	(13)	x		6926	(9)
<i>Escherichia Coli</i>	1479	(10)	5043	(23)	929	(23)	18081	(52)	x		25532	(34)
<i>Klebsiella spp.</i>	3284	(23)	4618	(21)	874	(21)	7900	(23)	x		16676	(22)
<i>Salmonella Typhi and Paratyphi</i>	348	(2)	x		x		x		4		352	(0.5)
<i>Shigella spp.</i>	x		x		x		x		35		35	(0.05)
<i>Pseudomonas spp.</i>	1754	(12)	3799	(17)	698	(17)	2732	(8)	x		8983	(12)
<i>Acinetobacter spp.</i>	3251	(23)	1986	(9)	921	(23)	1562	(4)	x		7720	(10)
<i>Vibrio cholerae</i>	x		x		x		x		36		36	(0.05)
Total	14,193	(100)	21,888	(100)	4,077	(100)	34,922	(100)	75		75,155	(100)

*x-specimen not included under surveillance

#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

AMR profile of priority pathogens

Gram Positive Cocci

AMR data of 15,821 Gram positive cocci from unique patients was submitted to NCDC during the reporting period.

Staphylococcus aureus

Staph aureus constituted 12% of the priority pathogens included in this data reporting period (Table. 1). This data is from 8,895 unique patients. *Staph aureus* isolation from blood, aspirated pus, and sterile body fluids was 20%, 26%, and 9% respectively.

Fifty three percent of these isolates from blood were MRSA (Methicillin resistant *Staph. aureus*) that is resistant to cefoxitin

(a surrogate marker for mecA-mediated oxacillin resistance). Similar resistance to cefoxitin was observed in isolates from pus aspirates (52%). Out of 5,818 isolates tested on Vancomycin screen agar, none of the isolate showed growth.

Among the *Staph aureus* isolated from blood, resistance to all the surveillance panel antibiotics was found to be higher among isolates from intensive care settings in comparison to those from outpatient clinics and the inpatient wards. (Fig. 5a).

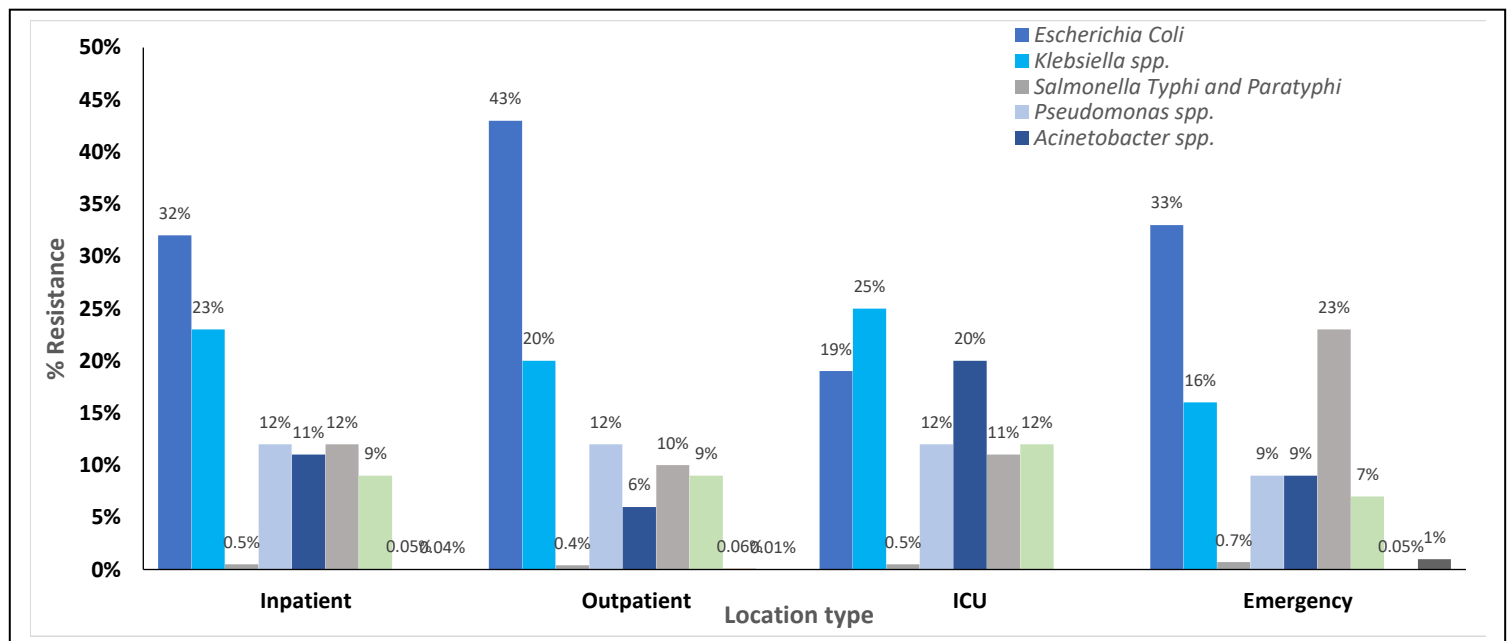


Figure 4- Distribution of each priority pathogen by location type (N=75,155)

Enterococcus species

Enterococcus species contributed 44% of the Gram-positive cocci. A total of 7,111 *Enterococcus* species isolate data was submitted by the NARS Net sites of which 6,926 isolates were from unique patients during the reporting period. Data analysis revealed, *Enterococcus* spp. isolation rate from specimen types like blood, pus aspirates, other sterile body fluids and urine were 9%, 3%, 7% and 13% respectively (Table 1).

Among *Enterococcus* species isolated from blood (N=1293), Erythromycin resistance was observed to be 79% (CI: 76.2-81.0) followed by Ampicillin 67%, (CI: 64-69.7). Alarming rate of resistance was reported to linezolid in *Enterococcus* spp. isolated from all specimen types - blood (1.9%), pus aspirate (0.30%), other sterile body fluid (1.17%) and urine (0.34%). Among the urinary isolates, resistance was observed to ciprofloxacin (82%), ampicillin (55%), vancomycin (5%) and 28% resistance to Nitrofurantoin.

Only the Linezolid resistant *Enterococci* isolates confirmed at NRL AMR-NRL at CBDDR NCDC have been included in this report

Gram Negative Bacilli

Under NARS Net, the seven most prevalent gram-negative bacteria of public health importance are included under AMR surveillance: *Escherichia coli*, *Klebsiella* species, *Pseudomonas* species, *Acinetobacter* species, *Salmonella* enterica serovar Typhi and Paratyphi, *Shigella* species and *Vibrio cholerae*. AST data of 62,785 gram-negative bacterial isolates has been reported from 59,334 unique patients during the period of July 2023 to December 2023 from 41 sentinel sites. Considering the challenges in testing methodology and quality and standardization issues with automated AST systems for colistin-resistant gram-negative bacteria, only the isolates confirmed by broth microdilution testing at the AMR-NRL at CBDDR NCDC have been included in this report.

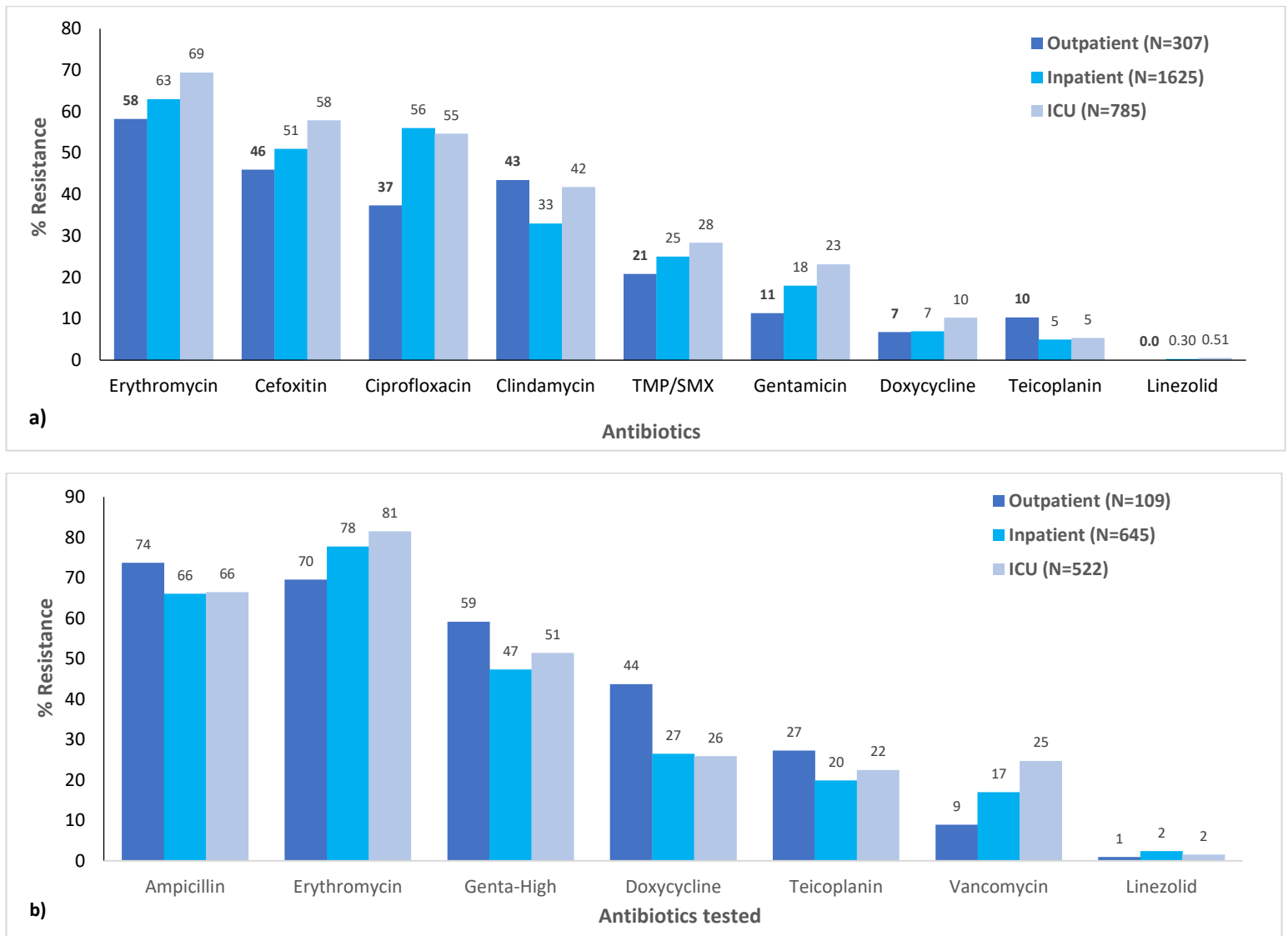


Fig. 5: Resistance profile of a) *Staph. aureus* (N=2,717) and b) *Enterococcus* species (N=1,276) in blood by location type; *Location type of 67 isolates of *S.aureus* and 17 isolates of *Enterococcus* spp. are unknown

Enterobacteriaceae

A total of 45,150 isolates were submitted from 42,595 unique patients during the data reporting period.

Escherichia coli

A total of 27,191 *E. coli* isolates were reported from 25,532 unique patients and have contributed to one-third of the unique patient AST data. *E. coli* was mostly isolated from urine samples (52%) followed by sterile body fluids (23%), pus (23%) and blood (10%) (Table 1). With respect to the resistance pattern, the highest resistance in isolates from all the specimen types was observed to ampicillin (85-88 %). Among the third generation cephalosporins, higher resistance was observed to cefotaxime in blood and OSBF isolates (84%) than in urinary isolates (76%). Resistance in blood isolates of *E. coli* was found to be 40% (CI: 37.1-42.9) to imipenem and meropenem whereas among non-beta-lactam antibiotics, 76% (CI: 73.7-78.5) resistance was observed to ciprofloxacin and 60% (CI:56.7-62.6) to trimethoprim-sulfamethoxazole. Among urine isolates, 19% showed resistance to nitrofurantoin and 4% to fosfomicin.

Seventy six percent of urine isolates were found to be resistant to third-generation cephalosporins. One isolate from blood and eight isolates from urine were resistant to colistin.

The location type wise AST of *E.coli* revealed a higher resistance rates in blood samples (Fig. 6a) and urine samples (Fig. 7a) isolated from intensive care units when compared to inpatient wards and outpatient clinics.

Klebsiella species

In this data period from July to December 2023, a total of 17,563 *Klebsiella* spp. were reported, of which 16,676 were from unique patients. Most of the *Klebsiella* spp. reported was from urine (23%) and blood (23%) followed by other sterile body fluids (21%) and pus aspirates (21%) (Table 1).

Among the urine isolates, resistance to third generation cephalosporins has decreased from 76% to 70% from the previous six months of this year. Among the urine isolates, amikacin resistance was observed in 38% (CI: 37.2-39.6) of isolates and 63% (CI: 62.3-64.6) showed resistance to ciprofloxacin.

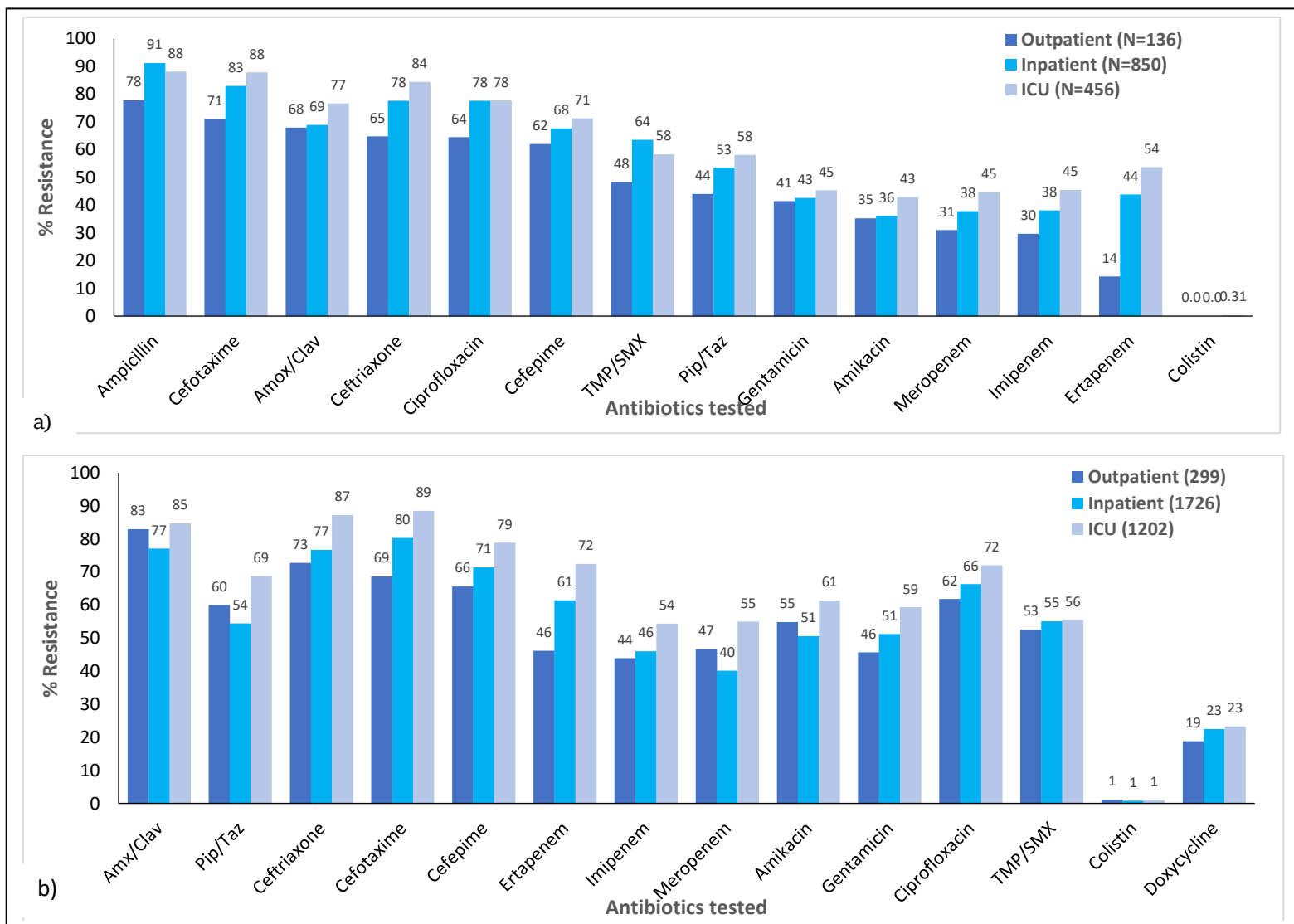


Fig. 6: Resistance profile of a) *E.coli* (N=1,442) and b) *Klebsiella* spp. (N=3,227) in blood by location type; *Location type of 37 isolates of *E.coli* and 57 isolates of *Klebsiella* spp. is unknown

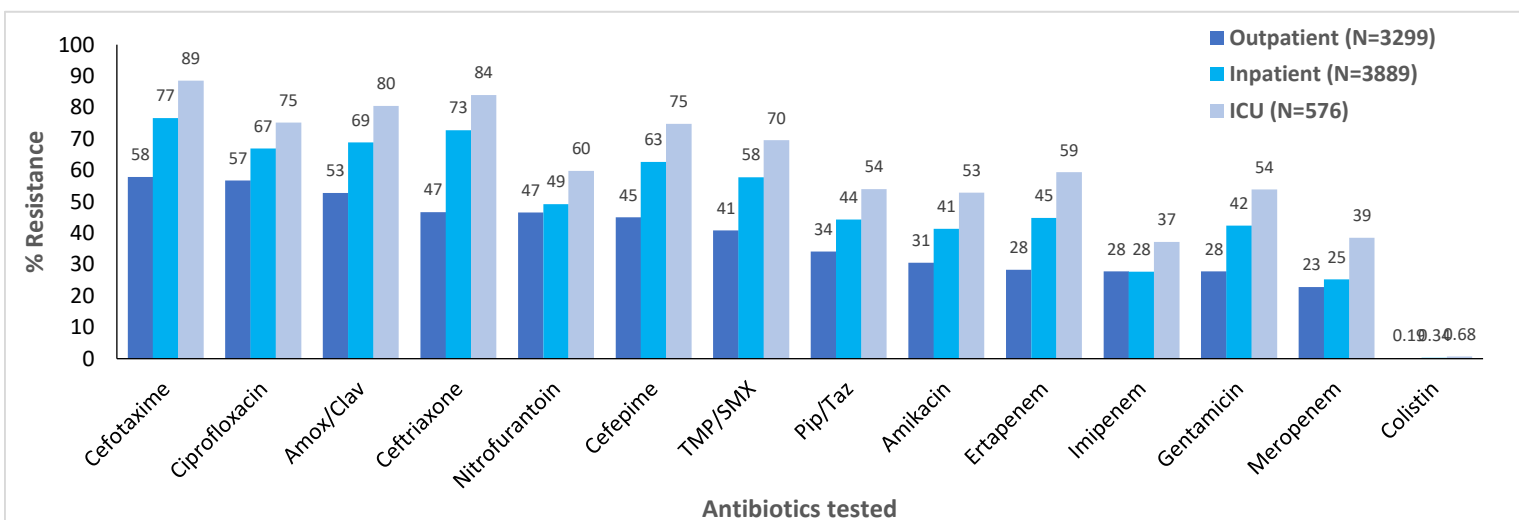
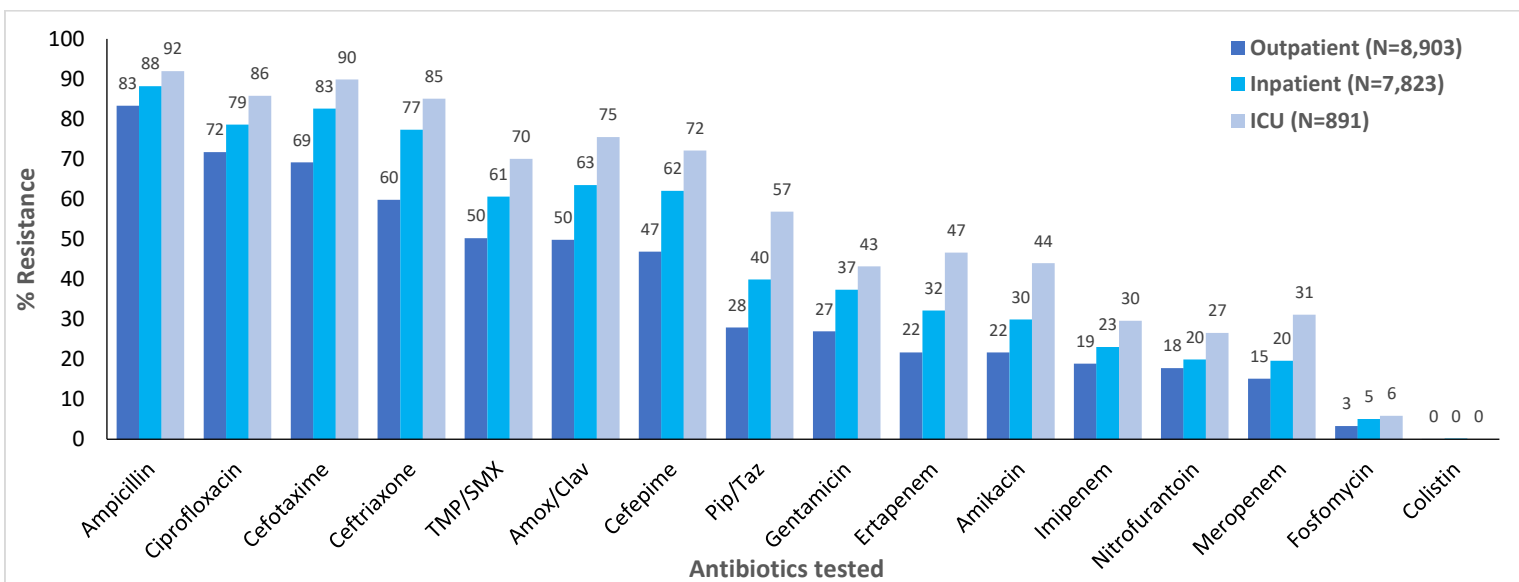


Fig. 7: Resistance profile of a) *E.coli* (N=17,617) and b) *Klebsiella* spp. (N=7,764) in urine by location type; *Location type of 464 isolates of *E.coli* and 136 isolates of *Klebsiella* spp. is unknown

Excepting imipenem and meropenem, more than 50% resistance was observed for all the tested antibiotics among blood isolates. The carbapenem resistance in *Klebsiella* spp isolated from blood was also found to be high 49% (CI: 47.4-51.3). Resistance to colistin was found to be highest in *Klebsiella* spp. among blood isolates (0.9%) followed by 0.3% resistance in other specimen types under the programme.

Notably, among blood isolates across all the location types, the resistance to all the tested antibiotics was seen higher for isolates of *Klebsiella* spp. than for *E.coli* isolates. However, contrasting trend was observed among urine isolates for all the location types. Eight isolates of *Klebsiella* sp. from blood of ICU patients and of inpatients were observed to be resistant to colistin whereas single isolate from outpatients showed resistance.

Table 2: Resistance profile of *Salmonella* serovar Typhi & Paratyphi from blood

Antibiotic tested	<i>S. Typhi</i> (N=296)			<i>S. Paratyphi</i> (N=52)	
	Number tested	Resistance (%)	95% CI	Number tested	(Number Resistant)
Ampicillin	277	3.6	1.8-6.7	47	0
Ceftriaxone	267	0	0.0-1.8	49	2.0
Imipenem	275	0.4	0-2.3	48	2.0
Ciprofloxacin	282	39.0	33.3-45.0	50	12
Trimethoprim/Sulfamethoxazole	281	3.6	1.8-6.6	48	2.0
Azithromycin	261	0	0.0-1.8	x	x
Chloramphenicol	266	1.5	0.5-4.1	48	0

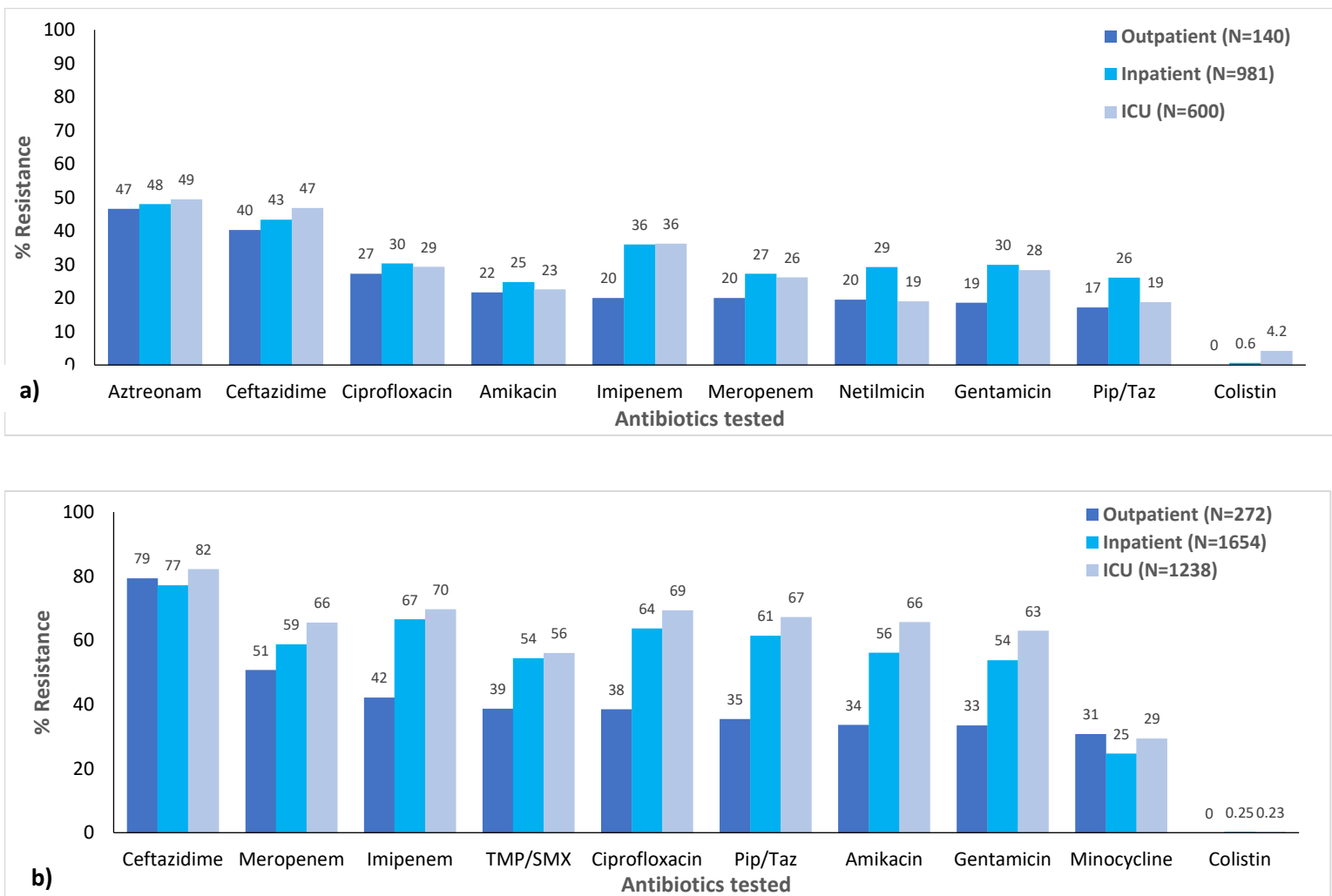


Fig. 8 - Resistance profile of a) *Pseudomonas* species (N=1,721) and b) *Acinetobacter* species (N=3,164) in blood; *Location type of 33 isolates of *Pseudomonas* spp. and 87 isolates of *Acinetobacter* spp. is unknown

Salmonella enterica ser. Typhi and Paratyphi

Of the 352 *Salmonella* enterica ser. Typhi and Paratyphi isolates reported, 4 were isolated from stool and remaining from blood specimens. In *S. typhi* and *S. paratyphi*, compared to ciprofloxacin (39%), lower resistance to first-line antibiotics namely ampicillin, chloramphenicol and trimethoprim/ sulfamethoxazole was observed. (Table 2).

Non-Fermenting Gram-Negative Bacilli

Among the Non-fermenting Gram-negative bacilli collected during July-December 2023 across the NARS-Net sentinel sites, *Pseudomonas* species (8,983, 12%) was the most isolated pathogen followed by *Acinetobacter* species (7,720; 10%) (Table 1). *Pseudomonas* species was predominantly isolated from inpatients (12 %), while *Acinetobacter* species was isolated mostly from patients in ICU—settings (20 %). (Fig.4)

Pseudomonas species

A total of 9,579 of *Pseudomonas* species isolates were reported from 8,983 unique patients. The isolation rate of *Pseudomonas* species was 12% from blood, 17% each from pus aspirates and from sterile

body fluids and 8% from urine. (Table 1)

About 54% (CI: 52.0-56.0) of isolates from urine were resistant to the third generation cephalosporin namely ceftazidime; 41% (CI: 39.4-43.5) to carbapenem namely imipenem; 57% (CI: 54.8-58.9) resistance was observed to the non-beta lactam antibiotic ciprofloxacin. Whereas lower resistance was observed in *Pseudomonas* spp. isolated from blood; 45% resistance (CI: 41.9-47.0) to ceftazidime; 35% (CI: 32.1-37.4) to imipenem and 30% (CI: 27.3-32.0) to ciprofloxacin.

With regard to reserve group antibiotics namely colistin, three isolates from blood (0.3%), six from pus (0.3%), one from sterile body fluids (0.3%) and seven from urine (0.5%) were found to be resistant.

Isolates from blood of intensive care units patients and inpatient wards showed high resistance to ceftazidime (47%) than blood of outpatients (40%). Similar trend was observed in resistance to aztreonam. For carbapenem class of drugs similar resistance was observed in *Pseudomonas* spp. isolated from inpatient wards (imipenem 36%; meropenem 27%)

and intensive care units (imipenem 36%; meropenem 26%) whereas from patients of outpatient clinics, resistance to imipenem and meropenem was observed to be lower (20%) (Fig. 8a)

Acinetobacter species

A total of 8,020 *Acinetobacter* species isolates were submitted by network sites of which 7,720 were from unique patients. Among all specimen types under the programme, *Acinetobacter* species was most commonly isolated from blood (23%) and sterile body fluids (23%), pus aspirate (9%) and the isolation rate from urine was 4%. (Table 1)

Acinetobacter isolated from blood showed 80% (CI: 78- 81) resistance to ceftazidime, similar high resistance was also observed in isolates from other specimen types namely pus aspirates 80% (CI: 77.4-81.5), sterile body fluids 77% (CI: 74.1-80.1) and urine 64% (CI: 61.2-67.1). Imipenem showed 66% (CI: 63.9-67.6) resistance in blood isolates, similar resistance was seen in pus aspirates 66% (CI: 63.4-68.1) and sterile body fluids 71% (CI: 67.8-74.3) and lower resistance was observed in urine isolates 44%, (CI: 41.2-46.8). Minocycline showed lowest resistance (23%-27%). among the tested antibiotics from all the specimen types under the programme. Five isolates from blood showed resistance to colistin, three were resistant from sterile body fluid and two isolates each from pus and urine were found resistant to colistin.

As compared to non-ICU settings, high resistance was observed in *Acinetobacter* species isolated from blood from ICU settings. Three isolates were resistant from inpatients and two were from ICU patients. Notably Imipenem resistance was as high as 70% in isolates from ICU setting and 42% in inpatient settings. (Fig 8b)

Discussion and Summary

Under the National Programme on AMR Containment, this bulletin includes aggregated data from 01 July 2023 to 31 December 2023 of 41 sentinel sites located across 31 states/UTs.

Compared to the previous year's National AMR surveillance annual report (<https://ncdc.mohfw.gov.in/showfile.php?lid=1004>), the number of sites submitting data has increased from 36 sites to 41 sites this year. The data mentioned in this report is limited to Government hospitals, majorly Medical College Hospitals as part of public healthcare systems providing primary, secondary, and tertiary care in India, and does not include private hospitals.

Over the past four years, there has been a gradual increase in the number of reported isolates in the current data reporting period. Consistent with the previous five years, *E.coli* remains the most commonly isolated pathogen, accounting for 33% of the AMR surveillance data. Among the isolated specimens, urinary isolates were the most frequently encountered, with *E. coli* being the predominant pathogen in this category. *S. aureus* was the most isolated pathogen from pus aspirates, aligning with the previous year's findings. *Klebsiella* spp. and *Acinetobacter* spp. were most commonly encountered in blood. A significant decrease in the proportion of Methicillin-resistant *S. aureus* (MRSA) in blood was observed in this data reporting period from July 2023 to December 2023 (53%) as compared to the same period of year 2022 (59%). Conversely, there was a significant increase in the proportion of Vancomycin-resistant *Enterococcus* spp. (VRE) isolated from blood culture during same reporting period (11% in 2022 to 19% in 2023). Also, blood isolates of Enterococci showed significant increase in resistance to high end antibiotic linezolid during same reporting period (0.5% in 2022 to 1.9% in 2023). Approximately 40% of *E. coli* and 46% of *Klebsiella* spp. were resistant to at least one of the carbapenems. Increase in the resistance to reserve group of antibiotics poses a call for immediate action to think out of the box to address AMR drivers and simultaneously developing and strengthening the antimicrobial policies, standard treatment guidelines and strategies focussed on strengthening local infection prevention and antimicrobial stewardship practices in healthcare facilities.

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